# ADADA+CUMULUS 2021

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December 4(Sat) ~ 5(Sun), 2021
Online Conferene, Korea

Hosted by
Asia Digital Art & Design Association
Society of Design Convergence

Organized by
Gwangju Design Center Foundation
HongIk University

# Conference Program

Day 1 (Dec. 4th)

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| 09:00-9:30 | Opening Ceremony | |
| 09:30-10:50 | General Session 1A _ TP1 | WIP Session 1A |
| | Digital Game and Innovative Devices | Digital Contents |
| 11:00-12:20 | General Session 1B _ AP1 | WIP Session 1B |
| | Digital Content for Art | UI UX & 3D Printer |
| 12:30-13:30 | Lunch | |
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| 14:30-16:10 | General Session 1C _ TP2 | WIP Session 1C |
| | Design Cases and Theory | Design Methodology |
| 16:20-18:00 | General Session 1D _ TP3 | WIP Session 1D |
| | Digital Contents | AI and networks |

Day 2 (Dec. 5th)

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# Bouncy Boids

## Moving boids using non-conventional movement methods in a real-time environment

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**Abstract**
Boid simulations have historically focussed on realistic simulation of flocking phenomenon, but with the rise in graphic technology and entertainment options, we argue that less realistic flocking behaviours are also important to consider.
Through the development of an video game, we have developed a boid simulation that primarily moves through jumping and found that additional rules need to be considered when using non-traditional boid movements. In particular, the need to predict target movement and to correct boid behaviour in case the target cannot be reached were important for successful simulations.

**Keywords:** user experience design, game design, interaction design

## 1 Introduction

Traditional flocking behaviour commonly uses 3 rules to determine boid movement[1].

- Separation: boids separate to avoid crowding (if boids get too close to one another).
- Alignment: boids align their direction with the average direction of other boids in range.
- Cohesion: boids try to steer towards other boids in range to make sure they stay in a group.

Over the years, this algorithm has been updated with various modifications. For instance, boids having a specific target on top of influence of other boids or boids swaying to avoid non-boid obstacles within the world. Other extensions include boid behaviour being compounded with effects of fear[2] or the inclusion of physics and behaviour patterns like aerodynamics and even reasons for why boids will aggregate in certain places[3]. However, the core of the algorithm has always revolved around those three rules. In recent years, complicated boid simulations have also become possible in real-time graphics applications, with a variety of flocking systems on sale for use within particular game engines[4]. With flocking systems now being possible in a wide array of entertainment mediums, it stands to reason that we may have to consider flocking behaviours that could only work in a fictional environment. In this paper, we explore one such system, where boids primarily move through jumping.

## 2 Approach

As a part of an educational effort to teach students level design, we developed a game prototype at Digital Hollywood University. In this game, the player uses various skills to solve puzzles. One of those puzzles is using a lantern to find the exit in a pitch-black maze, before the lantern runs out. However, to make this work we needed to have a valid reason for why the lantern couldn't just be relit. Therefore, we designed a monster that is allergic to light, aggregating around the player while there is light and attacking the player the moment the light goes out. To make the enemy more imposing, we made the enemy into a swarm to create an ever present threat. In line with the fantastical setting of the game, we designed a non-traditional swarm movement by opting to base the enemy on the flea[5], and use jumps as primary movement.



**Figure 1** The swarm monsters in the maze of darkness.

When constructing the flock, we found that the jumping behaviour had a number of limitations. In order to create smooth boid movement, the 3 core rules need to be applied often to update movement. However, since our boids moved primarily through jumping, we had to consider that a boid could not alter its course once it had committed to a jump. Compared to traditional boid behaviour, this meant far fewer options to apply the flocking rules and update boid movement. This led to two major problems.

1. Boids had trouble keeping up with the player. Since players have agency, players can change directions or speed at any given time while the boid is committed to the jump. This causes boids to lag or even get stuck within the death zone around the player which should, narrative wise, be lethal to the boids.
2. If the boid had a target, and the target moved higher than the maximum jump height of a boid while the boid was committed to a movement, the boid would have problems or become entirely unable to follow the target. This is primarily due to limited movement options in combination with obstacles prevent a direct path to the target.

To solve these issues, we introduced 2 additional rules.

### 2.1 Prediction

To deal with unexpected obstructions, we created a prediction rule. Initially, we simply added the current speed of the player to offset the target location of the boid determined during the jump calculation. However, since our boids can be damaged by light, we had to consider both the target's speed and location in relation to the boid's location, and found that boids needed different rules. Therefore, we added this additional rule.

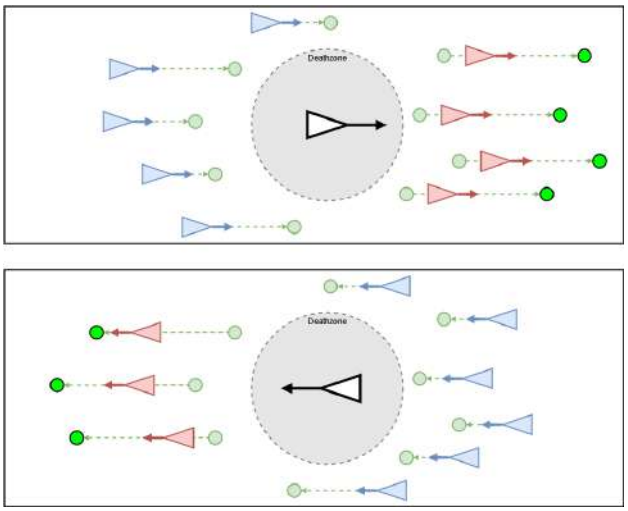



**Figure 2** Necessary adjustment for prediction based on player and boid direction and position. Bright green targets indicate the shifted target locations.

Depending on the heading and location of the main target, boids have to shift their target location to avoid getting caught in the deadzone. Red boids need to shift their target location while blue boids can aim for the original target location.

### 2.2 Correction

To deal with the boid becoming unable to following potential targets, we allow for the boid to temporarily stop using the flocking rules and instead use separate rules to approach the target again. Once a path to the target can be found using regular jumps, the boid reverts back to its default flocking behaviour.

#### 2.2.1 Performance issues with correction

Initially, we used path finding to implement the correction rule, using a custom navigation mesh that included queries on disconnected navigation mesh polygons, to generate paths that included options for jumping.

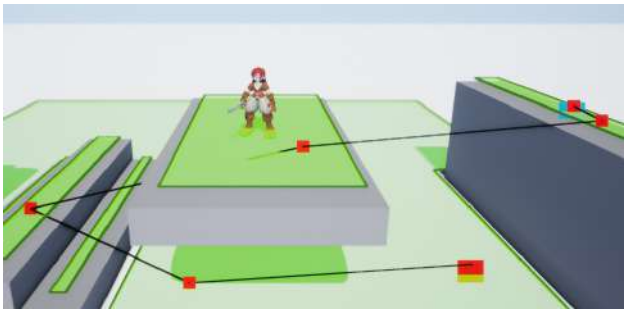


**Figure 3** Boid path finding using navigation meshes.

However, we found that a large number of path finding requests would put a large burden on the processor, causing a significant drop in frame rate. To solve the frame rate issue, we instead created emergence zones by which boids could be relocated to a location closer to the target. While this option was not optimal behaviour wise, it did significantly improve frame rate and allowed boids to keep up with the target.

## 3 Conclusions and future work

With the additional rules, the boids were able to flock to the player as a target, properly keeping up with the player or correcting their movement when not, despite the inherent limitations in their movements. However, we feel that the correctional rule in particular needs more development, and in the future wish to develop a more performance friendly path finding solution to further improve the simulation.

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# A New Claw Crane using a Moving Light - Aiming to Grab Stars in the Planetarium -

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**Abstract**
We are trying to create a new claw crane using light. Specifically, it is a game that erases the image projected on the wall or ceiling by irradiating the light using a moving light. Ultimately, we are aiming for a claw crane that grabs the stars and constellations projected onto the planetarium dome. Therefore, in this research, we will realize a program that controls a moving light and acquires the position information (coordinates) of the light by image processing to detect the collision. Currently, we are implementing a prototype with a simple mechanism and conducting simple experiments. This research is an attempt to develop games using light, and is expected to be applied to various games.

**Keywords:** claw crane, moving light, image processing

## 1 Introduction

The claw crane (Fig. 1) is a game in which players operate the crane attached to the top of the box containing the prize to grab the prize, and it is a very popular arcade game in Japan. The players operate vertically and horizontally to move the crane directly above the desired prize and try to grab the prize.

In such a claw crane, the operating range of the crane is very limited due to the size of the box. The size and number of prizes are also restricted by the size of the box. We would like to realize a claw crane with a wide crane operation range and a larger scale. This will require a major shift in thinking, reviewing all of the boxes, cranes and prizes.

From the above, we are trying to create a new claw crane using light. The main points are to eliminate the box, to make the prize a digital image, and to realize the crane using light. In other words, it is a game in which a box is removed and a prize image is projected on the wall or ceiling of the room, and the image is erased by irradiating light using a moving light used for stage production. Ultimately, we are aiming to realize a large-scale claw crane that grabs the stars and constellations projected on the planetarium dome. Currently, we are implementing a prototype of a simple mechanism and conducting simple experiments.



Figure 1: A Claw Crane



Figure 2: A Claw Crane using a Moving Light

## 2 Our Approach

In this research, we aim to realize a new claw crane. The basic policy is as follows:

- Remove the box
- The prizes will be digital images
- Realize a crane with the light of a moving light
- Get the prizes by shining light on them (images)

First of all, increase the scale of the game by eliminating the box. As a result, the conventional crane cannot be used. Based on this, the light of a moving light is used as a crane, and digital images are projected on the wall or ceiling, and these are used as the prizes. Furthermore, a prize will be obtained by

irradiating the image using light. Since the moving light can be moved 180 degrees in the vertical direction (pan) and 360 degrees in the horizontal direction (tilt), its irradiation range can be regarded as a virtual box. It has a dome-like hemispherical shape that extends upwards (Fig. 2), which is completely different from the traditional claw crane based on a rectangular parallelepiped box.

## 3 Implementation

In this research, we are implementing a prototype of an optical claw crane by superimposing two screen information (coordinates). One is the screen which displays digital images (prizes), and the other is the screen which displays a captured image in real time from a Web camera. The specific procedure is as follows:

- Project digital images as prizes (red circles in Fig. 3) on the wall (screen 1 in Fig. 3).
- Illuminate the wall using the light of a moving light (yellow circle in Fig. 3) and acquire the situation in real time with a Web camera (screen 2 in Fig. 3).
- Align the start positions of screen 1 and screen 2 above, and display image screen 1 in the foreground (screen resolution should be the same).
- Make the collision detection based on the position information of the image of screen 1 and the light of screen 2.

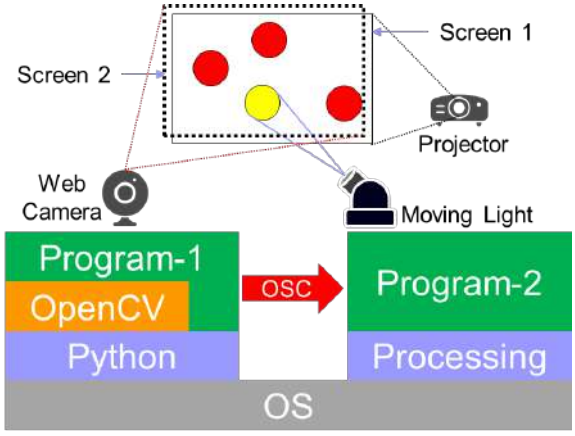



Figure 3: Prototype Implementation

In the prototype implementation, Processing is used to generate digital images as prizes, and Python's OpenCV library is used to detect the light irradiation position by the moving light. The cooperation of those programs (Program-1 and Program-2 in Fig. 3) is realized by simple OSC communication. In addition, ADJ INNO POCKET SPOT [1] is used for the moving light, and a DJ controller is used for its operation. Since the DJ controller has vertical and horizontal faders, it can be operated with almost the same feeling as a conventional claw crane (Fig. 4).

The control of the moving light is realized by using the DMX512 library of Processing (Program-2 in Fig. 3). In this way, the prototype implementation has appropriately modularized control of moving lights, generation of digital images of prizes, light detection and collision detection, and can be flexibly extended. For our final goal of a planetarium crane game, we can realize it by generating dome images of the stars as prizes, and modifying the collision detection.

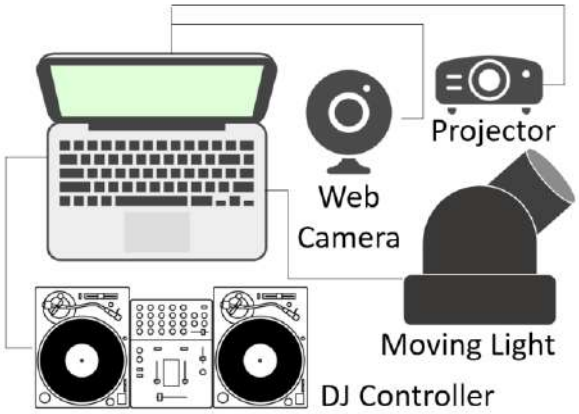



Figure 4: Hardware Configuration

## 4 Experiments

Until now, we have made a prototype that irradiates simple figures projected on the wall with light from a moving light, performs collision detection, and erases the figures (Fig. 5). In the future, we plan to extend this prototype to expand the light irradiation range. Moreover, in order to realize the dome-shaped claw crane we are aiming for, we will use dome-shaped images and light positions acquired with multiple Web cameras. Then, it is necessary to map the position information of the light to the dome-shaped images. We would like to clear the above issues and finally realize a claw crane with grabbing stars and constellations in cooperation with the planetarium.

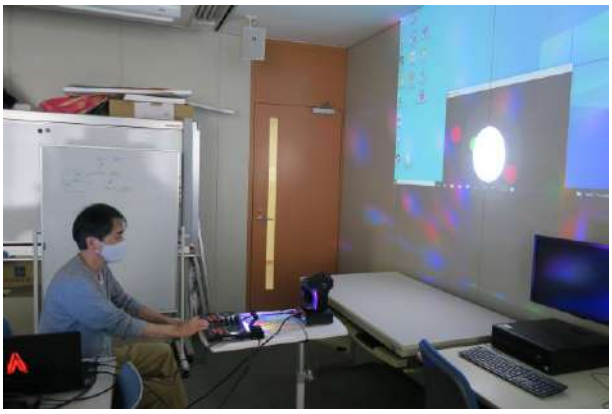


Figure 5: Experiments of a Claw Crane using Lights

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# Parametric Design Tool Development for Custom Shape Design Using Hand Feature Data

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**Abstract**
This research put forward a proposal for the development of customized parameter design tools that can be easily grasped using hand feature data (using the shape of a mouse as the experimental object). The main content of the research includes the following steps. Make full use of body characteristic data to perfect the form optimization system in parametric design (customized form design system). Combine data such as points/lines/planes on the palm to generate an Arduino+Grasshopper tool suitable for the shape of the hand. Design a shape design that is easy to hold, easy to operate, and more precise to suit the characteristics of the hand. Conduct repeated testing and achieve digitization through detailed models. Improve the fine model design method and design efficiency (thru design of customized products, and development tools to improve the customization process). The study outcomes support the design of hand-related products and products that consider physical characteristic data. We also hope to help users participate in design and customized design processes.

**Keywords:** body feature data, generative design tool, customized form

## 1 Introduction

Probably everyone has experienced inconvenience caused by purchasing improperly sized shoes or clothing or the improper grasp of the handle of an item. Except for special groups such as athletes and the disabled, few people have an opportunity to use customized industrial products.

Therefore, the goal of this research is to make full use of the basic data of human body characteristics to propose a generative design tool for a generative design method designed for specific things. Physical interaction can be used to collect body feature data (hand data) more intuitively and simply, and a custom hand shape design can be performed by generating design tools. The product form can be adjusted more conveniently and precisely through Tangible User Interfaces (TUI) and body data. This research approach is applied to develop a mouse shape for the palm of the hand.

This paper describes the concept and development process of a design tool that can develop custom shape designs for various physical equipment that interact with a human such as a computer mouse. This research attempts to find innovative points through the below three approaches:

1) Through a tangible user interface and body data, the product form can be adjusted more conveniently and precisely.

① A method to automatically transform the obtained hand data into a specific form.②A method of measuring and applying body data corresponding to the parameters required in the (mouse) design.③Recommendation of an optimal combination of these methods according to user needs and combine standardized methods to generate multiple design results.

2) Create design awareness through physical movement:

①Use more complex Arduino physical interaction to control the shape of the 3D model. Collect body data through a variety of sensors and map it to a wealth of Grasshopper morphological methods/parameters/algorithms. ② Apply Tangible User Interface (TUI): tangible, contact, sensory, physical and somatosensory design methods.

3). Apply the dynamic shape finding method to the design of the product: capture the most satisfying moments of the user in the dynamic process of parameter adjustment and shape change, making the design process and results more intuitive, such that users can easily choose the product design they want.

## 2 Related work

Generative design is an iterative design process. The designer does not have to be a human, but can also be a test program or artificial intelligence. It is a quick way to explore the possibilities of design.[2]

At present, the generative design of the products is done thru computer auxiliary design and a programmed environment (such as Rhino+Grasshopper), and a designer converts the possibility of schemes for one product and all abstract thoughts into the form of digital geometric models, thus finally having a system.[3]

## 3 Types and measurement methods of body feature data

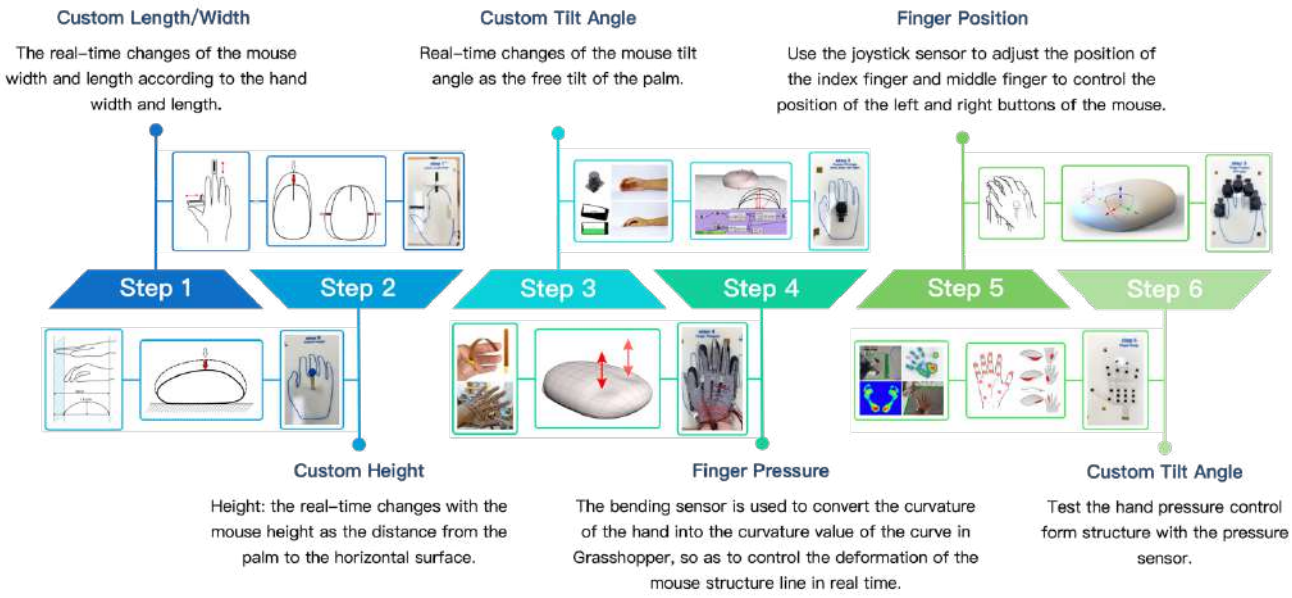



Figure 4: Hand data measurement method and morphological generation logic system diagram.

To make the product fit the natural shape of the human body to the maximum extent possible during usage, our body and spirit should minimize active adaptation to reduce fatigue. In the design, various physical characteristics data need to be considered to provide a basis for the design.

The below provides the main methods for the body characteristic data measurement:

1. Ordinary measurement and observation method
2. Photography measurement method
3. 3d digital measurement method
4. AR measurement method
5. Multiple biological sensor measurement
6. Mean measurement method, perform multiple repeated measurements to find the average value. Calculated as follows: (n is the measurement time, $X_i$ is each individual measurement value)[4]

$$\bar{\mathbf{x}} = \frac{1}{N}\sum_{i=1}^{N}\mathbf{x}_i$$

7. Standard deviation measurement.[5] The measurement formula is:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(X_i - \mu)^2}$$

These data serve as a reference for health examinations, and it will also improve all products used by individuals. In the future, the products around you may be designed for you, and the entire city may be "customized" for individuals.

## 4 Proposal of hand physical feature data conversion method

Convert the point and line data of hand into the curvature rate to control curve deformation. (Figure 4)

1). The method of converting the hand data into the curvature rate: ①Convert the size change of the hand into the curve deflection degree. (Figure 1)

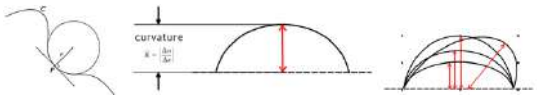



Figure 1: Use real-time hand data to change the curve curvature value and the highest point of the curvature value.

The curvature of the curve indicates the degree of the curve

②By measuring the distance between the fingertip and the wrist when the user is in a straight state and a bent and relaxed state, a reasonable mouse size and curvature of the mouse surface curve can be obtained.

2). The specific method of determining the highest point of the curve curvature value (the highest point of the palm/mouse surface):

①Measure the distance from the tip of the middle finger to the end of the base of the finger (capitate bone). (Figure 2)



Figure 2: The distance from the tip of the middle finger to the end of the base of the finger.

②The genetic algorithm can be used to calculate the position of the highest point (the point with the largest bending angle) of the curve.

3). Change the form with mechanical interference.

Kangaroo (mechanical calculation software) is used to make five spheres that mechanically interfere with the curved surface. (Figure 3)



Figure 3: Change the form with mechanical interference.

Table 1: Relationship between Hand Fit Data and Mouse Design and Grasshopper Form Changes

| Hand FIT data | | Relationship with mouse design | Relationship with Grasshopper shape change | Corresponding data collection tool |
|---|---|---|---|---|
| Size | Size | Mouse size and shape | Model size that can be adjusted in real time | Ruler, sliding resistance, rotating resistance (potentiometer), infrared rangefinder, ultrasonic rangefinder |
| | Thickness | Mouse size | | |
| | Fat content | Size, material and texture design | | |
| Usage habits | Using gesture | Angle, curvature, button layout | Adjustment of tilt angle and curve curvature, adjustment of pressure and surface curvature, adjustment of real-time button position. | |
| | Touching gesture | Touch gesture interaction design | | |
| | Left and right hand | Symmetry, button layout | | |
| | Force point | Shape, curved surface curvature, mouse bracket design, mouse pad design, wrist support | | |
| With the development of sensor technology, measurement data can be realized in the future | | | | |
| Accommodations | Disease | Functional prevention and testing for special conditions (hands can predict health and disease, and perform blood oxygen testing) | Collision mechanics and morphology (gravity, pressure, supporting force, etc.) | Thermistor, photoresistor, laser sensor, vibration sensor |
| | Hand missing | Form and function: Design for users with hand disabilities | | |
| | Blind | Braille display design, sound design | | |
| | User with depression | Reduce button noise (silence), interactive interaction | | |
| | User with high pressure | Decompression, fun function, enhanced material, special flexible material | | |
| | Elderly | Sound, display prompt | | |
| | Patient with hand trembling | Anti-shake design | | |
| Surface skin | Palm temperature | Surface material, texture, hollow, perspiration in summer, warm in winter | Real-time temperature and shape | Temperature, humidity sensor, fingerprint reader, touch reader |
| | Touch | Surface material, texture, and vibration function | | |
| | Handprint (palmprint, fingerprint) | Fingerprint recognition, palmprint recognition, surface material, texture | | |
| | Hand cocoon | Shape, surface curvature, surface material, texture, hollow | | |
| | Hair | Surface material, texture, parting line position (no hair clipped) | | |
| | Blood vessels, neurons (48 nerves, 33 arteries) | Vein detection/recognition, blood oxygen health detection, morphological structure cannot compress arteries | | |
| Muscle and skeleton | Hand skeleton (29 pcs) | Support structure | Grasshopper optimal algorithm and shape selection, movement and shape | Pressure sensor |
| | Joint (size, number) | Button density and space | | |
| | Muscle groups (123 ligaments, 35 muscles) | Button position and direction | | |
| | Acupoints | Massage, and shape and structure avoid pressure | | |
| | Hand force | Mouse weight, button sensitivity | | |
| Other information | Nails (length, nail art) | Mouse size | Changing points, lines, areas, bodies, clusters and morphological changes | Color reading sensor |
| | Race (finger ratio, complexion) | Color, size | | |
| | Softness | Button position | | |
| | Flexibility | Complicated button movement-game player | | |
| | Hygiene and epidemic prevention (cleaning) | Material, waterproof, easy to disassemble and combine, modular | | |

# 5 Develop tools to measure hand physical features

## 5.1 Develop Arduino+Grasshopper props fitting the hand form

Body data is directly converted into the data that controls the product form in Grasshopper, such as converting the bending curve of the fingers and palm into the curvature of the key structure line of the product form. Table 3 lists the relationship between specific hand data and 3D shape changes.

According to the different identities of the users and the different purposes of the users, the platform tools can provide and recommend an optimal design combination. For example, for the office family, the recommended design factor is to increase the contact area between the hand and the mouse as much as possible to reduce fatigue. For game players, the recommended design factors are customized size, customized multi-function buttons, customized weight, etc.



Figure 5: The prototype/testing process of the development platform of the Arduino+Grashopper tool that can be generated in the hand fit form.

This research developed a practical hand data measurement platform based on the relationship between the above hand information and morphology (Figure 5). The measurement platform combines various sensors through laser cutting and 3D printing. In addition, this research designed a real-time 3D model simulation system based on the conversion method of body information and shape. In addition, by linking the system with the measurement platform, measurement users can see feedback information for the 3D model of the measurement process in real time.

### 5.2 Customized mouse shape design fit to the hand data

Through the collection of actual hand data and testing of the prototype platform, the following design results were generated. The test platform uses various sensors to adjust the shape of the mouse as shown in Figure 6. This design maximizes the contact area between the hand and the mouse to reduce fatigue in long-term use.




Figure 6: Platform hand data collection and shape design process.

### 5.3 Automatically generate different styles of shapes based on physical body data in customized product shapes

According to the biological evolution law in nature, a genetic algorithm is used to simulate and generate a variety of forms (Figure 7) and recommends the best forms for users to choose. The specific method is to simplify the target form into several simple basic form combinations. The designer extracts the parameters of the basic form and generates a variety of target forms by changing the parameter combinations of the basic form within the set range.

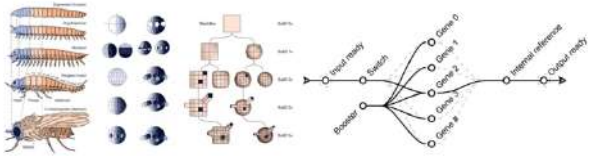


Figure 7: Gene-Regulation for Digital Architecture.[6]

For example, in the figure above, a circular tube shape is generated by lofting three circular curves, and then the diameter and curvature of the three circles are changed respectively to obtain a variety of combinations and generate a variety of shapes. (Figure 8) The multiple morphological results generated can be compared and observed at the same time for further selection and operation. The following figure generates a variety of mouse shapes by changing the basic parameters.



Figure 8: Generate multiple target shapes by changing various parameters of the basic shape

Users can check the design history to view all the shapes generated and choose the shape they like by comparison. If users are not satisfied with the generated results, they can return to any historical step at any time to reselect. (Figure 9)

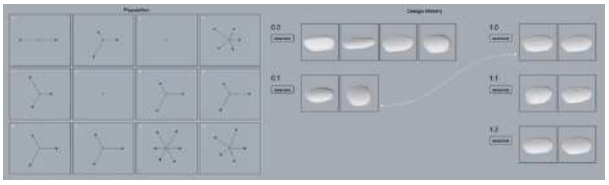


Figure 9: Population and Design History

## 6 Conclusion and future work

The aim of this research was to develop a customized parameter design tool that can be easily grasped using hand feature data. However, there are many shortcomings in this research, for example, the interactive mode of the hand data measurement platform is relatively cumbersome; and the Grasshopper algorithm does not work well with the real-time 3D model demonstration and needs to be further developed.

The following future work addresses these shortcomings: ① Simplify the measurement steps and integrate them into one glove. ② Networking: use existing sensors of nearby electronic devices (mobile phones/computers, etc.) ③Users can use the existing sensors of their electronic devices (mobile phones/computers, etc.) to implement online customization, online editing (ShapeDiver), and online gesture recognition. ④Use tool for other hand to fit customized products, such as a keyboard, handle, hand, and so on. (The method of transforming body data into form is rationalized and systematized. Optimize the physical test platform to make it more convenient to be applied to the measurement of other hand products. Explain the feasibility of application to other products and test the actual products.) ⑤Customize mouse design style and CMF. ⑥Add content of a user study: user customization research and user testing of the platform.

## Acknowledgements

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# Evaluation of Colour Attributes for Kawaii Robots using Biological Signals

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**Abstract**
Recently service robots are widely used in daily life. Their appearance plays a huge role in the first impressions and attraction toward people. Many studies attempted to improve the impression on robots by applying Kawaii attributes such as colours, shapes, and motion. However, the impression evaluation for the attributes of Kawaii robots using such objective evaluation as biological signals is not yet sufficient. Therefore, we aim to investigate the impression of Kawaii robots in terms of colour attributes using an integration of electroencephalogram (EEG) and pulse measurement. Two colour attributes, saturation and brightness, were used as Kawaii features applying to the appearance design of the robots. The results from biological signal measurements were compared with subjective evaluation to estimate the impression of colour attributes for Kawaii robots.

**Keywords:** Kawaii, Biological Signals, Kansei value, Robot

## 1 Introduction

Kansei engineering, a consumer-oriented methodology that has been recognized as an important role in broad range of Japanese manufacturing. It is defined as "a kind of technology that translates the customer's feeling (Kansei) into design specifications [1]. In Kansei engineering, "Kawaii", a Japanese word that denotes "cute", "loveable" and "charming" [3], is one of the Kansei value that plays an important role in worldwide success of many products, is considered as a key factor for future product design and development [1]. Recent studies attempt to quantitatively clarify Kawaii-ness of various attributes such as colours, shapes, motion of an object [3]. However, research regarding impressions of Kawaii attributes applied to products, especially robot is not yet scrutinized. Recent years, the high demand of robots was because of declining birthrate and aging population, especially in Japan, which was causing a huge issue. Therefore, robots are expected to work on behalf of humans in various environments such as entertainment and mental commit. For example, robots such as aibo [7] and PARO [8] give human a sense of well-being due to their good appearance and movement [6]. Which is why, one of the reasons that Kawaii attributes are recommended for robot is because of having a Kawaii design brings a good impression on the robot product. This study investigates the effect of colour attributes (i.e. – saturation and brightness [2]) on the impressions of Kawaii robot. The biological signals integrating electroencephalogram (EEG) and pulse measurement, are used for investigating the impressions of the Kawaii robots with different saturation and brightness.

## 2 Experiment Method

### 2.1 Robot Design and Development

To design Kawaii robots, we selected 3 Kawaii colours (Rose, Chartreuse, Orange), 1 non-kawaii colour (Blue) picked from previous study [3], and 1 gray scale. All of the colours were adjusted by 2 different saturation levels (75% and 50% decreased), and 2 different brightness levels (25% increased and decreased). The reason of picking 75% and 50% saturation is because the difference between them is observable, whereas saturation lower than 50% is consider too dark. Also, all the

brightness of the normal colours (Orange, Rose, Blue, Gray, Chartreuse) are set to 50%. Thus, we to evaluate the impression of brighter and darker in colour. As a result, 5 robots were obtained for each of the colours (Figure 1). Therefore, 25 robots are obtained in total (Figure 2). All of them were developed in 3D space using Unity.




Figure 1: 5 robots in orange colour with different saturation and brightness levels

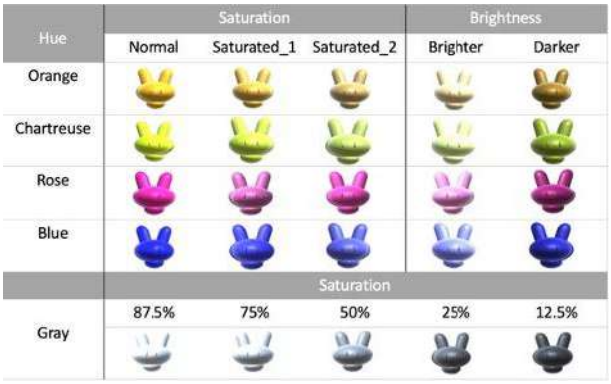



Figure 2: 25 robots with different colours, saturation levels and brightness levels

### 2.2 Biological Signal Measurement

From previous study [5], biological signal including EEG and HRV were successfully used to estimate emotions for robot interaction. Therefore, we also employed the same biological signals in this study. We measured EEG data using MindWave Mobile 2 (NeuroSky Co., Ltd.). Attention and Meditation were used as EEG indices, which can be obtained using NeuroSky's original algorithm [4]. Heart rate variability (HRV) was measured from pulse sensor (SwitchScience). pNN50 was used as HRV index, which can be used to estimate pleasure-unpleasure degree [5].

### 2.3 Questionnaire

Seven-point Likert scale questionnaire was used to evaluate the degree of Kawaii-ness towards the robot, from low kawaii degree (rating = 1) to high kawaii degree (rating = 7) (Figure 3. Also, questions asking how much tiredness participants felt during the experiment were also listed.

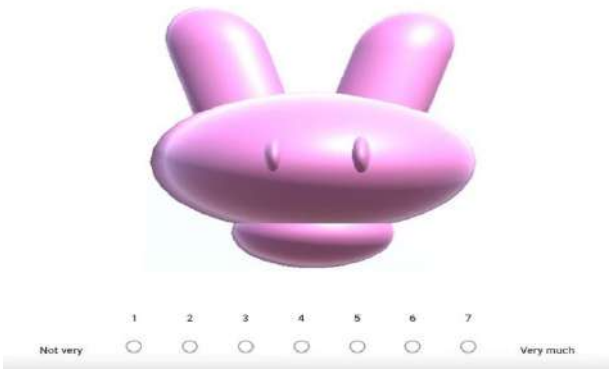



Figure 3: Questionnaire

### 2.4 Experiment Procedure

The experimental procedure is as follows:

1) Participants put on EEG and pulse sensor. Their biological signals were measured throughout the experiment.
2) Participants look at empty screen for 40 seconds (resting condition).
3) Participants look at one robot for 20 seconds.
4) Participants look at empty screen for 20 seconds (resting condition between stimulus).
5) Steps 3 to 4 are repeated 4 times with different colour attributes (brightness or saturation).
6) Steps 2 to 5 are repeated for the other 4 colours.
7) Participants answer questionnaire after the experiment.

## 3 Experimental Results

### 3.1 Participants

Eight volunteered participants (7 males, 1 female) in their 20's were recruited in the experiment. Prior to the experiment, they were asked to confirm themselves to have no colorblindness.

### 3.2 Results from Biological Signal Measurement

#### 3.2.1 EEG Result

The results of Attention show that the Rose colours are slightly higher than the other colours. Participants tended to focus more when looking at Rose colours.

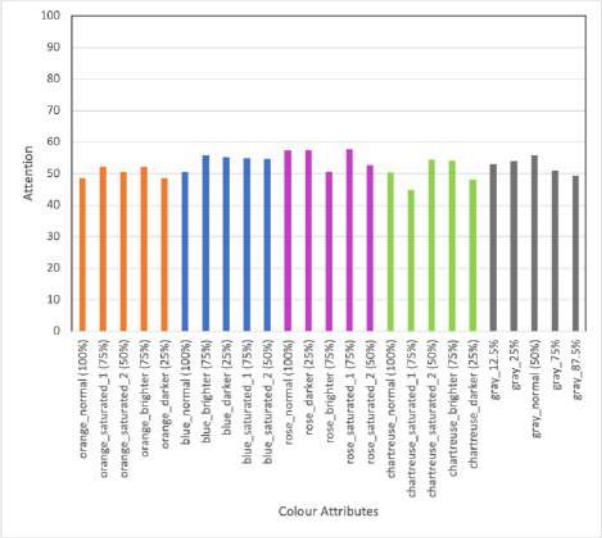



Figure 4 Attention result

The results of Meditation also show that the Rose colours are slightly higher than the other colours. Which show that the Participants tended to feel more relax while looking at Rose colours.

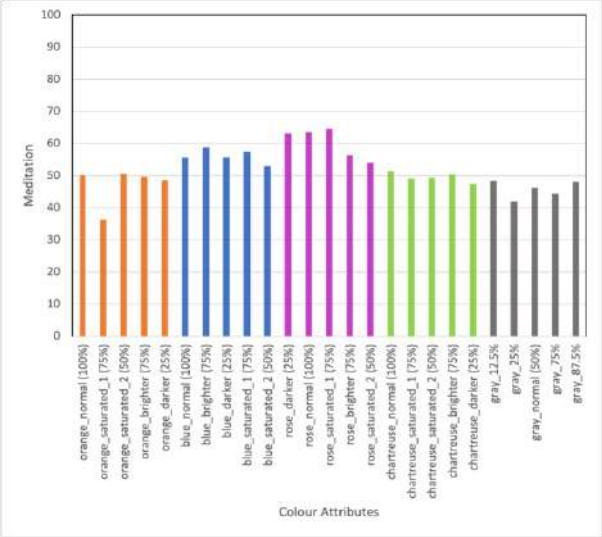



Figure 5: Meditation result

### 3.2.2 HRV Result

The results of pNN50 show that the Orange colours are slightly higher than the other colours. Participants tended to feel more comfort while looking at Orange colours.

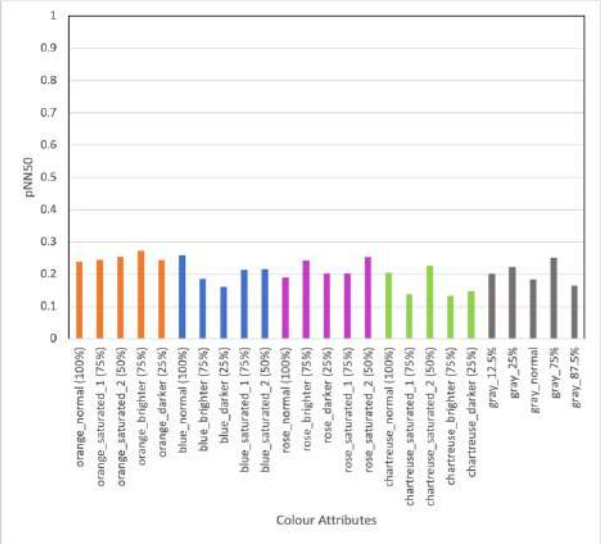



Figure 6: pNN50 result

### 3.3 Results from Questionnaire

The robots with Blue_Brighter and Chartreuse_Saturated_2 colours were rated as the most Kawaii with an average score of 5.125. On the other hand, the robot with Orange_Darker colour was rated as the least Kawaii with an average score of 2.

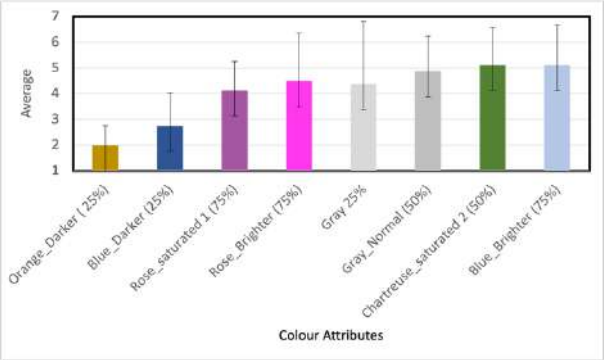



Figure 7: Questionnaire result

### 3.4 ANOVA results

One-way ANOVA was performed to compare the effect of colour attributes on Attention, Meditation, pNN50, and questionnaire result, among the five robots with different saturation/brightness of each colour. However, there were no statistically significant difference between any pairs of the robots for all colours.

## 4 Discussion

From the observation of average values, we obtained certain tendencies of the differences in biological signals among the robots with different colour attributes. These results suggest the possibility to use biological signals to evaluate the difference in impression of Kawaii robots. However, we could not clarify our experimental results from statistical analysis yet possibly due to small differences among the robots. We presumed that the static images of robots may be insufficient to evoke strong impression enough to clarify statistically.

Moreover, the questionnaire result is not consistent with the results of the biological signals. Since the participants kept

looking at similar robots for several times and the questionnaire was answered at the end of the experiment, they may feel tired or bored during the experiment, which was also reported by the participants themselves. Those feelings may cause inaccurate result in the biological signals and the questionnaire, which may lead to the mismatch between them. Further study is required to clarify this issue.

## 5 Conclusion

This study investigates the effect of colour attributes on the impressions of Kawaii robot using biological signals. We only obtain the clues that different saturation and brightness may affect the impression of the robot, however, we could not clarify the results statistically yet. Our future work will further consider the experiment setup, increase the number of participants, and include robot animations or voice to evoke the biological signals.

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# Modern but Friendly: An Exploration of Crutches' Form Design

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**Abstract**
Crutches are designed to help people walk; however, most people consider using crutches as aged or disabled. Nowadays, most crutches follow their traditional form. A few crutches are designed in a "modern" fashion. We survey 101 participants about the impression of 20 crutches from a collection of 50 items. A questionnaire with six items in 2 constructs is designed to analyze participants' perception of the crutches' form. The result shows that, although the "modern" form does show a different impression, it is significantly unfamiliar (distanced) to users. Based on this result, we suggest designing crutches in a "modern" but "familiar" manner so that the elderly users can accept the usage of these walking aids at an earlier stage. To this goal, we finally suggest two design strategies to shape the crutches.

**Keywords:** crutch, design for elders, product semiotics

## Introduction

Functionally, crutches are assistive tools to help people walk. In the contemporary age, crutch users are either the elders or the disabled. Due to the specific user groups, crutches as assistive tools are usually associated with some negative identity. Although crutches are necessary to prevent injury in advance, the elders tend to reject the use of such assistive tools due to the negative image [1] [2]. In fact, the stereotypical impression of aging and weak has existed for a long time. Some crutches are designed in a rather fashionable way to prevent this prejudice and motivate people to use crutches in a needed situation. However, the new designs are rarely commercialized. A potential reason is that, although the "modern" form of the crutches does avoid the negative impression, the form features might yet be "unfamiliar" or "strange." We, therefore, conducted a survey and analyzed the formal impression of different crutches.

## Related Works

The essential factor of the crutches' negative impression is users' experience of the artifact. It is the inconvenience that motivates users to use crutches. Although the artifact is supportive, the experience is always associated with a rather pessimistic scenario. Besides, many reported difficulties when using crutches [3]. The negative emotion further influences the elder's decision to use assistive tools [1].

Despite the subjective experience, the social impression of the assistive tools is also a factor that discourages users from using crutches [4]. For example, using crutches under a general perspective is a sign of frailness and aging. Being aware of this, users feel embarrassed when using crutches. In order to design persuasive assistive tools, what is considered socially "normal" must be integrated into designer consideration [5]. Two researchers found in their experiment that products with innovative appearance can evoke a positive impression [6]. However, people would consider them as unfamiliar.

Finally, not only does the form of the crutches play a role in crutches' impression, but also the material has symbolic meaning. Additionally, the material also can affect the product's meaning. Using different materials to design products is able to affect the impression. Furthermore, products that use similar materials (i.e., different types of plastics) also can create different attributions [7].

## Experiment Design

Our goal is to design crutches that have a modern form without distancing their users. To study the impression of crutches related to users' social perception, we identified two pairs of form descriptions - modern-retro and familiar-unfamiliar. Modern-retro should represent the degree how the negative impression is attached to the crutch. In other words, the "modern" form should have more degrees of freedom for creating a new product impression. The axis of familiar-unfamiliar represents the easiness of users to accept the form.

We then select 20 crutches (full-color images) from a collection of 50 samples. The selection was made within a peer survey. A questionnaire with four descriptions as four individual items in 7-points Likert scales was used for scoring. In this stage, a reliability test already shows that the item of modern and familiar have a negative correlation. According to the final result, we selected four crutches with the highest score in each measure (16 objects win total, see table 1). Compared to other categories, the crutches in familiar have lower scores. A potential explanation is that the participants in our pre-measurement are not crutches' users. Finally, we added four objects with the most neutral scores in all measures to our selection.

Table 1. Scores of the Selected 20 Crutches.

| category | selected crutches and the corresponding scores | | | |
|---|---|---|---|---|
| modern |  5.7 |  5.8 |  5.6 |  5.4 |
| retro |  6 |  5.1 |  5.3 |  5.5 |
| unfamiliar |  5.8 |  5.5 |  5.1 |  5.4 |
| familiar |  5.1 |  4.5 |  5 |  4.9 |

In the formal survey, we designed a questionnaire with six items categorized under the two constructs (see Table 2). The 6 items are semantic differential scales (7-points), and 3 are presented in reversed order. In addition, each participant was asked to give 3-5 descriptions to five randomly presented crutches. We made an online questionnaire and received 101 valid samples (female = 63, male = 38; for age distribution see Table 3).

Table 2. Items in the Formal Questionnaire
(original in Chinese, translated in English)

| construct | items (Chinese) | items (English translation) |
|---|---|---|
| retro-modern | 復古-現代 | retro-modern |
| | 懷舊感-科技感 | traditional-technological |
| | 傳統-創新 | conservative-innovative |
| familir-unfamiliar | 熟悉-陌生 | familiar-unfamiliar |
| | 普通-特殊 | common-special |
| | 常見-獨特 | ordinary-strange |

Table 3. Participants Age Group Distribution

| Age group | Number |
|---|---|
| Under 30 | 41 |
| 31~40 | 17 |
| 41~50 | 21 |
| 51~60 | 16 |
| Above 61 | 6 |

## Results & Analysis

A reliable test shows acceptable internal consistency (Cronbach's α = 0.703) of all the 6 items, excellent consistency in the construct of retro-modern (Cronbach's α = 0.921), and good in familiar-unfamiliar (Cronbach's α = 0.896). The crutches are distributed linearly with a significant and negative correlation (rs = -.755, N = 2020, p = .000). Figure 1 shows the mean score of the 20 crutches on a coordinate with the horizontal axis to measure modern-retro and the vertical for familiar-unfamiliar. The result is consistent with our hypothesis – the "modern" crutches are less familiar to the users, while the familiar form is directly related to an impression of "old style." If we observe their forms, the crutches in the bottom-right (modern and unfamiliar) quadrant are curved and achromatic. Additionally, they are made of metal or plastic. On the contrary, the crutches in the top-left (retro and familiar) are often made of wood in a straight form.

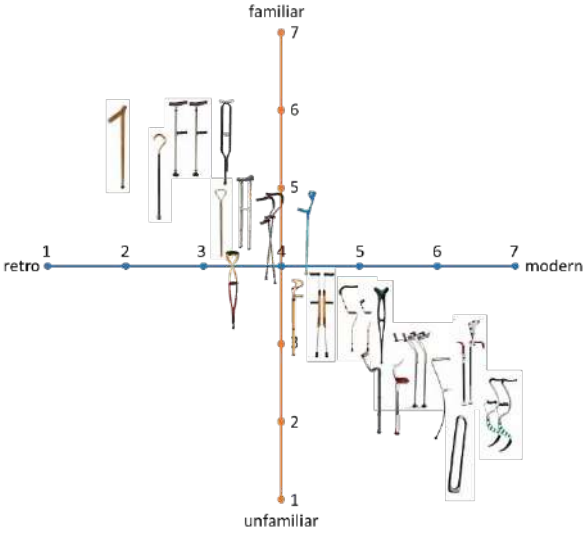



Figure 1. Crutches Overall Mean Score Distribution Chart

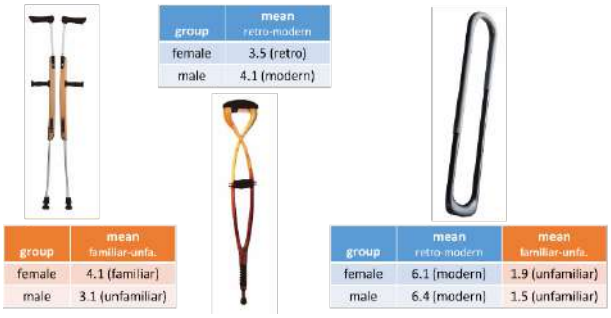
The overall scores between different gender and age groups do not have a significant difference, except for a few specific crutches (see Figures 2 and 3). These crutches are generally in the central area of the coordinate. However, the significant difference is still interesting to us. In Figure 2, the left two crutches are significantly scored as less "retro" in the elder group (age > 40), and, interestingly, they both present a woody material. The association of wood material with a retro impression is more considerable in the elder groups.




Figure 2. Crutches with Significant Difference between Age Groups

Except for the age difference, we found some gender differences in the evaluation of the crutches (Figure 3). Male participants considered these crutches are more unfamiliar and

modern than female participants. Since there is no solid theory suggesting gender difference in the preference of form and material, the difference could have resulted from the bias of responding attitude.



| group | mean retro-modern |
|---|---|
| female | 3.5 (retro) |
| male | 4.1 (modern) |

| group | mean familiar-unfa. |
|---|---|
| female | 4.1 (familiar) |
| male | 3.1 (unfamiliar) |

| group | mean retro-modern | mean familiar-unfa. |
|---|---|---|
| female | 6.1 (modern) | 1.9 (unfamiliar) |
| male | 6.4 (modern) | 1.5 (unfamiliar) |

Figure 3. Crutches with Significant Difference between Gender

Besides, in order to understand the content of the formal impression, verbal descriptions were analyzed. Descriptions for the retro-familiar corner are (translated in English; see Figure 4 for the original Chinese) *simple, retro, traditional, nostalgia, ordinary, old-fashioned, common, textured*. Comparing to this, the descriptions for the bottom right corner are (translated in English; see Figure 5 for the original Chinese) *technological, modern, special, strange, innovative, trendy, weird, fashionable*. As for the central, we see, unfortunately, a mixture.




Figure 4. Participants' description of the crutches at the top left corner




Figure 5. Participants' description of the crutches at the bottom right corner

## Discussion & Future Work

Our goal is to define a modern but, in the meantime, familiar form for crutch users. An ideal crutch should invite people to use it before they are already in a disabled condition (too old). A better impression should benefit from developing a fit habit of using the product. With the habit of using the crutches, the experience of being disabled will also become less significant. To understand the potential strategy of our form design, we marked the crutches with similar properties on the coordinate. The first selection in Figure 6 shows the crutches with wood material. Generally, these crutches are evaluated as less modern but more familiar. Material familiarity and identity should be the first concern of our future design. Crutches in Figure 7 are with significant combinative looking, such as material combination and color contrast. In combinative form language, we see the modern-unfamiliar crutches are color-centered, while the retro-familiar ones are material-centered. Finally, in Figure 8, we see that the crutches with exaggerated curved forms are considered modern and unfamiliar. Using curves to present new designs can be a potential strategy. However, it also leads to strange experiences.

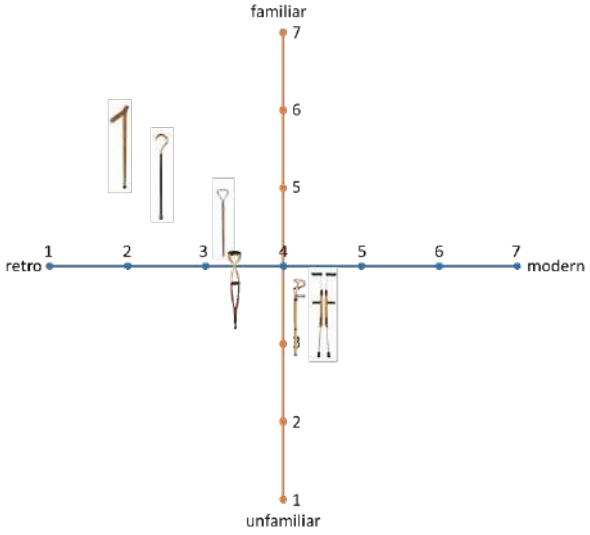



Figure 6. Crutches with Wood Material/Surface

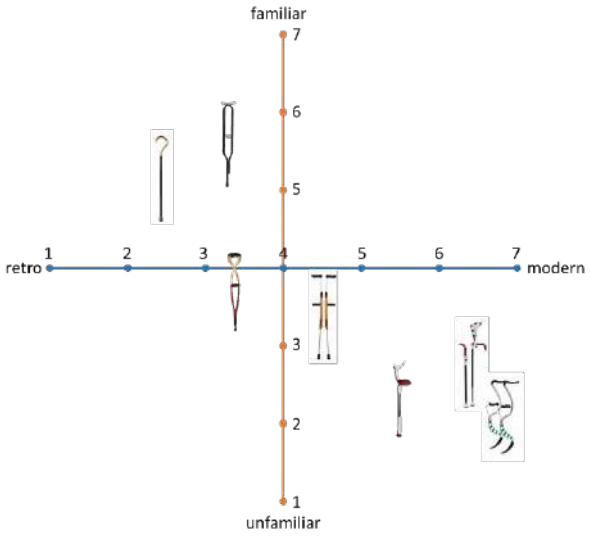



Figure 7. Crutches with Combinative Features (Material Combination or Color Contrast)

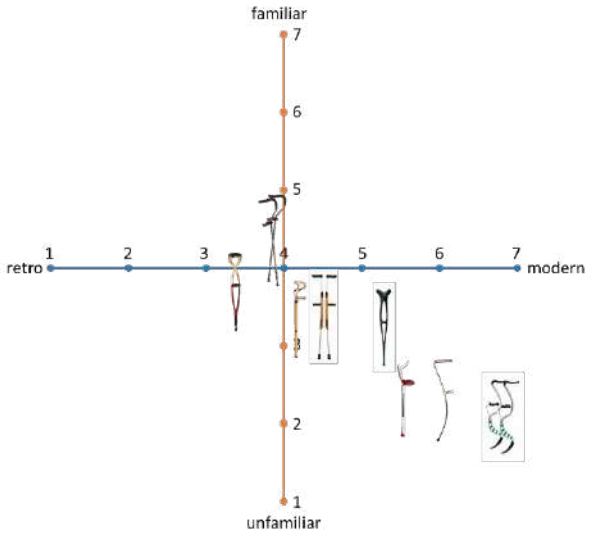



Figure 8. Crutches with Large/Unusual Curved Features

According to the analyses, we suggest two design strategies. First, a modern but friendly form could be created by combining the modern and luxury material with a traditional form, allowing users to quickly identify the products' function but experience a valuable quality of the form. Second, to assign the crutches a new form without causing strange experiences, adopting the form of other daily objects, such as an umbrella, can be an alternative and clever strategy. We can imagine a humorous design made by this strategy that shifts the first impression of the crutches away from the old and negative stereotype. With these strategies, our future work is to finish the design practically and evaluate the new design.

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# DESIGN THINKING FRAMEWORK IMPLEMENTATION IN YENAIZ SPECIAL SCHOOL TANGERANG INDONESIA

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**Abstract**

The development of visual communication design has always been dominated by industrial advancements and the resulting commercialization. Design, under the new paradigm, is no longer focused on commercially oriented items, but has become community-centered with all of its social concerns, including the community as stakeholders and being more collaborative. The final objective is to demonstrate how visual communication design can improve the social life of the community and the surrounding area. Schools for children with special needs have the right to the attention and assistance of designers in order to solve some of their problems. Yenaiz special school is one of the special schools for students with disabilities in Tangerang City that have a myriad of issues with the learning process, teaching materials, and communication in learning, particularly during this pandemic. Using the Design Thinking approach, designers are expected to be able to identify the essential problems that occur throughout the teaching and learning process at the Yenaiz special school, as well as to discover innovative solutions and make them a reality through organized phases.

**Keywords:** Design Thinking, Special School, Visual Communication Design

## 1 Overview

Yenaiz School in Tangerang is a special school founded by Izak Timisela and his wife, who are concerned about the education of children with special needs, particularly children with disabilities. This school became a reference for special schools with disabilities in its surrounding area over the course of its journey because the school had very adequate facilities and teachers in leading the learning process. On the other hand, teaching materials for special schools are regarded as inadequate in terms of helping the learning process because the teaching materials provided by the government are the same as those provided to regular students in general, and there are very few teaching materials that are appropriate and cater to the needs of students with special needs.

Given the importance of teaching materials and methods in special schools, the involvement of designers is required to create more innovative and effective learning solutions. Stanford's Design Thinking approach provides a learning foundation for design students to understand the challenges holistically in order to find answers and actualize them in the form of design solutions. This approach is expected to aid in solving the problems of teaching animal recognition to visually impaired children in elementary school, sentence structure to hearing-impaired children, and mathematics to children with Intellectual disabilities at Yenaiz Special School. Based on the problems above, the research questions are as follows.

1. How can the implementation of design thinking solve the problems of learning animal recognition for visually impaired children, learning sentence structure for hearing-impaired children, and learning mathematics for children with intellectual disabilities?
2. What is the response to the resulting solution using a design thinking approach?

The aims and advantages of this study are

1. Assist Yenaiz special school in providing learning media design sokutions for students and teachers
2. Understanding the importance of the design thinking approach in design solutions
3. Encouraging designers' awareness of social issues and creative solutions through design.

The Limitions of this study are

1. Case study at Yenaiz Special School in Tangerang
2. Case studies in the form of learning media to recognize animals for visually impaired children,

learning sentence structure for hearing-impaired children, and learning mathematics for children with intellectual disabilities

3.

## 2 Theoretical reviews

Main objective of Design thinking is to provide solutions on problems and needs for the community. In its implementation, the thinking design is very suitable for Design for Society course because this method is relevant to Problem Based Learning (PBL) simulation. The *design thinking* method in IDEO (2016: 13), has a *human centered* aspect and a spirit of collaboration. *Human centered* directing students in the design for society class to establish empathy for the surrounding community and collaboration is how students will work on projects alongside to find problems and learn to find and realize solution that have a direct impact on communities [1]. The advantages of Design Thinking according to IDEO (2010) [2] connecting the organization with the people it serves, 2) transforming data into realizing formulation of ideas, 3) seeing opportunities for new innovations, and 4) the acceleration and effectiveness of creating new solutions. Of the Design Thinking method when it is introduced by various versions and stage models, one of them is the 5 stages of the Stanford University Design Thinking method. The five stages of MDT according to Stanford University - Hasso Plattner Institute of Design [3] are:

1. ***Emphatize,*** is the first stage that focuses on understanding and mastering the problem to find a solution. In this phase, it is expected that designers are able to enter the world of users, understand their perspective on their encountering problems. Deepening the problem from user's point of view will help produce relevant solutions according to the user's problem conditions.
2. ***Define,*** the second stage is data collection from the first stage, then analyzed and synthesized to obtain core of the problems encountered by users.
3. ***Ideate,*** the third stage, where there is a process that creates a solution. At this stage, it is expected that innovative ideas will emerge from the point of view of a creative person, resulting in new possible solutions. From the discussion process, these solutions will produce the relevant main solution and implemented in the field.
4. ***Prototype,*** The fourth stage embodies ideas into design work and visual into prototypes. This process is the first step in internal testing and obtains an idea of whether the design and visual work will be relevant and able to provide the expected solution.
5. ***Test***, The fifth stage is the overall testing including prototyping and obtaining feedback from users. This testing stage can be executed repeatedly, so, the proposed solution can be found according to the designer's expectation for potential users.

## 3 Methods

Stanford's five-phase Design thinking approach was utilized in the design process. The first one is Emphatize. This phase is carried out and goes straight to the object of study by using research data collection methods such as observations, interviews, and focus group discussions with stakeholders. The next phase is Define. In this phase, the data analysis to map possible problems, identify problems, and formulate the core of the problem is based on the findings of observations, interviews, and focus group discussions. The third phase is Ideate, which is the process of formulating relevant alternative solutions to answer problems using design approaches. In addition, this phase also involves the design visualization process from raw materials into a design medium through digitization. The fourth phase is Prototype, which is the process of implementing and finalizing the design that was started at the conceptual stage by focusing on components of prototype production so they can be ready to be tested in the field. The last phase is Monitoring, Evaluation, and Review. This is the phase in which the prototype is evaluated by the stakeholders and users and the findings are recorded. The results of this evaluation will be used to improve and refine the prototype before it is produced and used.

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## 4 Implemetation & Results

### 4.1. Emphatize Phase

Data mining is carried out in this phase by utilizing a qualitative approach through observation, interviews, focused group discussions, and online interactions with management, teachers, and students to identify possible problems in the school. It is believed that data mining would allow for the identification of prospective issues that may develop in the study object chosen.

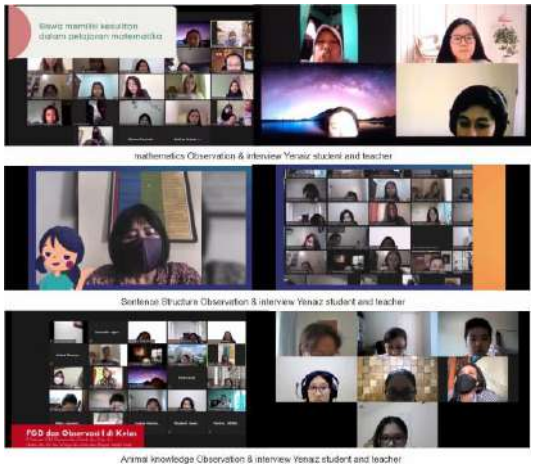


*Figure 1 : Emphatize Process*

## 4.2. Define Phase

At this phase, the problem identification process is carried out as well as the problems formulation through the affinity diagram and fishbone methods. The creation of a project plan also included in this phase

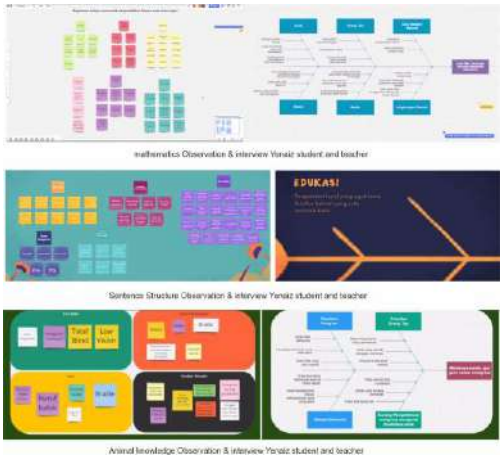



*Figure 2 : Define Process*

In the case of hearing-impaired children's mathematics lessons, the primary issue is the level of basic understanding of mathematics in the form of multiplication and division, which is regarded as more difficult to grasp through sign language. Meanwhile, the challenge encountered for sentence structure language lessons is the difficulty of children with Intellectual disability in constructing the correct sentence structure and being frequently confused. As for the visually impaired children, the encountered issue is understanding the material on animal anatomy that can only be gained through braille text, and they didn't have previous knowledge of the shape of the animal object.

## 4.3. Ideate Phase

This phase is the continuation from the previous stage, namely, identifying problem and determining the design solution by formulating goals, gathering alternative solutions, generating possible ideas, formulating finalization of ideas, and executing designs.

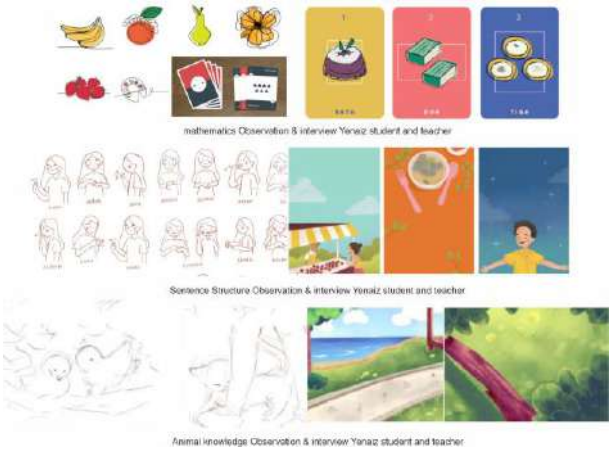



*Figure 3 : Ideate Process*

The solution for teaching mathematics comes in the form of a "palkaba" multiplication and division simulation card and a QRcode that contains a video showing how to play a complete simulation using sign language. Lessons on word structure in sentences utilizing interactive book solutions and the off-paste approach. Each sentence structure is turned into a puzzle and a guideline is provided to help students adjust the correct sentence structure. Lessons for visually impaired children will be created using a story-based book design that combines text and visual elements. The images or visuals are made by utilizing braille techniques so that students can imagine the shape of the picture

## 4.4. Prototype Phase

This phase involves completing and digitizing the design sketch that has been created. The design process is also implemented in the relevant media. The object of design for mathematics teaching materials "palkaba" focuses on the production of simulation cards, video game simulations using sign language and packaging design. For sentence structure teaching materials, the object of design focuses on completing the illustration design, interaction techniques, layout, letters and learning methods. Meanwhile, animal learning design focuses on designing image textures that are easy to touch for visually impaired children, as well as the backgrounds and braille text narrations.




*Figure 4 : Prototype Process*

## 4.5. Monitoring & Evaluation Phase

This stage involves testing design prototypes that are ready for production in order to get feedback from users and stakeholders. Because of the COVID-19 pandemic, online testing is conducted. Interviews, virtual testing, and the preparation of user response questionnaires are used in testing. The feedback results will be utilized as a measuring tool for achieving the design objectives and for evaluating the design to make changes and refinements.

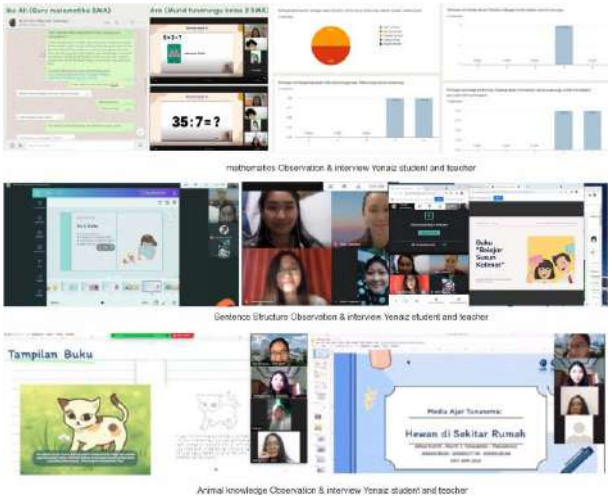



*Figure 5 : Monitoring, review & evaluation Process*

Stakeholders gave favorable feedback on some of the tests and evaluations. According to the evaluations, the designs can make children with special needs excited about learning and making it easier for teachers and parents to explain. There were other problems associated with the mass production of previously created designs, such as the price of the teaching media, which had to be competitive and easily accessible, as well as the production processes related to materials used and manufacturing.

## 5. Conclusion

The Design Thinking approach is thought to be capable of providing direction in a methodical process that designers can easily understand in developing designs that are on target.

The application of this sequential method guides designers around concrete and focused problems and finds creative solutions based on dialogical activities between designers as well as between designers and stakeholders. This stage also allows stakeholders to share their expertise or recommendations that might aid in the designing process.

The case study at the Yenaiz special school provides concrete evidence that the design thinking framework can produce different but on-target innovative ideas that have the potential to be used in the field. The response and enthusiasm of the teachers and students of special schools during the evaluation stage by conducting simulations were able to build a positive response to the improvement of design projects that were much more effective and efficient when they were produced and implemented. In general, it can be concluded that visual communication design is able to offer different creative perspectives in helping to solve social problems that exist in society.

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# Automatic Generation to Assist in Package Design: The Case of Chocolate by Price Range

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**Abstract**
The goal of this study is to automatically create a chocolate packaging using price as the primary indicator. Before agreeing on the package, a designer must spend time deciding on the concept and target audience, coming up with product names, visuals, and slogans, and then designing variations. To gain profit, the product must be provided at a price that is appropriate for the target market, and the packaging must not be too cheap or too expensive but must look to be right.
We trimmed only the package part of the image after taking it and loaded it into "Color Spatioplotter" to analyze the colors used in the packaging by visualizing colors. The chocolate we purchased and gathered will be used as a data set for the package that will be generated automatically. The four design elements of the chocolate to be used in this generation are: background color, concept, product name and illustration/photo. By modifying these elements such as color and layout, we can automatically generate the packages. Depending on the given price parameters, we can change the attributes of each item and decide to place the item on the package. Packages are automatically generated in this study utilizing the quantitative parameter of pricing, making it simple to obtain design ideas from the generated packages. A considerably larger data set and further complicated analysis would be required to objectively check whether the designs automatically generated by this technology are compatible with the price range.

**Keywords:** package design, price, automatic generation

## 1 Introduction

This research is an automatic generation and assistance of package design, and particularly in this case, considers chocolate packaging for the research topic. It takes an enormous amount of time for a designer to decide on the concept and target audience, think of the product name, illustrations, slogan, and then create variation, and decide on the package from there. When designing, there is a need to decide which target audience the product will be targeted for. To make a profit, the product must be sold at a price that matches the target audience, and the package must not be too cheap or too expensive, but it must look like just the price. [1]

Today, there are technologies to automatically generate packages, and PLUG, Research & Design and Yamazaki Laboratory at University of Tokyo developed an AI that can automatically generate packages from past data. The images and illustrations used in package design are given to AI, and it generates over 1,000 design proposals based on emotional keywords like "delicious" and "cute".[2] While existing research and generators use qualitative data such as affective words like "delicious" and "pretty" as parameters, the new feature of this research is that it uses quantitative data such as "price".

Quantitative data has the advantage of being more objective than qualitative data. The appearance of a package is a deciding factor for consumers when selecting a product. Brown packaging are more likely to be viewed as delectable, blue packages are more likely to express a sense of luxury and flavor, and white and red packages are more likely to convey a sense of familiarity, resulting in increased purchasing intentions, according to Maeda et al.'s research. [3]

## 2 Purpose

The goal of this study is to automate package generation to increase the production efficiency of numerous package designs. The purpose is to construct a chocolate package automatically using "price" as the key parameter. The price (Japanese yen) is the only parameter for automatic generation, and the system will build a package with the desired pricing.

## 3 Method

Since this search automatically generates packages of chocolate, 72 types of chocolates available in retail stores, supermarkets and pharmacies have been purchased as reference materials.

For each chocolate purchased, the following data has been registered: "name", "price", "date of purchase", "manufacturer", "content", "price per 10 gram" and "place of purchase. The packages of the chocolates purchased were photographed. For the specific method of photographing, the camera was fixed on a tripod set up at a distance from a window so that the brightness would be as constant as possible, and the camera was also set up at a location with a sill so that the brightness would be uniform.

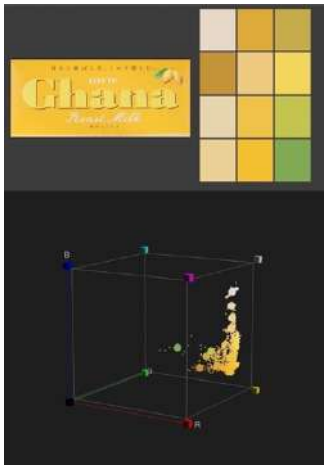



Figure 1: Color analysis and mapping in sRGB space

To measure the brightness and uniformity of the colors, the chocolate package was placed on a sheet of white paper with Kodak's Color Separation Guide and Gray Scale and x-color rite's checker CLASSIC placed next to it.
We cropped only the package part of the picture after taking it and used "Color Spatioplotter" to analyze the colors used in the package by visualizing the colors applied, as shown in Figure 1.

## 4 Automatic Generation

The chocolate we purchased and collected will be used as a data set for the packaging that will be generated automatically. The four design elements of the chocolate to be used in this generation are:

**Background color [3]**
**Concept (slogan)**
**Product name**
**Illustration/photo [4]**

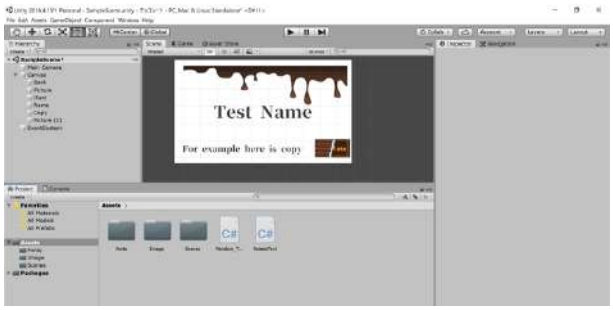



Figure 2: UI of the tool

By modifying these elements such as color and layout, we can automatically generate the packages. We will build the tool illustrated in Figure 2 using the engine: Unity. Depending on the given price parameters, we can change the attributes of each item and decide to place the item on the package.

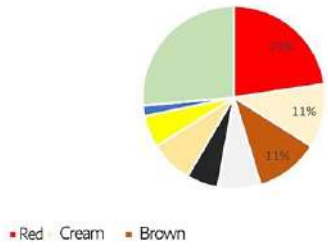



Figure 3: Colors used in chocolate packages under 300 yen

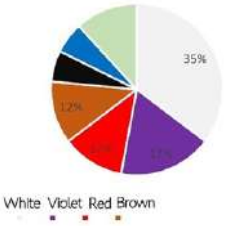



Figure 4: Colors used in chocolate packages over 301 yen

## 5 Discussion

The colors applied in the various price ranges differ greatly from that were reported in Maeda et al.'s study. Our current postulation is that chocolates in different price ranges have different characteristics: packages priced below 150 yen have more illustrations and are more saturated, packages priced between 150 and 300 yen have more red and white colors [Figure 3], and packages priced over 300 yen have more blue and black colors and smaller text. [Figure 4] We would like to compare tool results to improve the tool accuracy.

## 6 Conclusion

In this research, packages are automatically generated using the quantitative parameter of price, so it is possible to easily acquire design ideas with the generated packages. Objectively verifying whether the designs automatically generated by this tool are consistent with the price range would require a much larger data set and more complex analysis.

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# Quantifying Haptic Qualities for Real World Automotive Applications

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**Abstract**
The use of haptic feedback via the five haptic senses and its effects in both arts and science has been widely discussed. However, the application can be explored further especially for automotive interiors. Haptics can play a significant role in improving the perception and appeal of products in the automotive value chain as the depth of the study goes across many levels. Existing research has found that most consumers prefer to touch and feel a product prior to purchase. The main purpose of this study is to identify a method to quantify haptic responses within car interiors in the effort to improve its product quality in a systematic approach. Specifically, the study aims to synthesize the data and conclude a process that will allow automotive manufacturers to quantify haptic responses in achieving its objective of increasing volume through product improvement. Hypothesis: Increasing the ability to quantify haptic responses through mix-method studies will support enhancement programs for real world automotive applications. This study is significant because the New Automotive Policy 2020 has indicated a clear direction for Malaysia's automotive industrialization plan where it underscored the importance of investing in research and development of new sectors, disciplines and skills that underpins the value chain. This study will potentially be conducted in a secure location in Selangor, Malaysia. The researcher will also use purposive sampling in Phase 1 to collect data through questionnaires distributed through handouts prior to the studio model assessment and data will also be gathered through qualitative observations. Ninety respondents from different backgrounds will be invited to the lab and subsequently be asked to assess the studio model for haptic responses using the sense of touch. The group of ninety will be evaluating one Control Exhibit and one Treatment Exhibit. The results of this research could add a new body of knowledge into the subject of haptics within the context of Malaysia's automotive value chain. The researcher believes there is a large number of applications that can benefit from this research. It can also be applied to other businesses that rely upon the human sense of touch.

**Keywords:** haptics, automotive interiors, touch, automotive value chain, human senses

## 1. Introduction

The automotive sector in Malaysia is in a vibrant stage where consumers have a substantial number of choices, in the form of brands, to choose from to satisfy their wants. Consequently the Malaysian automotive sector has proven itself to be one of Malaysia's key industries (*Malaysian automotive sector on the rise | The ASEAN Post*, n.d.). Research and development is a highly capital intensive endeavor. The automobile industry in Malaysia is growing, and the local car manufacturers are investing heavily in research and development to enable products that are more functional ((Eze et al., 2012). Haptic research is one such area that is in the realm of R&D but still in its infancy, especially in Malaysia. However it plays a very important role in lifting the brand perception and quality appearance of a product ((Glohr et al., 2015) and this is further explained in the works of ((Doerrer, 2003) where it is proven that haptics is one aspect of high perceived quality.

Directly correlated to that assumption will be the increased sales and volume going forward as any positive feedback will certainly generate brand preference potentially leading to eventual sale. An added benefit from the use of haptic feedback is the inherent physical interaction between the car and driver, as the user perceives a direct physical relationship with the product (Summerskill et al., 2003). Haptics can play a significant role in improving the perception and appeal of products where existing research has found that most consumers prefer to touch and feel a product prior to purchase (Jha et al., 2019).

Haptic sensibilities, by their very nature defy reductionist methods of investigation, yet are demonstrably highly significant in the perception of our reality (Stanley, 2002). Such a strong conclusion derived from a well-known piece of research substantiates the critical nature that presides over haptic studies. Blake Hannaford and Allison M. Okamura explained that in the psychology and neuroscience literature, haptics is the study of human touch sensing, specifically via kinesthetic (force/position) and cutaneous (tactile) receptors, associated with perception and manipulation (Hannaford & Okamura, 2008), whilst a more common and simpler description would be that it is a term derived from the Greek word "haptikos" means pertaining to sense of touch. It is a

tactile feedback technology that takes advantage of user's sense of touch by applying force, vibrations or motion to the user (Sharma et al., 2011).

According to the pioneering research entitled A Multilayered Model of Product Emotion (Desmet, 2003) it is no longer enough to have the product to function as it is required to but it is in fact fundamental for it to satisfy the user across many levels of emotion. Haptic qualities gravitate towards this notion as it connects to all the five senses of the human being. Connected to this assumption is contained within the classic literature A Theory of Human Motivation, where the physiological need felt by us is the very basic need of every human being (Maslow, 1943).

Quantifying measurements of the haptic senses is undoubtedly an area of less focus within the automotive value chain. This can be attributed by the seemingly engineering based nature of the business where cost and technical aspects are of paramount importance in manufacturing. However, experience requirements involve product attributes that may not be directly controllable by the design process, although they are inherent to the product experience (Valverde et al., 2019).

The researchers also presented that product experience, by itself, cannot be entirely described by engineering parameters. It is necessary to consider non-parametric sensorial cues and emotional or satisfactional qualities. The authors concluded that further research could bridge the more subjective user experience and, ultimately, attain a better understanding of the brand sense and the perceptual expectation of quality for the products. To date, existing research has found that most consumers prefer to touch and feel a product prior to purchase (Jha et al., 2019). This behavior has been difficult to measure especially in the context of understanding the underlying mechanisms that influence product selection in making the purchase decision.

Reflecting from the research problems and though extensive literature review, there isn't a lot of studies done on haptics research specifically within the realm of automotive interiors related to touch & feel. This is even more obvious when it comes to the act of measuring such feedback. This naturally opens up the opportunity to realise new body of knowledge where the quantification of responses can benefit the larger industry.

In that respect, the main purpose of this study is to identify a method to quantify haptic responses within PROTON car interiors in the effort to improve its product quality in a systematic approach. The method proposed should be able to be used, referred to and be set as a standard within the company. Specifically, the study aims to investigate the three main research objectives listed below:

1. To investigate the extent of quantifying a haptics framework that is robust and applicable across the automotive value chain. - (IV)
2. To conceptualize a Standard Operating Procedure that can act as a guide and be applicable in the automotive value chain. - (Mediator)
3. To establish a quantifiable haptics framework towards achieving positive haptics for the user. - (DV)

The study aims to synthesize the data and conclude a process that will allow automotive manufacturers like PROTON to quantify haptic responses in achieving its objective of meeting business objectives through continuous product improvement in a systematic approach.

This study aims to answer the three research objectives outlined in the previous section. The research questions proposed in-line with the research objectives are as follows: -

1. To investigate the extent of quantifying a haptics framework that is robust and applicable across the automotive value chain. - (IV)
    a. What is the best method to measure the sense of touch in an applied environment that is replicable in a structured manner?
    b. Which measurement theories are best used in this context of achieving measurable feedback?
2. To conceptualize a Standard Operating Procedure [SOP] that can act as a guide and be applicable in the automotive value chain. - (Mediator)
    a. What studio model theory is applicable in order to create an automotive industry focused standard operating procedure to measure haptics?
    b. Is there a studio model environment that is suitable to the national automotive value chain?
3. To establish a quantifiable haptics framework towards achieving positive haptics for the user. - (DV)
    a. Is there a correlation between the quantifiable haptics framework applied in the automotive value chain and achieving positive haptics for the user?

Therefore, the hypothesis is: Increasing the ability to quantify haptic responses through mix-method studies will support enhancement programs for real world automotive applications.

This study aims to investigate the extent of quantifying a haptics framework that is robust and applicable across the automotive value chain (independent variable) in order to achieve positive haptics for the user (dependent variable). The creation of a robust standard operating procedure based on a studio model (mediating variable) will also be evaluate and analyzed. The conceptual framework diagram shown below illustrates the experimentation design approach for two hundred Malaysians drivers from either national or

non-national brands in order to investigate the touch and feel feedback that can be applied across the automotive value chain. A survey will also be used to measure objectively and subjectively how the proposed touch & feel responses can lead to the development of a standard operating procedure applicable across the value chain.

In summary, the results of this research could add new body of knowledge into the subject of haptics through a haptics framework within the context of Malaysia's automotive value chain. It can also be anticipated that the study could be implemented elsewhere for as long as the objective is to improve product quality based on feedback of the human sense of touch. It is hoped that the results will highlight the importance in investing in haptics research and its novelty into the subject of haptics within the context of Malaysia's automotive value chain.

## 2. Literature Review

This study aims to create a quantifiable measurement framework for haptic responses towards achieving positive haptics for the user. The creation of a robust standard operating procedure based on a studio model (mediating variable) will also be evaluated. It begins with the review on the origins of haptics, its definitions and scope of applications. This is then followed by the analysis of the differences between the five haptic senses and its effects in both arts and science (Breitschaft et al., 2019).

The review then studies the potential impact of utilising Biggs' and Collis' Structure of Observed Learning Outcomes (SOLO) taxonomy (Minogue & Jones, 2009) to form a basis of research into feedback quantification. Coupled with the methods underlined in the comparative research by Bordegoni and Caruso, the research procedures will be guided accordingly (Bordegoni & Caruso, 2012). Both of these models will be the basis of study in relationships between touch sense haptics to the vehicle interior.

Next, this implementation model will be used in defining what is touch haptics ((Scully, 2018). Thereafter the research centers on the definition of standards, standard operating procedures and why it is critical to have them in order to achieve a clear understanding of the final objective. The recommended methodology for this research is the mix-method as it provides opportunity to obtain responses in both quantitative and qualitative. Therefore, some literature on that method as a quantifying procedure will be included.

The definitions of haptics can be observed in many disciplines. Even in the context of 2D or 3D there can be a unique way of identifying or describing the term. Haptics refers to manual interactions with environments, such as exploration for extraction of information about the environment or manipulation for modifying the environment. These interactions maybe accomplished by human or machine hands and the environments can be real or virtual. Also, the interactions may or may not be accompanied by other sensory modalities such as vision and audition (Srinivasan & Basdogan, 1997). Srinivasan & Basdogan also explains how the subsystems and information flow underlying interactions between human users and force-reflecting haptic interfaces are shown as in Fig. 1 as described by Srinivasan & Basdogan.

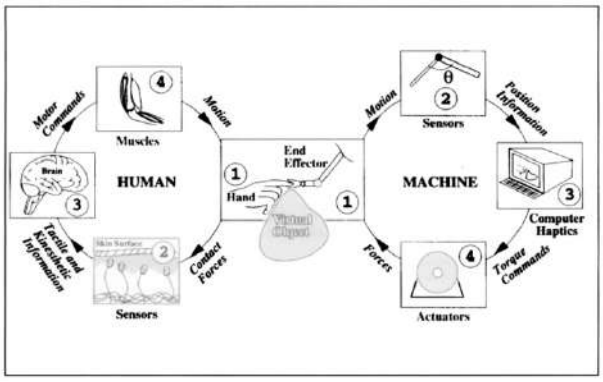



Figure 1: Haptic reactions between humans and machines.

Haptics is the science and technology of experiencing and creating touch sensations in human operators. Imagine trying to button a coat, shake someone's hand, or write a note without the sense of touch. These simple tasks become extremely difficult to perform without adequate haptic feedback (Hannaford & Okamura, 2008). Through this observation it becomes clear that haptics is more than just a science-based technology. The cause and effect show how emotive actions, which are in no way related to technology, plays a critical part in acknowledging and responding towards haptics. The researchers Hannaford & Okamura (2008) also extrapolated the terminologies of haptics into the categories of Anatomy and Physiology, Psychophysics and Psychology.

Other researchers also did further dissection into the terminologies as the industry grapples with many individualized definitions. It is noted that companies and institutions usually try to identify their uniqueness by giving specific names to their definitions. However, through academic research it is possible to identify those that are easier to be applied in industry specific situations. Figure 3 shows various meanings of the term "haptics" in the context of car interiors. In general, haptics in control elements can be viewed from a technological (How is haptic feedback generated?) and a perceptual perspective (What can be felt by the user? How are the haptic impulses interpreted?) (Breitschaft et al., 2019).

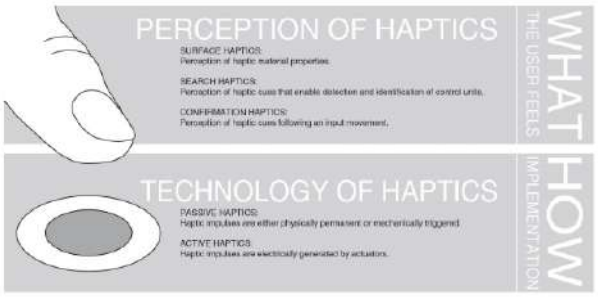



Figure 2: Haptic reactions between humans and machines.

Surface haptics refers to all haptic surface and material properties that can be used in car interiors. They presume that high-level processing of haptic stimuli involves utilization and aesthetic evaluation. This means, interior materials convey hedonic as well as functional aspects. Regarding hedonic aspects, surface haptics refers to the use of haptics to evoke aesthetical evaluations. Other haptic categories, as explained by the researcher, include confirmation haptics, passive haptics and active haptics.

Biggs' and Collis' Structure of Observed Learning Outcomes (SOLO) taxonomy is a diagnostic tool with the ability to detect differences in understandings resulting from the addition of haptic feedback in a particular experiment ((Minogue & Jones, 2009). This method of assessment may prove invaluable to be an invaluable tool in measuring cognitive impact of haptics in vehicle interiors. The SOLO taxonomy, developed by Biggs and Collis (1982), provides educators and researchers with a systematic way of classifying and describing the range of performances produced by learners in attempting a particular academic activity. Although the SOLO taxonomy was not intentionally designed to assess the influence of sensory feedback and/or manual interactions, we assert that this tool's inherent attention to the respondents' ability (or inability) to connect and relate facts into a coherent whole will make it well suited for the accurate assessment of impact of haptic feedback.

The possibility of performing the validation of aesthetics and ergonomics in the early stages of the concept design deserves investigation. In fact, this would allow elimination of problematic issues of the designs, which could lead to unsuccessful products, at acceptable cost ((Bordegoni & Caruso, 2012). The researchers agree that the design review of new products is particularly complex.

There are numerous interpretations on what defines the subsets of haptics; from science to education, from engineering to arts, from applied to theoretical. There are also many types of disciplines that propagate their own levels of haptic types, for example in the medical discipline and also in the performing arts. Haptic technology is typically separated into two broad classes based on the complementary human sense modalities: tactile sensations, perceived through the skin, and proprioception, or the sense of body location and forces; the latter includes kinesthetic senses of force and motion. Human haptic perception is synthesized from the tactile and proprioceptive senses, and is influenced by vision and hearing. Tactile sensations rely on multiple sensory organs in the skin, each of which detects different properties ((Schneider et al., 2017).

An appealing haptic aesthetic may even motivate us to use a product. Such haptic aesthetic can be considered on a level of engagement that leads to the emotional level. On the other hand, the visual aesthetic is a precursor and can entice or dissuade haptic engagement. When we use a handheld product, certainly there are forms and materials that are more pleasurable, what looks like good quality or poor quality is confirmed or denied by the haptic ((Scully, 2018), it may meet or exceed the expectations of the user.

The research into haptics and its applications also extend broadly into many new generations of disciplines; from eSports to interaction design, from robotics to cultural philosophies. Although the disciplines are invariably different, there are similarities in the interpretation of the meaning of haptics, how it is implemented and also the eventual results achieved.

Automotive haptics is very specific in that it focuses on the relationship between the users (predominantly the driver) and the vehicle. It is highly personal and comes across many levels of responses. There is more to cars and trucks than just being a mode of transportation and mobility. The perceived quality and comfort of control devices used in heavy trucks or busses is generally on a lower level than with passenger cars, although truck and bus drivers spend more time behind the steering wheel than regular car drivers. In addition, the overall impression of the interior and the image of the product as a whole could be improved. Thus, a characteristic perceived quality and haptic feedback may lead to a higher brand recognition factor and may permit specific differentiation from competitors ((Glohr et al., 2015).

The basic interaction between vehicles and humans, the layout of the steering wheel, pedals and gear lever has stayed roughly the same ever since the early 1900s. So have the internal structures that define the build of every vehicle until today. Technology has progressed and, in that effect, improved significantly the occupants experience when inside but the general layout is maintained. This is especially true for the automotive industry in which user interfaces need to be intuitive and usable. Practitioners in the automotive industry are currently facing disruptive changes. Through changing perspectives on mobility concepts, functionality in car interiors is dramatically increasing. Concept studies are dominated by clean and harmonic interior surfaces that incorporate not only multiple layers of functionality (e.g., sensing, lighting, and haptics) but also a wide variety of new materials (metal, wood, and textiles). These so-called "smart surfaces" facilitate the development of dynamically responding and context-sensitive surfaces in interaction situations ((Breitschaft et al., 2019). Touch surfaces with no surface deformations delineating the individual function fields open up new design possibilities in the car interior ((Tunca et al., 2016).

According to the Center of Automotive Research (CAR), automotive value chain is defined as the accumulated value produced by a company that sells component, materials and light vehicles. CAR is an independent, non-profit, research organization with a multi-disciplinary approach. They engage with leaders in the global automotive industry to support technology advancements and improve competitiveness (*About | Center for Automotive Research*, n.d.). The sum value

of the automotive value chain is much larger than the typical estimate of the annual net output produced by a nations automotive industry (*Estimating the New Automotive Value Chain | Center for Automotive Research*, n.d.). Value chain covers the entire range of activities from the conception of the product to its final delivery into the hands of a customer. In case of the companies involved in the production of goods, there value chain begins from the acquisition of the raw materials. It consists of all the processes down the chain till finally the product is sold to the customers (*Value Chain Analysis of the Automobiles Industry*, n.d.).

Standard Operating Procedures (SOP) can be described as established or prescribed methods to be followed routinely for the performance of designated operations or in designated situations (*Standard Operating Procedure | Definition of Standard Operating Procedure by Merriam-Webster*, n.d.). Certainly, in the professional context the detail explanation can be varied when compared to an academic detail.

It is generally agreed that requiring employees to perform their tasks according to Standard Operating Procedures (SOPs) can improve production outcomes in the context of repetitive manufacturing. It can improve the output consistency, efficiency and learning rate of a given process (De Treville et al., 2005). The authors clearly shared how luminaries in this field like Levinthal & March (1993) acknowledged the ability of SOPs to facilitate the accumulation and transfer of knowledge acquisition, leading to variability reduction and organizational effectiveness.

Notwithstanding the deep and broad meanings researched, it should be taken into context of this research. The SOP on how to quantify haptic responses will need to be conceptualized through valid processes that are established in the automotive industry. The SOP will need to be trimmed down to achieve the intended aim of enabling companies to improve the haptic feedback they want their customers to feel.

Standards are varied in the process of haptic measurement. The underlying principle is to ensure the methods applied can be replicated accordingly and be understood globally. The differences in industry, although expected, should not be a deterrant in understanding the processes that are applied. Developing effective touch experiences requires bridging ideas, hardware and interactions across interdisciplinary communities of practice. Academic papers and commercial device specifications report a dizzying array of engineering attributes therefore cataloguing all potential attributes is impractical and can undermine the most useful. They noted that while haptic design benefits from an iterative process similar to that in other design fields, it also requires unique tools for ideating and designing in both hardware and software. Hannaford and Okamura (2008) further categorize haptic devices into grounded devices, which are connected to a stable surface (e.g., the floor or desktop), and ungrounded devices (e.g., exoskeletons, wearables).

According to extensive research done by D. Subedi (2016), there are three communities of researchers in the educational field: qualitative oriented methodologists, quantitative oriented methodologists and mixed methodologists. Based on their knowledge claim they are constructivists, positivists and pragmatists respectively. The positivist believes that the knowledge is universal and absolute whereas the later believe that there may be more than a fixed knowledge and it is fallible in the universe by non-positivism thought. Based on their knowledge claim, positivists adopted quantitative method to state reality in the world whereas constructivists espouse qualitative method to construct the meaning of the phenomena under investigation. Pragmatism on the other hand, embraces mixed method as the third research community in order to avoid either or view of positivism and constructivism (Subedi, 2016).

According to Creswell (2017) there are six types of mixed method design. They are: the convergent parallel design, the explanatory sequential design, the exploratory sequential design, the embedded design, the transformative design and the multiphase design (Creswell, J. W., & Clark, 2017). Out of six mixed method designs explained above, the explanatory sequential design is highly popular among researchers. Plano Clark explains how this method of design consists of first collecting quantitative data and then collecting qualitative data to help explain or elaborate on the quantitative results. In explanatory sequential mixed methods design, which involves the implementation of an initial quantitative component followed by a subsequent qualitative component that depends on and is informed by the initial quantitative results. This design allows researchers to dive deeper into understanding the nuances and mechanisms that explain the quantitative results (Plano Clark, 2019).

## 3. Research Methodology

A preliminary online pilot survey was conducted to test the survey questionnaire related to the studio model six days. The objective of the pilot survey was to support the researchers' assumptions on which component within the vehicle is the top three focus objects respondents will engage in the actual survey. The top three objects will become the basis to structure the final questionnaire and interview questions.

The survey was created using Google Forms that was guided and based on a survey titled Survey of Malaysian Car Owner Needs of a Car Interior (Rosli et al., 2014). This reference survey is very valid as it captures the local Malaysian idiosyncrasies when dealing with questionnaires and the subject of vehicle interiors together. The pilot survey contained 3 sections; Section 1 contains the qualifying questions; Section 2 contains the questions containing six main components in a vehicle interior together with an open-ended general feedback question and Section 3 seeks to acquire the respondent's demographic profile. In Section 2 each of the first six questions are accompanied by high quality images of the said main components. This is to ensure clarity whilst enabling the participants to focus quickly. The survey

was published online via the author's Facebook account and also organically shared through WhatsApp for 5 days. In total it received 256 responses. From the data it is clear the seats, steering wheel and instrument panel are the top 3 components that capture the respondent's interest. Added to the objective questions, the sole open-ended general feedback question also provided insights into the subjective impression of each participant whilst going through the survey where some were vital to the improvement towards the final survey structure.

The questionnaires that have been completed clearly point towards the critical components important to users. The data shows a high number of respondents who value high haptic feedback on contact surfaces. As most of the respondents are drivers, the data is noticeably skewed towards the driver's location in the vehicle interior.

Thereafter, in Phase 1 of the data collection process, approximately 200 respondents will be identified to participate in a quantitative online survey that will be sent to them via email and/or social media channels. From the 200 respondents, ninety participants from different backgrounds will then be invited to the studio lab and subsequently be asked to assess the studio model for haptic responses using the sense of touch. The same group of ninety will be sequentially evaluating one Control Exhibit and one Treatment Exhibit, where an updated surface condition has been applied in order to gain an alternative haptic response. The role of the researcher is to supervise the lab and to enforce non-biased monitoring during studio model assessment. This includes the assistance of colleagues who are not involved in the research proper. The researcher will also use purposive sampling to collect data through questionnaires distributed through handouts during the studio model assessment and data will also be gathered through observations. This will ensure the quantitative data analysed from the questionnaires can be viewed from a more holistic perspective and explain constructs in a non-linear view.

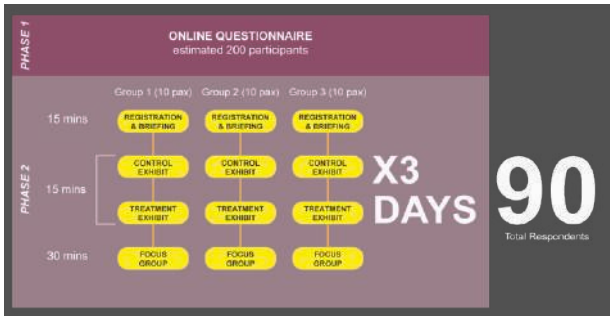



Figure 3: Data collection diagram for studio lab sessions.

The entire studio lab and focus group surveys will take 3 days to complete, with each day having 30 respondents segregated into groups of 10 persons each. According to a previous study entitled Reporting and Justifying the Number of Interview Participants in Organization and Workplace Research, the data collected reveal an overall norm of between approximately fifteen and sixty participants for qualitative interviews within O&W studies (Saunders & Townsend, 2016). The study also elaborated where these comprise around thirty participants when chosen from a single organization or analyzed as a single group and around fifty participants when chosen from multiple organizations or analyzed as multiple groups. Both estimates are larger than the upper limits suggested by previous empirically justified guidance of twenty for single case studies, quoting Marshall et al., 2013 and twenty-five for interview studies as explained by Brinkmann and Kvale, 2015. A quasi-experimental design will be used to assess the conceptual framework.

Statistical software like SPSS or PLS-SEM will be used to validate the research instruments. PLS-SEM in particular offers solutions with small sample sizes when models comprise many constructs and a large number of items. Technically, the PLS-SEM algorithm makes this possible by computing measurement and structural model relationships separately instead of simultaneously. PLS-SEM can certainly be used with smaller samples but the population's nature determines the situations in which small sample sizes are acceptable (Hair et al., 2019).

## 4. Data Collection and Analysis

As described earlier this research will use purposive sampling from different participants with varying backgrounds to ensure suitability in answering the research questions. This is to ensure the sampling is relevant to the research questions. Out of the 200 respondents from the questionnaire the ninety participants in Phase 2 will be carefully selected based on the researchers own judgment to focus on particular characteristics of the population that are directly related to the research objectives (Etikan, 2016). To ensure validity and avoid biasness, a set of criteria's will be created to guide the selection of participants. One of the most important criteria is the participants have to be a mix of national and non-national car owners.

Additionally, the inclusion of non-automotive participants will add a more accurate and varied response from the generalised public. A very recent study by Cornell University entitled Designing Mid-air Haptic Gesture Controlled User Interfaces for Cars (Young et al., 2020) showed the importance of having participants in an experiential survey whom did not specialize in the study area to ensure realistic responses. As the study will employ mixed method, the participants will be required to respond to both quantitative and qualitative questions in specific formats. The groups in Phase 2 will start with the Control Exhibit first and thereafter the participants will be asked to assess the studio model for haptic responses using the sense of touch. Concurrently the participants will be required to answer a questionnaire related to the Control Exhibit before moving on to the Treatment Exhibit.

Participants will be required to answer a structured quantitative questionnaire first. This questionnaire will use a five-step Likert Scale (strongly agree, agree, undecided, disagree, strongly disagree), and should capture their demographic profile, component preferences and their

understanding of what touch haptic is in relation to automotive applications (Gustavsson et al., 2017). The individual means from each student participant will be taken as the score for each participant, with a high score as positive result. The scale's internal consistency reliability, as to how consistent the scale's items in measuring the similar attributes; will be determined by Cronbach's Alpha.

In the process of constructing and validating the questionnaire for both Phase 1 and 2, Delphi method is applied. The Delphi method emphasizes structured anonymous communication between individuals who hold expertise on a certain topic with a goal of arriving at a consensus. Pragmatism is evident in the qualitative Delphi method in the following ways: (a) The Delphi method is flexible and can be used with quantitative and qualitative data sources; (b) The Delphi method is affordable, as it incorporates inexpensive questionnaires varying from more open ended to more structured that can be easily disseminated to participants utilizing either traditional or electronic delivery; (c) The Delphi method is not concerned with having a generalizable sample but instead seeks input from a purposive sample of individuals with specific expertise on a topic; and (d) Delphi studies lack the complexity of many other research designs that demand highly specialized education, technology and knowledge (Brady, 2015). The Delphi method is deemed suitable for this research as the participants were from all around Malaysia therefore making face to face meet ups unpractical, the participants are professionals who have limited time to engage long contact sessions and as professionals they are usually less concerned with participating in academic interviews that offer little to no forms of return to them. The Dephi method will also allow the researcher to obtain maximum amount of information and knowledge from the experienced professional participants in the least amount of time.

The Delphi assessment commenced for approximately one month. It started with the identification of 15 individuals who represented the sampling explained in the researchers research method. One key element was that the assessors must be from variable backgrounds and professional responsibilities to effectively represent the actual respondents who will answer the final questionnaire. Personal invitations were made and once the full quorum was obtained the link to their online questionnaire was simultaneously distributed to everyone. Core demographic information retrieved from the assessors are as follows: -

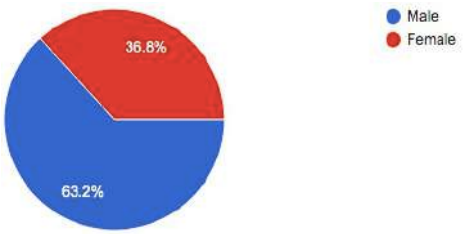



Figure 4: Delphi assessors gender split.

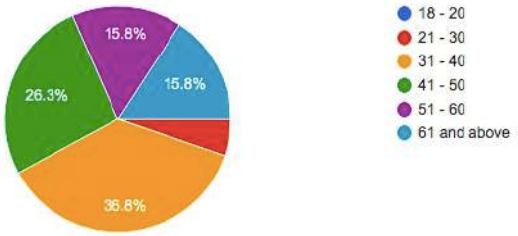



Figure 5: Delphi assessors age range.

The Delphi results showed a balance response from a mature and knowledgeable group of professionals. To enhance the findings, 1/3 of the assessors were foreigners residing in another country besides Malaysia. This gave a different perspective to the questionnaire and gave higher reliability in terms of being able to be understood by a wider audience. Collectively the comments from every assessor were analyzed for context viability and those that were applicable were applied as part of the new questionnaire.

Once the input from the Delphi assessors were integrated into the final Phase 1 questionnaire, another safety measure was put in place to ensure robustness of the questions asked, overall approach and ease of understanding. This was to ensure the majority of answers received in the final questionnaire will be credible and mature enough for studio lab participant consideration for Phase 2. A total of 30 participants were selected for this pre-test via convenience sampling. This pre-test was executed for 5 days. The top 3 findings from the session illustrated the following: -

1. Foreigners (non-Malaysians) place strong emphasis on equality in terms of race, creed, sexual orientation and country of origin. Neutrality is a high request when constructing the questions.
2. Flow of the questionnaire is good but better to keep everything quantitative e.g. Likert scales, 1's and 0's, rather than mixing it with open-ended questions.
3. Related to the finding no. 2 above, the use of statistical analysis tools like SPSS work best when qualitative elements are removed. Validity is much easier concluded.

Input from this pre-test allowed for further amendments to the final questionnaire that made it clearer and easier to understand. Changes involved small movements of questions to improve flow, removing all qualitative open-ended questions and questions that were leading, and lastly refinement of expressions that involved sensitive matters such as ethnicity and sexual orientation.

Moving forward to the next phase of data collection, to ensure and implement a certain measure of surety to the upcoming studio lab session in Phase 2 the researcher will exercise a simple studio lab pilot survey. Not to be confused with the early pilot survey, this exercise will involve everything that has been planned earlier to ensure the exact procedure and

timing plan is followed. The number of participants for this pilot is reduced to 50% of the planned 10 persons per session. The layout for the exhibits are approximate but within the anticipated measurements for the actual event to give a moderately accurate timing expectation. During this time the questionnaires and focus group survey questions will also be ready for testing.

At the end of each of the studio lab session (Control Exhibit first, Treatment Exhibit second), all participants will be required to participate in semi-structured interviews after completing their respective questionnaires. Each interview session will be in the initial groups of 10 participants in a focus group setting. Located within the same proximity of the exhibit, the focus group interviews will be done in a controlled environment lead by the researcher and his selected assistants. The semi-structured interviews provide the capacity to gather insights into how the participants view the sensory experience in a more meaningful way beyond the provided questionnaires (Bryman et al., 2008). The interviews were guided by a list of questions for the interviewee to answer. However, the interviewer allows the participants to flow freely and flexibly in providing answers to the questions (Raji et al., 2019).

The interview will be a guided session to ensure consistency between groups and also to guide the interviewer to explore or prod further should questions be raised during the interview session. The questions designed for the semi-structured interviews are aimed to gain detailed feedback regarding their thoughts and reflections in both Control and Treatment sessions.

To ensure reliability, the data between the groups of ten should be consistent when compared to each other. This will also show the validity aspect of the findings as the data should measure exactly what the researcher wants in terms of touch haptic responses. For generalizability, the findings should be applicable for other product development approaches as long as they are within the automotive value chain.

## 5. Discussion

The analysis of the quantitative data will be done in the first phase for all groups involved. The findings will be used to infer and cross reference results of the semi-structured interview questions for phase two of the quantitative data collection phase. These data will be described with means and standard deviation (SD) using SPSS. The differences between demographic and preferences in haptic responses will be analysed using independent t-tests, analysis of variance, Pearson's and Spearman's correlation coefficients. At the end of the lab experiment where all the participants have undergone the Control and Treatment Exhibits together with the questionnaire and semi-structured interviews, the combined data collection will also include observatory notes/data from the researcher and his assistants. The integration of both the quantitative and qualitative data will be conducted in the end where the mixing of both data will help to inference both data sets individually as well as complementarily.

The qualitative data will be analyzed using thematic analysis method to be able to decipher the nuances across many levels of observation. The thematic analysis method is chosen because patterns could be identified and connections could be made to form meaningful categories and themes for the phenomenon. Recorded transcripts will be analyzed using a thematic analysis approach, which will involve five discrete phases: familiarization, thematic coding, extracting themes, reviewing themes, and defining and naming themes (Hogan et al., 2017). Thematic analysis can be applied across a range of theoretical frameworks and indeed research paradigms. The aim of thematic analysis is not simply to summarize the data content, but to identify and interpret, key, but not necessarily all, features of the data, guided by the research questions (Clarke & Braun, 2017). Braun and Clarke (2006) argued that thematic analysis should be a foundational method for qualitative analysis, as it provides core skills for conducting many other forms of qualitative analysis (Nowell et al., 2017). It is a method for identifying, analyzing, organizing, describing, and reporting themes found within a data set. These identified themes will be analyzed and developed to further evaluate the data relevance in the coded extracts and across the entire data set.

This study is will be undoubtedly be of interest to the industry. Therefore, the subject of confidentiality and ownership will be of high concern. Confidentiality is associated with the location where the studio lab and respondents will observe the exhibits to facilitate questionnaire feedback. Ownership, on the other hand, is the question of who will have the rights to the findings of the research and other usability clauses that comes after the research study is completed.

To ensure transparency, clarity and positive cooperation from those involved the researcher stakeholders to explain the background and objectives of the study. Ownership of the findings is to be jointly held and the names of those involved can be generalized.

## 6. Conclusion

There is a very opportunity to use the concepts and results from this study to formulate a conceptual framework to measure haptic responses within automotive interiors in the effort to improve product quality. This in turn can undoubtedly produce a systematic Standard Operating Procedure that guides automotive industry executives to use data from haptic feedback throughout the value chain.

Evidences clearly show correlation between positive haptics in automotive interiors and its ability to support increased product preference. Moving forward production of a methodical proposal of enhancements programs that can be applied in the context of vehicle interiors to improve touch and feel feedback can easily be done to the benefit of industry.

The results of this research could also add a new body of

knowledge into the subject of haptics within the context of Malaysia's automotive value chain. The researcher believes there is a large number of applications that can benefit from this research. It can also be understood that the study could be implemented for other businesses for as long as the objective is to improve product quality based on feedback of the human sense of touch. The idea for this research is novel as it gives insights on perceptual and cognitive processes during haptic interaction, which is a theoretical approach. One aim of this model is to provide guidelines on how to optimally utilize haptic information during the automotive design process by including already existing literature. The proposed framework helps to understand how haptic feedback can be successfully integrated into tangible user experiences by dividing the perception process into Exploration, Detection, Identification and Usage. Positive haptic feedback enhances user experience. Haptic feedback also has the potential to create unique and brand-specific design features (Breitschaft et al., 2019).

This research study will focus on one out of the five selected senses of the human body, which is the sense of touch. The choice to limit the research to only Malaysian domestic brands will also constrain the findings to local car customers within Malaysia and to a lesser extent within their projected business markets inside the ASEAN region. Future researchers can expand on this. The automotive sector also has limited research inventory in the area of haptics due to the lack of awareness in such a new technology and this is exacerbated by the lack of understanding into the field together with its potential of application (Grand View Research, 2018) The researcher believes there is a large amount of applications that can benefit from this research. It can not only be applied to the automotive sector but also to other businesses that rely upon the human sense of touch. Future researchers can potentially link the findings of this research to the branding side of product marketing where the variables of brand affinity and brand loyalty are also related to haptics.

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# Art-Tech: Exploring New Opportunities for Digital Art and Design

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**Abstract**
The present digitalisation process has resulted in the formation of alternative media businesses, which is creating potential opportunities for artists and creatives to reach a wider audience. Additionally, as a result of new economic models enabled by digital technology, creators may produce and extract higher value from their work. Social media sites flourish because of the value added by their users. This is enabled through the digitalisation of a variety of types of media, including text, sound, and pictures. As a consequence of the fast-growing global upload–download phenomenon, people are increasing their knowledge and creativity, and user-generated content has exploded in popularity, influencing and converting public opinions of goods and organisations. As a result of enabling consumers and producers to collaborate and co-create works of value, social media and information and communication technology are disrupting the typically understood boundaries of creative production. This disruption is having a disproportionate influence on the creative industries and is causing the re-evaluation of the positions of creative middlemen, production gatekeepers, artists and other creatives. This study examined the twenty-first century's ongoing artistic trends to further knowledge of the potentially altered artist outputs and to analyse the joy of seeing creative design works using a fundamental, straightforward, and accurate approach.

**Keywords:** Art-tech, Digital Art and Design, Creative industries

## 1 Introduction

With the current age of digitisation comes the formation of alternative media corporations, which open up alternative avenues for artists and creatives among the 'creative industries to reach a broader range of people [1]. A wide variety of industries that value innovation in product design and manufacturing processes. In addition, new modern economies enabled by digital technology allow creators to produce and extract more value from their output. The value produced by the contributions of users on social media platforms allows them to grow. Digitisation of diverse media formats, including text, music, and pictures, has made this possible. As a result of the rapidly developing worldwide upload–download phenomenon, users are contributing their expertise and creativity to these platforms. An extremely popular trend is the use of user-generated content (UGC) to help shape and alter how the general public views various goods and organisations. Consequently, information and communication technology and social media are altering the historical boundaries between producers and consumers by allowing them to collaborate to create works of value, while also redefining the roles of artist intermediaries, creative gatekeepers, and design experts. The goal of reforming the Art and Technology Framework is to avoid detracting from the artist's productions or enjoying creative design works. To be clear, this satisfaction comes from personal experience and knowledge of what lies underlying what we see. A wide range of visual arts and imaging designs were used, ranging from classical photography, cinema, and computer graphics to the Internet and its capillary network for interacting with a wide range of issues. These changes brought about by information technology and communication and social media have more substantial ramifications in the creative fields than in others, as described in this paper.

## 2 Typical Creative Industries

The term 'creative industries' is used to describe a broad range of industries that emphasise the creativity that goes into the development of their goods and the procedures they employ [1]. Architecture and interior design, commercial advertising, fashion, visual communication, cinematography, fine arts, and industrial design are among the industries that are included under this term [2]. These industries consist of individuals and organisations that provide designs and services with significantly symbolic and aesthetic outcomes [3], and which are sold to the public. Numerous studies have attempted to determine which industries should be considered creative, and there has been considerable debate over the terms 'creative' and 'cultural industry'. Several academics concur that the arts and cultural studies should be considered disciplines of the creative industries [1]. Caves [2], an economist, proposed a number of characteristics that distinguish creative enterprises from other industries. His list of creative industries includes publishing, visual arts/communication (including painting, sculpting, etc.),

performing arts (including theatre, opera, dance, etc.), media production (including sound recordings, cinematography), and even entertainment (including game design). In addition to defining the creative industries in a socially relevant and dynamic manner, Caves' list was revolutionary and significant. Creative industries arose as a result of industry change and have evolved through time to become more creative and experience-driven (for example, the culinary arts), and new industries are now emerging as a result of technological advancements. Virtual reality and video games are two examples of this. There appears to be considerable variation between nations in terms of what is regarded to be a component of the creative industries, and the definition is extremely context-dependent. In some developed countries, visual art is associated with pleasure. Conversely, in other developing countries it is considered to be mostly a matter of presenting information, or a matter of luxury craftmanship for visual enjoyment only.

For those working in the creative industries, imagination is a vital component of the manufacturing process, and the success of creative companies is dependent on the quality of the outcomes. There are many different ways to describe creativity, but one of the most often recognised definitions is the production of a helpful and suitable reaction, product, or response to an open question that is both innovative and appropriate in the circumstances [3]. Instead of being the outcome of an individual or collective work, creativity, in contrast to innovation, is mainly the result of a single individual or group endeavour. There is a plethora of literature on the subject of what makes people more or less creative [4]. Overall, this literature concentrates on individual creativity as being separate from, and generally unconnected to, creativity outside of and within groups. Another flaw in virtually all creativity research is the widespread belief that creativity is an objective quality that can be recognised and analysed. This is a frequent misconception that has been proven false. Due to this assumption, it was believed that 'creativity' was a social assessment rather than an objective characteristic of the work that can be comprehended regardless of its social context outside of research. We believe that this assumption is incorrect. Certainly, we have no other way of determining an object's intrinsic features other than through subjective judgments of those properties. Nonetheless, it is possible to argue that an idea or thing is not creative unless it is considered to be so by others. The acceptance (and thus possible adoption) of creativity within a larger community of integrated professionals and mavericks is, according to this view, essential to comprehending its potential influence and how it might be harnessed [5]. In the same vein as the previous argument, Mihalyi [6] suggested that definitions of creativity should consider the significance of the percipients and the larger group context in which their evaluations take place. Based on this work, Khaire [7] went one step further and acknowledged the set of actors within the sphere of cultural production, which is comprised of artists, producers, market middlemen, and consumers. The ability to generate new ideas is unquestionably important to the competitiveness of businesses across a wide range of industries, and the creative industries in particular attempt to improve and maximise creativity. Compared to a range of other (traditional) industries' design outcomes and services, it can be argued that the cultural creative industries [2] and their products are characterised by the fact that they produce intangible design outcomes that are symbolically charged, experiential, and highly subjective in nature [3] [8].

## 3 Technology and Contemporary Art

There has never been as widespread a misunderstanding between technology and contemporary art as there is now, and the reason for this is obvious. The focus of media outlets on spreading scandal and gossip has detracted from the sportsmanship and healthy reflection of the art that made it a bulwark of humanism, as well as detracting from the love of intelligent workmanship. However, the media isn't solely responsible for the current state of affairs. Many museums are run with the purposes of increasing the number of museum subscribers and visitors, and of furthering the city's political interests. Art schools are particularly accountable in this regard and have produced so much confusion that many important works of contemporary art history now seem to be of less importance than other works by the same artists. The result of all of this has been a surge of shows that have nothing to do with the art world. As a result, the number of artists and private galleries are proliferating exponentially. This is similar to art reviewers who feel entitled to express their opinions on artwork as often as they are able to publish articles in a newspaper. These reviewers believe that their audience will have no objections due to the public’s lack of education on the subject matter. In a system like this, art doesn't have much support. However, art has hidden meanings that people fail to see when looking at a painting or sculpture. A label, listing all of the important national and international exhibitions the work has been in, fails to convey the true, unseen value of the work. However, once trained to have an open mind, it is possible to develop an eye capable of identifying with artworks.

The objective for investigating the reshaping of the Art and Technology Framework is to avoid detracting from the drama of the artists’ productions or the pleasure of viewing creative design works. To be clear, this enjoyment is derived from personal experience and an understanding of what is beneath the surface of what we see. Everything in this world is connected, and art is no exception. As a result, it's best to have a foundation of knowledge before getting caught up in the beauty around you. Because modern art employs a pictorial language, it is not easily copied by imitators who only have a superficial understanding of aesthetic form-play but who are blind to the work's true problems: creativity. Even though it's relatively simple to produce eye-catching artwork using loose brushstrokes and use Conceptual Art techniques like the elimination of the object, it can be difficult to persuade others of artists’ abilities. This is even true of those who are confident of their own drawing and technical skills, and who can paint as well as the best Neo-classicists. Despite the overtly flamboyant aesthetics, the overall impression is one of timidity and great triviality. Modern art has always been about more than just aesthetics. The goal of this book is to shed light on an area that

has received little attention in recent years: the philosophy that underlies the creative process. Some creative scholars intended for their works to be quick reference guides for all creatives – young and old, cultivated and culturally insecure, professionals and students – who seek to comprehend what art has been, and continues to be in our century. Naturally, their studies make no claim to be encyclopaedic and make no attempt to develop a critical theory for reading the past and present. The straightforward, synthetic structure of this study would stimulate further research, fosters a larger perspective, and conveys the joys of art to people who have previously just looked at its surface, and in recent years, solely at the spectacle and performance it has become. This book does not analyse the numerous significant artists and works they created during the twentieth century; rather, it examines the aesthetic ideals and theories that impacted them and contributed to their extraordinary vitality despite such variation in accomplishments. The artists considered are fully in accordance with the descriptions of the various movements. As a result, many notable personalities are omitted because they do not fit into the categories of the many aesthetic movements, despite the fact that they are significant for their autonomous research. The major and minor artistic movements discussed here have all contributed to significant shifts in the vocabulary of art, allowing for a more certain and less ingenuous approach to modern art. Today, art is no longer defined by the formation of movements. A new language is being established, driven by concepts that link to the known, and aesthetics that aim for universality. It is no longer progressing subjectively. In the view of modern art that stays suspended, impartial inquiry is no longer carried out. It is an entirely novel attempt, startling and exhilarating, to call into question novel concepts such as subjectivity to discover a new language, the nature of which is still unknown.

## 4 Hyper-Realism

In the mid-1960s, as other groups questioned the materials and procedures of the art, a group of painters and sculptors developed the Hyper-Realist style in the United States [9]. Their works were inspired by photographic representations of reality and were therefore highly detailed and painstakingly crafted. Indeed, photography could capture subtleties of reality that the naked eye could not see, and it also cooled the image through the mechanical process. Hyper Realism extracted every detail from a snapshot and reproduced it using creative materials and techniques. While realists, particularly in painting, believed that the object to be portrayed was nature, Hyper-Realism believed that the object model should be a photographic representation of reality. Hyper-Realism was a style that arose in the United States during the second half of the 1960s and gained international recognition. By employing a precise, meticulous technique to create images that were ‘more real than real’, hyper-real in fact, those artists created paintings and sculptures that contained every detail of reality, details that at times were invisible to the naked eye and could only be captured by a photographic lens. Malcolm Morley, widely regarded as the style's founder, Chuck Close, Richard Estes, Franz Gertsch, as well as the sculptures of Duane Hanson and John de Andrea, reconstructed scenes of typically American daily life using increasingly sophisticated artistic techniques [9].

Natural forms were analysed through the camera lens in an aseptic, almost scientific manner, without the artist's emotional involvement, resulting in an unpleasant formal reality. The visuals that resulted from it created unease in the observer since they exhibited a hyper-reality that not even the eye could comprehend, casting doubt on vision science and exaggerating the attributes of each form. Certain artists in Europe were also working along similar lines, however, their work differed in some ways from their American counterparts. Gerhard Richter distorted the image optically in Germany, whereas Gerard Titus Carmel and Jacques Monory in France, as well as Francisco Lopez and Antonio Lopez Garcfa in Spain, appeared more concerned with defining the form, and while their personal preferences varied, their starting point was always the photographic image. In Italy, Roman Domenico Gnoli, who had been concentrating on the minutiae of magnified things such as shoes, buttons, and gloves for some time, replicated highly realistic bits of many realities. On the other hand, his research was fully autonomous in that it was not based on photography but rather on graphic suggestions of philosophical origin.

## 5 The Contemporary Period

The current topic appears to be the hunt for a new persona. The 1990s were marked by a profusion of subjectivity-related issues that are difficult to speculate on and that do not adhere to the conventional concepts and conventions of art criticism. This subjectivity appears to pertain primarily to the legal right of the individual citizen to live creatively. More than art theories or research, the contemporary art scene appears to be defined by the individual's indiscriminate ability to express himself without regard for objective theoretical or formal rigour. Today's young artists (and here we are speaking specifically to Italians) find themselves operating in an increasingly mobile and provisional reality or system, a continuous, fluid, unpredictable cycle of events that offers neither support nor certainty. This situation began in Italy, specifically in Milan, in the mid-1980s, when a group of artists rallied around the figure of Corra do Levi, an artist, and thinker. As the artists of the 1990s, their work was frequently diverse, eclectic, and frequently antagonistic. They were no longer organized in avant-garde groups, tendencies, or schools in quest of an objective language, they found themselves in logistical or generational groups. Despite the fact that their content may have dealt with social issues or subjective issues, it is still difficult to categorise the works produced during the 1990s because they do not appear to have the specific characteristics of a language; however, it is perhaps because of this that these proposals are so timely and exciting, as they correspond to the expectations of the rest of the world. Every artist, just like every citizen, studies the world within and without. He tries to bring back to the artwork a combination of sensitivity and emotivity rather than an objective vision of reality or an answer to the world, analysing it through the spirit of research that has always marked the avant-garde, as in the case of the Germans, Franz Ackermann, Michel Majerus, Robias Rehberger, and others.

From the most traditional visual art to the most current, such as digital photography, cinema and computer graphics up to the Internet and its capillary network for interacting with a wide variety of themes, the techniques used in conversation varied widely. Today the banal, the ordinary, the commonplace, one's secret world, and the necessity to survive cake precedence over the search for the slightest assurance or legitimisation chat one would hope to find among what remains of reality and an artistic system chat are about to undergo a radical change. In truth, art seems to be open to everyone: it is within everyone's reach, accessible to one and all, not only as a fearful viewer but as a protagonist or haughty artist, in an almost "do-it-yourself" that heeds no restrictions but those of one's own private and personal enjoyment. In this sense, the entire art system (museums, galleries, critics, publications, etc.) has become a manual of individual creativity that has little or nothing to do with the study that has typified modern and post-modern art. The objective, universal and all-encompassing languages of the historical avant-gardes at the turn of this century, and their subsequent revival on the part of the Neo-avant-gardes during the second half of the century have been substituted by an incessant, private, subjective chatter that has no scope other than to satisfy itself. It is the private joy of one who wants to say his own thing, and in doing so, does not seek the objective language of art as much as his personal survival, as in the case with Maurizio Cattelan, and Sukran Moral.

## 6 A Focus on Creativity

There are no longer any objective viewpoints in the art world. Artworks are no more the result of the artists' knowledge than the artists' attempts to reconcile the fates of art and the world. The scenario of Art Tech has been referred to on several occasions as 'ordinary art'. The framework of Art Tech thus is carried out. The Frameworks of creativity among different roles are reshaped and developed across various disciplines. Scientists and scholars, technicians, artists and creatives, performers initially focus on their professional disciplines. Scientists and scholars not only focus on knowledge construction (shaped square). Technicians no longer only focus on technology (shaped triangle). Artists and creatives do not solely focus on creativity (shaped circle). Performers are no longer only concerned about the approaches of expressions (shaped pentagon). Everyday art in the digital age is created by citizen artists rather than professional artists; it is a form of self-expression rather than a historical study. Various roles investigate their professional and widen their knowledge and skills to enlarge the barriers of art across disciplines in the framework of Art Tech. Nowadays, movements do not seek to transform the world, as the historical avant-gardes did, or to collaborate on creative form, as the Neo-avant-gardes did. What has evolved most substantially are the movements that see art as a form of everyday survival. The resultant artworks cannot be authentic or beautiful if they do not result in tangible work. A market survey is more significant than a reviewer in this writer's opinion. In any event, many artists include such elements into their work when confronted with the new utilitarian concept. In order to stay anonymous while speaking the truth and reciting the final chapter of this century's art history, they generally use pseudonyms or logos. Contemporary art's main goals have stalled and must be recreated from scratch. Soundscapes, electronic gadgets, programming, data visualization, and other media forms will be skillfully integrated by artists and creatives to make people ponder on life and death, space, awareness. Detailed concept had been illustrated in Figure 1.

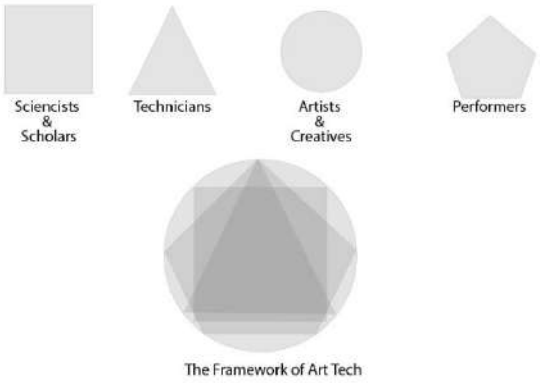



Figure 1: The framework of Art Tech: reshaping Frameworks across various disciplines and focusing on creativity.

## 7 Conclusion

This study investigated the ongoing twenty-first-century's artistic movements to understand the potential reshaping of artistic productions and to analyse the pleasure of viewing works of creative design using a fundamental, straightforward and precise approach. As a consequence of the current digitalization process, new media enterprises are being built, which opens up new chances for artists and other creatives to reach a larger audience. New economic models offered by digital technology also allow artists and creatives to generate and extract more value from their work with a higher level of quality. The value contributed by its users is what makes social media platforms successful. Text, music, and image media have all been digitalized, making this possible. User-generated content influences and transforming public attitudes about commodities and organizations. Social media disrupts traditional production functions by allowing consumers to collaborate with producers to co-create works value outside of the traditional boundaries of creative production, while also reinterpreting the positions of creative middlemen, producers and artists and creatives. Using a fundamental, clear, and precise approach, this research analysed the ongoing patterns of the twenty-first-century artistic era to get a better understanding of the potentially transformed artist outputs or the delight of viewing creative design works.

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# Narrative Ecosystem Analysis on IP 'NKCTHI' using Transmedia Storytelling Approach

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**Abstract**

Transmedia cannot be separated from narratives or stories. Although transmedia is centered on the world building creation, the narrative is the central core in building the story universe. The narratives are interrelated; related and form a narrative ecosystem that is the basis for creating the universe (world building). According to Martha Boni, a transmedia storytelling researcher, a narrative ecosystem has specific characteristics, namely inhabited by narrative forms, characters, and audiences modified through space and time, interconnected narrative structures, tend to achieve and maintain a certain level of balance (stability), governs the universe persistently and can dynamically modify its own narrative according to an often-unpredictable developmental paradigm. An example of a fairly complete narrative ecosystem is the IP 'Later We Talk About Today' or commonly called NKCTHI, where several narrative developments and multi-platform applications change the narrative universe to be more holistic. This study aims to study the flexibility of the systems and processes that govern the narrative universe of NKCTHI through the transmedia storytelling tools approach to map the spread of the narrative (transmedial cartograph).

**Keywords:** NKCTHI, intellectual property (IP), transmedia, story world, narrative ecosystem.

## 1 Introduction

Transmedia storytelling involves the use of various media to tell stories. The legacy of storytelling included in this broad definition is enormous, making experts use many cross-media storytelling tools to study different phenomena. One of the effective ways to deal with media convergence and narrative dissemination is to treat the story world as a narrative ecosystem [1]. It can account for all the aspects involved in producing a cross-media narrative without removing the specificity of each product that configures the ecosystem. The narrative ecosystem treats narratives as complex networks based on interactions between various elements and governed by modularity, interoperability, scalability, scalability, and flexibility. The idea of a narrative ecosystem makes the relationship between various narrative blocks and the many media involved necessary; it makes the narrative universe (transmedia story world) more holistic. Narrative ecosystems are constantly changing, vulnerable to various forms of impact, and are affected by external and internal pressures (including pressure from users).

One of Indonesia's intellectual properties (IP) with a narrative ecosystem is 'Nanti Kita Cerita Tentang Hari Ini (Later We Talk About Today)', commonly abbreviated as NKCTHI, which Marsella FP created. NKCTHI's content first appeared in February 2018 on an Instagram account, containing quotes and slice-of-life illustrations aimed at the target audience aged 18-30 years (millennials). The NKCTHI narrative developed and became popular when it was transferred to book media. It does not stop at the book media, the NKCTHI universe also penetrates the film, which was released on January 2, 2020 [2]. IP NKCTHI also collaborates with big brands such as Uniqlo and Toyota. In its development into these various media, the NKCTHI narrative is not redundant with the book content, but the narrative changes, moves, or borrows references from the primary narrative (intertextuality). Dissemination of NKTCHI content in various media without losing the primary narrative further strengthens and develops the universe of NKCTHI, enriches its narrative ecosystem, and strengthens the relationship between the media used.

Based on the previous phenomena and background, it is interesting to analyze how the universe's expansion from NKCTHI changed the old narrative ecosystem and enriched the story world itself. This research aims to study the flexibility of the systems and processes that govern the narrative universe of NKCTHI through the transmedia storytelling tools approach.

## 2 Method

The data collection methodology that the authors use in this research is a qualitative research methodology, which also

involves philosophical assumptions and a theoretical framework. The qualitative method to be used is observation and literature study to obtain data that will be processed and describe the narrative ecosystem in the NKCTHI universe.

## 3 Narrative Ecosystem and Transmedia

The narrative ecosystem itself is an interdisciplinary paradigm used to describe contemporary narratives (written and unwritten). This approach focuses on the complex web between the products that produce and therefore belong to the same narrative, studying their relationship and the balance between the apparent narrative material and the non-biological media landscape it contains. Therefore, the narrative environment is open, both to the characters and the audience, then develops according to the principles of selection and evolution. In particular, it is governed by modularity, interoperability, scalability, scalability, and flexibility [3].

Along with the development of the era and technology, narrative distribution also has the flexibility to expand and spread to all platforms/media, both conventional and digital. It can attract various kinds of audiences actively and widely. One of the new types of narrative distribution is called transmedia storytelling where it is a new type of storytelling in which engaging narratives are produced in various channels. Because of the narrative information from previous platforms, viewers enjoy the story more with each new platform.

Jenkins [4], describes transmedia as an integrated approach in developing a message conveyed in various media platforms that contribute significantly to the audience's understanding of the world. Meanwhile, Pratten [6] stated that transmedia storytelling tells stories through various platforms, wherein the audience participates in the presentation to achieve a comprehensive experience. The challenge to achieve this is when each media can still be enjoyed singularly. However, the culmination of the experience will be obtained when all media have been accessed and understood. The elaboration of the definition focuses more on the production process and not on the audience's consumption process. Transmedia Storytelling should prioritize the audience as the core. With this understanding, Pratten concludes that Transmedia Storytelling is a narrative process that can take the audience on an emotional journey from one moment to another through various media.

## 4 NKCTHI universe

Transmedia Storytelling is a particular narrative structure that develops through different languages (verbals, icons, etc.) and media (cinema, comics, television, video games, etc.). Transmedia Storytelling is not just an adaptation from one medium to another. For example, comics' stories are not the same as those told on television or in the cinema; different media and languages construct the transmedia narrative world. Transmedia creates a narrative flow that does not stop in one medium/platform. This textual spread is one of the most important sources of complexity in contemporary popular culture [7]. There are three essential aspects of how a brand or IP can be called implementing Transmedia, namely: the first aspect is that the narrative is spread through several media platforms, the second aspect is the narrative that is spread, not the repetition of content but expansion; so that it becomes a new and relevant narrative presented in a media platform that is different, and the last aspect is audience engagement, where the narrative must be able to make the audience interact or participate [8].

One of Indonesia's contemporary popular cultures that applies transmedia storytelling is Later Kita Stories About Today (NKCTHI) created by Marcella FP based on a collection of personal daily life experiences of writers and Indonesian millennials. The main narrative of NKCTHI is packaged in the form of a book published in October 2018 [9]. Semesta NKCTHI does not stop at the book. The narrative evolves to reach many audiences with various platforms, following the first aspect of transmedia storytelling. As Robert Pratten put it: "the experience of enjoying all media must be greater than simply enjoying some of its small parts." [10]. The individual narratives of each platform are based on meta-narratives [11], or the grand narrative world.



Figure 1: NKCTHI book
(Source: https://www.gramedia.com/blog/fakta-di-balik-larisnya-buku-nanti-kita-cerita-tentang-hari-ini-marchella-fp/)

Narrative distribution from NKCTHI starts from posting short quotes (quotes) and illustrations about daily life (slices of life) on Instagram social media with an account called @nkcthi, created in February 2018. Then the collection of quotes is assembled and made into a book of the same name, NKCTHI, which contains a character named Awan, a mother who wants to convey a message to her children and grandchildren in the future by writing a letter. Each page's content is written with short quotes about everyday life and added visuals in illustrations. This NKCTHI book is included in the flash fiction category. Flash fiction itself can be defined as a popular writing genre from the creative writing process that contains elements of short stories. Flash fiction can also be called sudden fiction, short-short stories, micro-fiction, and micro-stories [12].

The narrative in the NKCTHI book is the center of the NKCTHI transmedia universe. From this book, the expansion of content and narrative to various platforms develops dynamically because the strategy for expanding content and

narrative in the NKCTHI universe is not all planned from the beginning, unlike the Marvel Cinematic Universe (MCU) or the Star Wars Universe. For example, where the NKCTHI narrative switches platforms to web series, there is a retranslation of the narrative where each web series is taken from a page in the book. Meanwhile, when it develops into a feature film, the content departs from the characters in the book. Carlos Scolari [13] mentions the importance of cross-media storytelling for branding products, IP, or companies. He describes how media storytelling creates a symbolic world for consumers. Usually, in Transmedia, one platform also borrows the aesthetics of another platform to produce a coherent story world [14].

NKCTHI's narrative theme in the form of slice-of-life makes content expansion more dynamic to enter into other platforms or collaborate with brands. For example, NKCTHI's collaboration with Gojek. Gojek is a multi-service platform and digital payment technology brand that collaborates with NKCTHI to create a book about the story of Gojek's partners where the content is visually similar to the NKCTHI book with the use of quotes and illustrations but with a different narrative point of view. [15]. Likewise, the collaboration with the Toyota brand has produced a web series where the narrative is a continuation of the NKCTHI feature film. The distribution of content from the NKCTHI brand does not always focus on the book's characters' stories. Based on the analysis and observations in several media, the NKCTHI narrative becomes easy to spread because the content is more personal to the audiences and the choice of platforms and media that are widely used by the audiences in interacting and communicating.

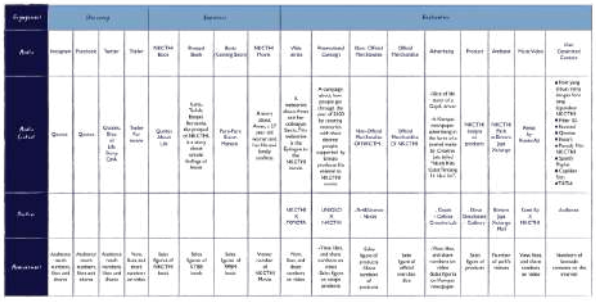
Table 1: NKCHI platform and media

| Location Agnostic | | Location Dependent | |
|---|---|---|---|
| Personal | Shared | Personal | Shared |
| Quote Posts<br>Books<br>Webseries<br>IG Filter<br>Playlist<br>Music Video<br>Product Collaboration<br>Newspaper Advertising | | | Movie Poster |
| Promotional Campaign<br>Merchandise | | NKCTHI Park | |
| Movie | | | |

The selection of the NKCTHI narrative and platform focuses on the audience to participate and interact. One example is the official Instagram account @nkcthi which, until September 2021, has 1.5 million followers with an engagement rate of 4% [16]. This Instagram account actively engages its audience by using participatory features from Instagram, such as IG Story with question stickers, poll stickers, and the like. One of the Instagram posts released on July 13, 2019 with a simple illustration that says Terima kasih sudah bertahan (Thank you for holding on) and the caption: Perjalanan panjang, kalau sempat rasakan kelelahan. Tolong dibaca ulang pesan ini #nkcthi (It's a long journey, if you feel tired. Please reread this message.) received a relatively high audience response with 185 thousand likes and 2,990 comments.

Then to strengthen the ambiance and translate the space and feelings of people reading feeds on Instagram or NKTCHI books, Marcela FP as the author, created a playlist of official NKCTHI songs that can be listened to on Spotify [17]. This treatment can make the audience feel more immersed when reading excerpts from every book or Instagram feed.

Table 2: NKCHI media engagement



The reliability of content with a high enough audience, such as the quarter-life crisis and daily life problems experienced by Indonesian millennials and their habit of pouring out their hearts on social media, make NKCTHI content easy to accept. These contents increase engagement, audience participation, and the novelty of the content of the @nkcthi account itself; it can also be one of the media for collecting material to expand the narrative to other platforms. The relevance and popularity of NKCTHI also resulted in even higher audience participation, where they made UGC or parodies of NKCTHI's official content that had appeared before.

The NKCTHI book also opens the door for narrative expansion to other platforms or media. Several narratives, such as Instagram filters, NKCTHI book series, are divided into four parts (morning, afternoon, evening, and evening). There is also a NKCTHI prequel book entitled 'You Are Too Many Jokes' (KTTB), interactive games, NKCTHI widescreen film, and NKCTHI prequel film entitled Story of Kale. The collaboration between NKCTHI and musician Kunto Aji in the song 'Rehat', NKCTHI park in Bintaro, and many others are also done to widen the NKCTHI universe. Klastrup & Tosca quoted from van Leeuwerden [18], define a story world into three core features: Mythos (the establishing narration of the world with the defining struggles), Topos (setting of the world geographically and historically), Ethos (the moral codex of the behavior of characters).

The application of the NKCTHI narrative to the three core features above can be seen from the following example. In the NKCTHI book, it is explained that the book's backstory is a character named Awan who gives a message to his future children and grandchildren about how to experience life and how to go through it. While in the NKCTHI features film, the backstory tells the story of three brothers named Angkasa, Aura, and Awan, who face new experiences and challenges as their family secrets are revealed. The depiction mythos can be seen in the prequel film called 'Story of Kale', where the backstory of this film tells the point of view of Kale's

character who goes through a toxic relationship before meeting Awan. The difference in backstory does not make the narratives between media increasingly distant; the narrative thread is maintained through the character Awan and his narrative premise that builds mythos in the NKCTHI universe. In general, the universe of NKCTHI has explained the myths in its world quite deeply and easily understood by the audience. Moreover, information about topos is already available in full or in part from the media and platforms that have been published. From the NKCTHI book, the description of topos can be seen from the timeline where Awan's character had become a mother and has children.

In contrast, the timeline in the features film NKCTHI is a prequel to the book, where still revolves around when Awan's character was still a teenager and very protected by her family, has not experienced any problems that changed her life entirely. On the same timeline, the film Story of Kale, tells the point of view of the character Kale, who is one of the characters who changed Cloud's view of life towards relationships and the world. The audience can understand and feel familiar with the world of NKCTHI, because the universe of NKCTHI is the world of the audience itself, where their daily lives are there. The depiction of ethos is quite evident in his two feature films (NKCTHI and Story of Kale). For example, the character Awan, the youngest child, is always pampered by his family and treated special; this makes the character fragile when facing a problem. Whereas in her book, Awan's character has grown up, mature in thought and wise in making decisions in life. Problems such as toxic positivity, quarter-life crisis, mental health presented in the NKCTHI narrative make it easier for the audience to relate and understand the meta-narrative of the NKCTHI universe.




Figure 3: NKCTHI narrative distribution

## 5 Conclusion

NKCTHI universe and its narrative distribution succeeded in making the audience understand the meta-narrative of the NKCTHI narrative itself. Audiences are interested in participating, interacting, and contributing content to expand the NKCTHI narrative to other media and platforms. Unhurried narrative development, gathering content, increasing engagement before the final narrative is made makes it easier for NKCTHI to become a holistic narrative universe. Transmedia storytelling NKCTHI develops organically, where producers or content creators try to understand the audience and even create new narratives based on the content created by the audience.

Narrative adaptations vary from media and platforms but always leave the same narrative trail. As Jenkins explained that every medium must be enjoyed without having to understand the previous medium. Creating coherent complex transmedia narratives requires a degree of storytelling control, which, based on Schiller [19] responds to the growing influence of fans, the industry will have to produce an enhanced diversity of characters and story world representations, as already happening to a limited extent. Based on the results of this study, it can also be concluded that the distribution of NKCTHI narratives is able to respond to the needs and influence of the audience on the content. Problems such as toxic positivity, quarter-life crisis, mental health as the main content in the NKCTHI universe are brought to life in characters that relate to the target user, so that user feel familiar and feel that these characters are a reflection of their daily lives. When the content is analyzed and expanded into many platforms according to the audience's behavior, it enriches the NKCTHI universe in the future.

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# Analysis of Vertical Music Videos in a Mobile Environment

Focusing on Music Video of K-POP Group LOONA

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**Abstract**
In 2005, YouTube, a video-based SNS service was started. Since then, personal video content creators have begun to increase exponentially. In addition, as people's usage patterns changed from a web environment to a mobile environment, a new usage behavior emerged.
Modern people use cell phones 24 hours a day. It was not difficult to predict the development of vertical content in this mobile use environment. This is because contents produced horizontally, focused on traditional media, inevitably have gaps in the upper and lower parts when viewed on a vertical screen. For this reason, it was predicted that not only the platform but also the content will change rapidly depending on the vertical environment.
This study selected the music video of the Korean K-pop group LOONA as the case. This is the first time in Korea that vertical music videos have been released in a row. Therefore, it is predicted that many useful skills for vertical music video production will be shown.
As a result of the analysis, LOONA's music video had features such as composition, depth, divided screen, moving camera, and shots. The contrast between black and white and primary colors gave a strong feeling, and objects on the screen are designed so that the viewer is not bored. It also uses the depth of the screen to give the impression that the screen looks wide. The main character's running scene also gives viewer a sense of speed and depth. Dynamic scenes are also created through screen segmentation.
Through the case study of this paper, it is possible to find factors that can be effectively applied to vertical images. This can be used not only for music videos but also for various contents in the future and will contribute to media development.

**Keywords:** Vertical Music Video, K-POP, Mobile

## 1 The Background and Purpose of the Study

In 2005, YouTube, a video-based SNS service was started. Since then, personal video content creators have begun to increase exponentially. In addition, as people's usage patterns changed from a web environment to a mobile environment, a new usage behavior emerged.

As the media changes, mobile media content consumption behavior also changes from the "Horizontal First" which consumed existing horizontal content first, to the "Vertical Only" (Kim Minsung, 2019). In line with these changes, vertical content was produced on many platforms, and people assumed that vertical content would be a huge part of new media.

However, although 94% of the population is using mobile devices, the reality is that the development of vertical content is slow. There are two reasons for this, because the first is difficult in the making of the content, and the second is unfamiliar in a multi-device environment.

In order to find out the factors that prevents the growth of vertical content in the mobile environment and to find out how to overcome it, the music video of the k-pop group 'LOONA' was analyzed. Through the analysis of the music video of 'LOONA', we would like to present the direction of vertical content in the future.

## 2 Mobile Media Environment And Vertical Film of YouTube

### 2-1 Mobile Media Environment and Content

As of 2017, 94% of people in Korea use smartphones. This can be seen that almost everyone is using a smartphone except for young children. With the increase in smartphone users, people's lives have also quickly adapted from the web to mobile. As Instagram began to appear in 2017, platforms using mobile vertical content became more popular.

Modern people use cell phones 24 hours a day. It was not difficult to predict the development of vertical content in this mobile use environment. This is because contents produced horizontally, focused on traditional media, inevitably have gaps in the upper and lower parts when viewed on a vertical screen.

In other words, when horizontal video is viewed without turning the screen on the smartphone, the impact is reduced as it fills only about a third of the entire screen. Nevertheless, media analysts have observed that many people do not necessarily turn their smartphones sideways to watch videos loudly. People are reluctant to tilt their smartphones alternately

vertically and horizontally(Song HwaSun, 2018). For this reason, it was predicted that not only the platform but also the content will change rapidly depending on the vertical environment.

### 2-2 Youtube Platform and Using Multi Screen

With the development of smartphones, modern people can use various contents 24 hours a day at any time they want. In particular, youtube is a platform where content creation and consumption occur at the same time. And they can communicate freely on YouTube.

YouTube was officially founded on February 14th, 2005. The first video followed on April 23rd, with co-founder Jawed Karim publishing “Me at the zoo”. (https://backlinko.com/youtube-users “how many people use youtube in 2021”)

Starting with this historic first video, YouTube has become a platform with the world's best users. YouTube can be played not only on computers but also on various media such as mobile devices and smart TVs. However, content creators are produced and published at one screen ratio. Therefore, when YouTube contents are used in a multi-device, the user has a different experience depending on the ratio of the screen.

If you play vertically produced content on YouTube on your mobile and watch it on full screen, you can watch it without loss or modification of the content. However, when viewing vertical content on the web, the horizontal ratio is set as the default value, so there is a margin on the left and right sides of the content. In the early days of YouTube, the margins shown on the screen were black color. However, the margin has recently been changed to white to reduce the sense of difference that users watching on the web can feel.

Nevertheless, since vertical content still has a lot of screen loss in web use situations, users are easily lost concentration. It is that the probability of getting attention to other content outside the screen increases.

## 3 Music Video And Vertical Music Video

### 3-1 Characteristics and History of The Music Video

The opening of MTV (Music Television) is a milestone in the history of music videos. On August 1, 1981, Music Television (MTV), a music cable channel that broadcasts only music videos 24 hours a day, opened as the first song of Bugles' <Video Killed the Radio Star>. Since then, videos that have been variously called have also been integrated into the word 'music video' (LeeJong-won, 2019). Even now, numerous singers are trying to produce music videos and feel the art of hearing with peole’s eyes.

In the music video, visual and auditory harmony is achieved through the combination of music and video. This has become a unique genre of popular art (Bum Mun-yeon, 2021).

Now, instead of airing music videos on TV, you can watch music videos on mobile anytime, anywhere you want. Therefore, the music video is now familiar to modern people. In addition, the influence of music videos is also increasing as people around the world can enjoy them on various platforms. For this reason, research on music videos will have a positive effect on the development of K-POP culture.

### 3-2 The Limit of Vertical Music Videos

Kim Min-sung (2019), who studied the remediation of vertical videos in a mobile media environment, summarized the types according to the characteristics of vertical videos as follows.

| Types | Types of Expressions |
|---|---|
| Types of expressions according to changes in mobile hardware and software. | Expressions using mobile displays |
| | Expressions using mobile interface |
| Types of expressions in vertical environment of mobile | Expressions using platforms |
| | Expressions of character-centered |
| Types of effective use of vertical video | Expressions for mobile marketing |
| | Expressions using traditional media format |

**Table 1** Type of vertical video according to the characteristics

As shown in the table, YouTube's vertical video has more content such as advertisement, music, and comedy than content of narrative.

Vertical content may experience various problems in the production process. First of all, the main character can easily go out of the screen during filming. This is because the screen is long up and down. Thus, it is difficult to construct a dynamic scene.

Also, because of the narrow screen, when two or more characters appear on the screen, the distance narrows or the characters overlap.

For this reason, the scene that the characters talk becomes awkward, and it is difficult to construct a narrative in the video.

## 4 Case Study

### 4-1 Case

As an example of the vertical music video, a total of four songs were selected: k-pop singer LOONA's <Hi High>, <New>, <Odd Eye Circle>, and <Eclipse>.

LOONA released a vertical music video promoting LG and smartphone G6 in 2017. A music video that fits each member's image was produced.

This is the first time in Korea that vertical music videos have been released in a row.

LOONA's music video used various attempts and experimental techniques to effectively use the vertical ratio. So it will be possible to present a new direction for the vertical video.

### 4-2 Analysis Factors

Analysis elements were classified into color, composition, depth, screen division, camera walking, and scene change. Cases commonly appearing in four music videos were selected, and six factors that could stimulate viewers were selected.

**4-3 Analysis**

a. Composition

In the music video of LOONA, we could see a lot of case types using the diversity of composition.

A long vertical screen could also be used to induce the gaze to move from top to bottom. Images such as falling from the diving board, diagonal stairs, and ink flowing from top to bottom make a viewer's gaze move from top to bottom.

Another case is to show the scene vertically, which is often seen in traditional media. This gives viewers an unfamiliar experience, and at the same time, viewers feel refreshed. Louis Giannetti said in his book 'Understanding Movie' that the director can place objects on the edge of the screen to destroy visual balance and create images suitable for a more psychologically dramatic context.

One example is the use of close-ups. Close-up is used to enlarge the subject extremely, or wide-angle shots are used to distance the viewer. The distance between the camera and the subject is proportional to the distance the viewer feels. If this is used effectively, viewers will be interested.

In addition, a case of showing a new composition using diagonal objects or light could be found in the music video.

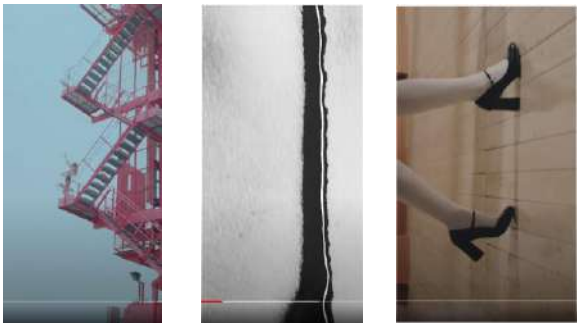


Figure 1. Diversity of composition.

b. Depth

Due to the nature of vertical content that cannot be widely used left and right, vertical music videos are more effective when using screen depth. In LOONA's music video, you can see the main actor running down a long hallway or jumping out of a building. This expresses the depth of the image, making it feel dynamic.

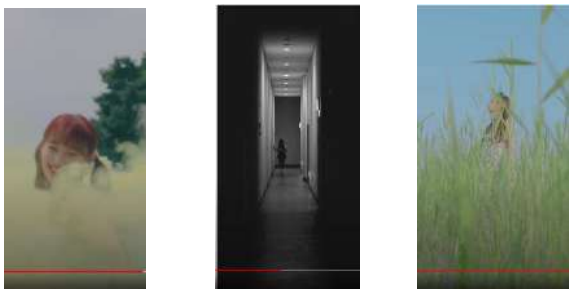


Figure 2. Show the depth in screen

In addition, there were many scenes that showed depth using props in the two MVs of <Eclipse> and <Hi High>. Small objects such as smoke, leaves, snowflakes, and lighting can be placed in front of the screen to give depth as well as mystery.

c. Divided screen

The technique of dividing the screen up and down in a music video is a screen segmentation method that is difficult to find in traditional media. In traditional media, medium short is often used. Medium short shows a person from above the knee or waist, which is often used in scenes where the person moves or talks(Louis Giannetti, 1987). However, in vertical videos, medium short is difficult to use due to the proportion of the screen. However, when the screen is divided, even if many people appear, they may not be out of the screen.

In the music video of LOONA, not only did it use props to change the screen composition, but also intuitively divided the screen to show different subjects or showed it to the main character's other camera to give a fresh visual effect.

In addition, by dividing the screen up and down and arranging the images symmetrically, a new shape was given to the subject that may become boring. This is a technique that cannot be attempted in traditional media and can be said to be a new technique that appeared in vertical music videos.



Figure 3. Music Video <Eclipse>

d. Moving camera

Another technique is camera movement. In the 360-degree camera rotation filming in the vertical image, the subject does not disappear even on a narrow screen.

<Eclipse> of LOONA was filmed on a circular stage and a circular building as if expressing the meaning of "moon." Therefore, the 360-rotation technique using the circular place was used for the camera's movement. The camera rotation motion around the actor in the music video is a special directing method used to highlight the actor. When the camera rotates around the actor, the background continues to change, and the viewer focuses on the subject (Sung Changkyung, 2012), when the camera rotates 360 degrees, the viewer changes visual emotions.

The advantage of a 360-degree camera moving in vertical music videos is that you can place a singer in the center of the screen and see the choreography and performance from various angles.

e. Shots

Yoonhoo Kang and Jin-ho Park (2020), who studied YouTube music videos, analyzed the frequency of shots of popular

music videos in Korea. The average song was 120-130 BPM, with a frequency of about 50 shots per minute.

"LONA"'s <new> music video was also filmed at the average K-pop level with an average of 45 scene changes per minute.

But the important thing is the duration of the shot. If the duration of the shot is equally distributed in all videos, viewers are more likely to feel bored.

In addition, if the tempo of music is not fast, it will be less immersive.

Looking at the music video of <new>, objects located in the center appear in a short time of about a second, giving a strong impact. Most of the objects have the symbolism of music, and through this, the atmosphere of viewers was changed and immersed. Having such a short shot also means that there are shots with a relatively long time. It is effective in drawing visual and emotional changes by sensibly arranging short shots and long shots.

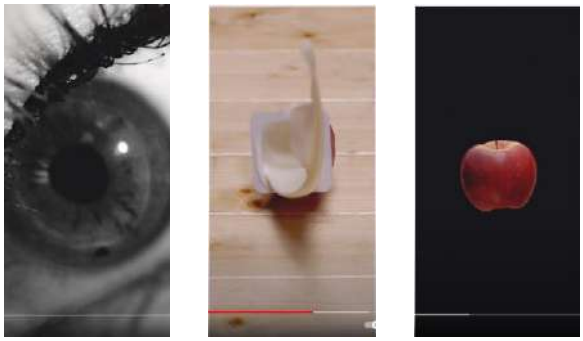


Figure 4. Music Video <New> and <Odd Eye Circle>

## 5 Conclusions

As the media usage environment changes mainly to mobile media, changes in content are essential. People are getting used to the vertical screen of mobile, and they are getting used to vertical content. However, despite the change in the media used by people, not much research has been conducted on content.

For vertical content, it is important not only to study traditional media techniques, but also to find an appropriate expression method for vertical ratio.

Through the case study of this paper, it was possible to find factors that can be effectively applied to vertical images. Composition, depth, divided screen, moving camera, and shots will be a good way to add visual pleasure and emotional effect to vertical images. This can be applied to various contents as well as music videos in the future and will contribute to the development of new media.

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# Deep Learning Based Estimation of Exercise Effects from Workout Videos

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**Abstract**
This paper proposes a method to predict EMG potential from workout videos with deep learning techniques. The proposed method estimates skeletal information, then predicts the EMG potential of the target part of the body. The experimental study shows the LSTM model can predict EMG potential with high accuracy.

**Keywords:** Deep Learning, EMG prediction, Pose Estimation

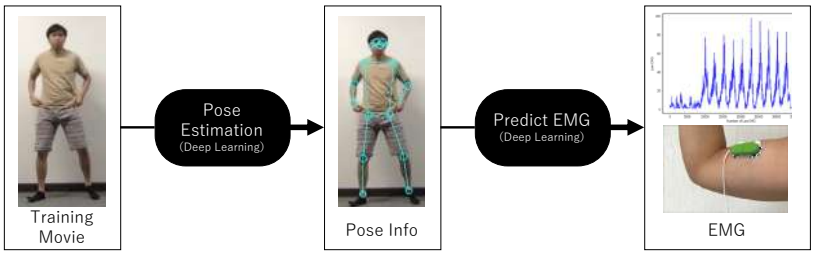



Figure 1: The proposed method predicts the posture from the training video and predicts the muscle potential from the posture information with high accuracy.

## 1 INTRODUCTION

In recent years, there has been increasing attention to workout. Workouts are performed for a variety of purposes. Workouts are important for the elderly to prevent accidents caused by muscle weakness associated with aging. Athletes also work out to improve their performance in competition. Many people in the general public also perform strength training in order to lead a healthy life. In order to work out effectively, it is necessary to perform the exercise with proper form. So, it is important to receive guidance from trainers in gyms. However, going to gyms requests people money and time. In addition, in recent years, many people prefer to avoid going to the gym to avoid the risk of infection of COVID-19. In such a situation, some applications and games have been developed to support workouts at home. However, although they are easy to start, they do not accurately evaluate the effect of their workouts.

Up to now, some methods have been proposed to accurately evaluate the effects of workouts. A typical method for this purpose is the use of myoelectric potential. The myoelectric potential of a part of body can be calculated as the sum of the action potentials of the muscle fibers that make up a muscle when they contract. By measuring the myoelectric potential, it is possible to predict how much load is applied to the target part of body. Some systems that senses biometric information such as myoelectric potentials while a trainee is working out and evaluates them to provide feedback on exercise evaluation have been proposed [1]. The main purpose of those systems is to support workouts and rehabilitation. However, they require special equipment, such as EMG sensors, to be prepared. Since most of these devices are expensive, and it is not practical for most people to use them at home. In addition, wearing the EMG sensors is a cumbersome task for the user, which is an obstacle to using it for continuous workouts on a daily basis.

In this paper, we propose a method that uses deep learning techniques to accurately predict the myoelectric potential of a target part of body from workout videos taken with a smartphone camera, etc., without the need for a special device such as an EMG sensor. If we can accurately predict the EMG potential of various parts of the body during workouts from the workout videos, we can evaluate the effectiveness of the training and provide various feedbacks to the user for effective workouts.

An overview of the proposed method is shown in Figure 1. The proposed method uses deep learning techniques to make predictions in two stages. In the first stage, the user's posture in each frame is predicted from the workout video. In the second stage, we predict the myoelectric potential at each time from the posture.

The contributions of this paper are as follows.

1. We proposed a method to predict the EMG potential of the target part of the body during workout with high accuracy with machine learning techniques.

2. The experiment shows that LSTM is suitable as a machine learning model for predicting the EMG potential.

# 2 PROPOSED METHOD

## 2.1 Approach

In order to estimate EMG potential from a user's workout video with deep learning techniques, it is necessary to recognize the state of the user's movement from the workout video. In general, various objects are captured in video images, and the angle of view and size of the images vary. Therefore, it is difficult to obtain a general-purpose machine learning model that can predict with high accuracy using video images as input directly. Therefore, in this study, we adopt an approach that detects the posture of a video image using a general posture estimation algorithm and estimates the EMG potential using the posture information as input. In this study, instead of using the workout video as a direct input, we perform posture estimation on the person to be trained and use the posture information obtained from the posture estimation as an input to predict the EMG potential using deep learning.

## 2.2 Posture Estimation

Posture information from videos is actively being studied because it is expected to be applied in various fields such as gesture recognition and game interfaces [2]. In this study, we use PoseNet [3], one of the representative posture estimation methods, for posture estimation. The 17 characteristic coordinates of the body can be obtained with high accuracy by using PoseNet.

## 2.3 Estimation of Muscle potential from

In this paper, we propose three types of deep learning models to predict EMGs from posture information. The following the three models.

- Fully coupled (NN) model: Simple model with only fully coupled layers
- CNN model: A model that uses convolutional layers to capture planar features of posture information.
- LSTM model: A model that uses LSTM layers to capture time-series features

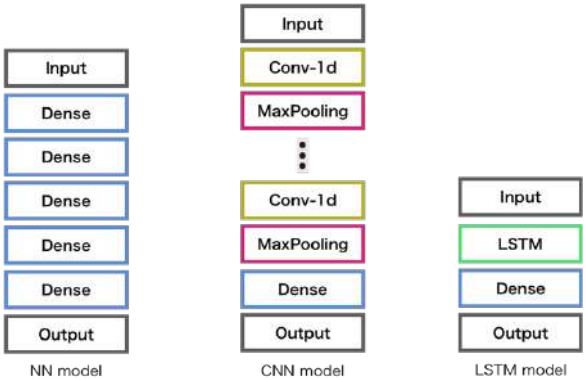



Figure 2: Three types of deep learning models.

# 3 EVALUATION EXPERIMENT

An experiment was conducted to evaluate the effectiveness of the proposed method. Using the experimental dataset, we predicted the EMGs for the unknown workout videos using the proposed method. We calculated the error of the predicted data and compared the accuracy of each of the three deep learning models.

For making the training data we asked a subject to do the squats as one of popular exercise on workouts with EMG sensers. For the training data, the subject repeated 30 sets of 10 squats as one set. Video data and EMG potential data were acquired during the workout. Muscle BIT made by Bitalino Co. was used to acquire the EMG data. Then, for making the test data we asked the two subjects to do the same activity with EMG sensers, One of the subjects is the same person as the training data, and the other subject is a different person.

Figure 3 shows the average error of the prediction using the test data for each model. The experimental results show that the LSTM model is the most suitable for EMG potential estimation, because the LSTM model has the lowest prediction error. Figure 4 shows an example of the result of predicting EMG potential with LSTM. The green line in the graph shows the EMG potential measured by the sensor, and the red line shows the EMG potential predicted with the LSTM model.

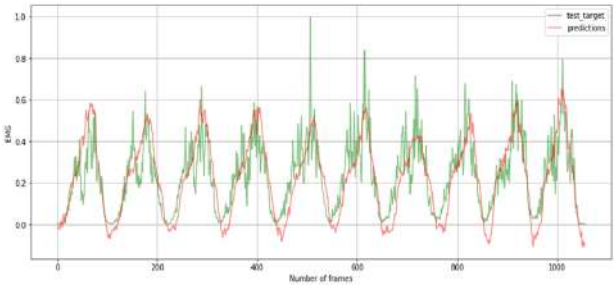



Figure 3: Average value of the error in the prediction result

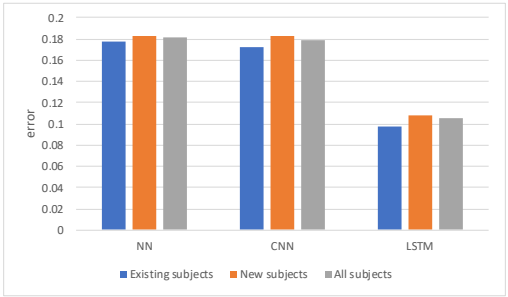



Figure 4: Results of the prediction EMG using LSTM

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# A Study on Visual Attention between Webtoon and Comic Book through Eye-tracking focused on Romance 101

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**Abstract**
In this study we aimed to analyze the difference in the reader's visual attention to content according to the difference between the mobile layout of a webtoon and that of a comic book. To compare the visual attention paid to the webtoon compared with that paid to the comic book, experiments were conducted using eye-tracking. There was a difference in visual attention between the webtoons and comic books. The attention paid when the animation technique used a webtoon's scroll method was different from that paid to a comic book. This result demonstrated that there was a difference in visual attention according to the media. Thus, this study proposes which production items should be considered for each medium based on the reader's visual attention.

**Keywords:** Layout design, Webtoon, Comic book, Eye-tracking

## 1. Introduction

Webtoons were established as a type of content with the popularization of smartphones. Compared to 32.1% in 2015 [1], the rate of reading cartoons more than once a week increased to 58.1% in 2020. The rate of reading webtoons was 68.6%, that of comic books alone was 4.4%, and that of both webtoons and comic books was 27.0%, indicating that the rate of reading webtoons was the highest [2]. With this increasing read rate of webtoons, a comic book “I love scary things!” drawn by Lee Dongkyu, which was popular in 2002, was put into a webtoon form and serialized on Naver Webtoon. The rate of reading comic books is lower than that of webtoons, but 22.6% of webtoon readers have experience purchasing comic books of webtoons. The proportion of readers intending to purchase comic books in the future was 23.4% [2], which indicates that popular webtoons are published in the form of comic books, resulting in a transfer between different media. Accordingly, a comparative analysis study substituting the format of webtoons with that of existing published comics [4], and a study on editing conversion from published comics to webtoons [5] were conducted. Choi, et al. (2012) analyzed readers’ scrolling speeds, and presented a webtoon design technique using a practical viewing method [6]. However, scrolling speed does not necessarily measure visual attention, since it cannot determine how much or where the reader's attention is concentrated. Thus, in this study sets we investigated the differences readers have in visual attention when viewing content in the mobile layout of webtoons versus the layout of a printed comic book, using eye-tracking. We aimed to propose what production matters for each medium should be considered based on the reader's visual attention.

## 2. Theoretical background

A frame is a minimum unit in a cartoon, which is similar to a cut, a minimum unit in video editing [7]. Authors of webtoons and printed comic books make an entire page layout by arranging frames consecutively. This arranged state is called a layout, and planning the size, shape, and location of a frame, whether to make it bigger or wider, is known as “layout design” (Figure 1) [8].

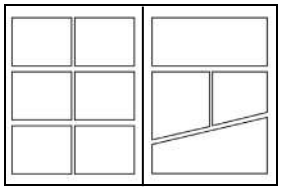


Figure 1: Layout and layout design image

According to a study by Lee and Jun (2015), the layout of a webtoon is different from that of a printed comic book. A comic book has frames in one or two pages, whereas a webtoon has a long vertical structure, suitable for reading in a mobile environment [9]. A page in a comic book is partitioned into frames, so the layout on each page can be seen at once. In contrast, a webtoon has long vertical frames, in which the entire layout of the webtoon cannot be viewed on a mobile device. The layout of two or three frames on a mobile screen corresponds to the layout of one page in a comic book. Thus, this study viewed the two to three cuts on a mobile screen that can be seen at a time as the mobile layout of the webtoon. Choi et al. (2012) divided the scenes where scroll fixation and navigation occur in this vertical structure into “speaking” and “viewing” areas. They claimed that scenes where scrolling was fixed were “speaking” areas, in which text information

maintains visual fixation, whereas scenes where scroll search occurs were “viewing” areas, in which test information was small, resulting in faster scrolling speed [6]. With the use of this vertical scroll mode in webtoons, a unique layout design method has been devised using the vertical layout characteristics. The mobile layout design of webtoons has a long vertical canvas with a narrow horizontal width, so that a speech bubble comes out of the frame, or the speech bubble spans both the frame and the blank space at the same time [10]. Sometimes, a frame is not bordered by lines at all. Due to this mobile layout design, it is difficult to determine the scope based on the page unit of a comic book, and the division between scenes becomes ambiguous [10]. As the frame's borderline is not constrained by the page, due to the scrolling of a webtoon, the continuous motion sequence of the animation can be freely utilized, increasing the sense of liveliness and dynamic power. Kim (2007) mentioned the effect of continuous motion sequences in frames when looking at frames from top to bottom as an animation technique [11] (Figure 2). This animation expression can also be viewed in comic books. In Captain Underpants [12], animation movements were expressed like a flip book by thumbing through the current and next two pages. This expression is called Flip-O-Rama in a cartoon (Figure 3).



Figure 2: Example of applying an animation technique (Webtoon)
[13] (Kim, S. E.,2017; re-cited in 2021), [14]

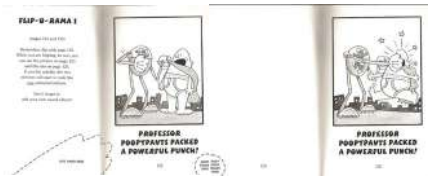



Figure 3: Example of applying an animation technique (Comic book) [12]

Every frame in a comic book has borderlines. A scene is composed of a collection of frames. The layout in a comic book is narrower between frames than that of a webtoon. This layout in a page is configured considering the reading method from the left to right side and top to bottom [5]. Frames are read in sequence because of the repeated reading experience of readers, which creates a “Z” line from the left to right and top to bottom [15].

## 3. Study method

In this study, “Romance 101” (Table 1) was selected as the experimental material from the webtoons and comic books in Naver Webtoon, which has the highest number and usage rate of works.

Table 1: Romance 101 Episode 1 [16–17]

| Webtoon | Comic book |
|---|---|
|  |  |

The eye-tracking experiment was conducted with 13 subjects in their 20s and 30s (five males and eight females). As shown in Figure 4, the webtoon was viewed on an iPhone 6s using the Tobii Nano Pro mobile testing accessory, and the Tobii Pro X2-30 eye tracker. The comic book was scanned on a 15-inch screen, and was then viewed using a viewer. The experiment was conducted independently for each subject in a separate room isolated from the outside. After the experiment, the fixation counts and fixation durations were analyzed and used to construct a heat map. In the heat map, the shorter the fixation time, the more green color was displayed, and the longer the fixation time, the more red color was displayed.

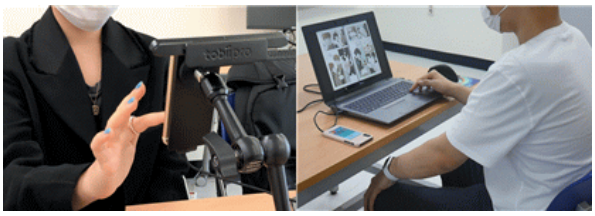


Figure 4: Participant and eye tracker

## 4. Measured results of visual attention between webtoon and comic book

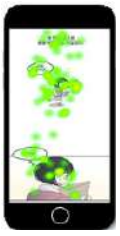
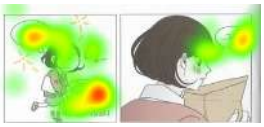
The results of these experiments were different from those of previous studies. Choi et al. (2012) [6] found that scrolling speed was slow in the speaking area. In the present experiment, a user's gaze stayed long in the speaking area, indicating the relationship between the speaking area and the reader’s fixation time. Table 2 shows that a frame with many letters in Scene 1 produced a red color, whereas a frame with few letters in Scene 2 produced a green color, as found in previous studies. However, Table 3 presents a different result. For the comic book, the result was the same, but for the webtoon, a frame with many letters produced a green color, a different result. These results can be interpreted in two ways: First, the webtoon in Scene 1 of Table 2 had a borderline to the frame, whereas the webtoon in Scene 1 of Table 3 had no borderline in. A reader may therefore follow the flow of the scene quickly, rather than slowly reading each scene, whereas a frame plays a role in dividing scenes distinctively. Alternatively, the webtoon in Scene 2 of Table 3 is a speaking area and has a frame border, which is similar to Table 2, but the gaze stays

short. The difference may arise because the webtoon in Scene 1 of Table 2 is the initial scene of an event, so the reader stays on it for a long time to acquire information. The webtoon in Scene 2 of Table 3 is a scene at the end, where the event and conflict are resolved, so the reader does not much care about the dialog.

Table 2: Common results of heat map

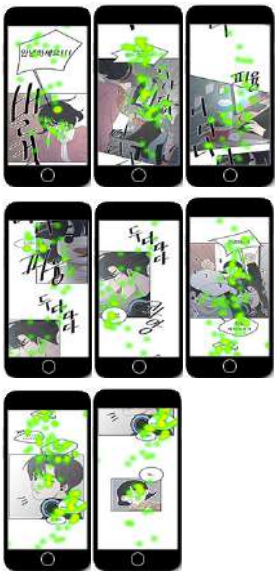
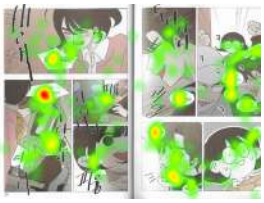
| Scene | Webtoon | Comic book |
|---|---|---|
| 1 |  |  |
| 2 |  |  |

Table 3: Different results of heat map

| scene | Webtoon | Comic book |
|---|---|---|
| 1 |  |  |
| 2 |  |  |

The green colors in the scenes displayed in the webtoon in Scene 1 of Table 4 indicate that the readers' gazes were short, with the reader quickly turning their eyes to the next scene. This mobile layout design represents an animation technique that indicates a sequence. This empty space indicates that time went by. In the webtoon of Scene 2, a green color is distributed widely, in contrast with that in the comic book version of Scene 2. This observation indicated that the gaze stayed short overall. An animation shows a still image by connecting images of continuous motion, and uses an optical illusion such as moving due to an afterimage of the previous image [18]. This basic principle of animation was applied to webtoons. The illusion of movement is created by moving the scroll quickly and flipping through the still images in which the sequence of movements is drawn.

Table 4: Heat map results

| scene | Webtoon | Comic book |
|---|---|---|
| 1 |  |  |
| 2 |  |  |

## 5. Conclusions

In this study we analyzed the differences in readers' visual attention to content due to differences between the mobile layout of a webtoon and the layout of a comic book. The reader's gaze stayed for a relatively long time in the speaking area in both the mobile layout of a webtoon that was displayed in a vertical scroll mode and the layout of a comic book where each page is viewed one at a time. The reader's gaze stayed for a short time in the viewing area. However, the reader's gaze stayed for an even shorter time in the speaking area in webtoons depending on the presence or absence of an outline dividing the frames and the development of the story. The animation technique used in webtoons can express the passage of time and continuous motion as a reader controls the scroll directly, allowing the time spent gazing at the empty space between frames and continuous scenes to be short. In contrast, perusal of comic books is limited to thumbing through the pages of a book, as done in webtoons. Because of this necessity, it is difficult for comic books to express such an animation technique as done in webtoons.

These study results indicated that there is a difference in fixation according to whether there is an outline of a frame in webtoons. A reader may read the beginning part of the event in a story slowly, to acquire information correctly, whereas the reader may read the ending part where the event was resolved quickly, since this section requires less information. The mobile screen in webtoons can be used vertically infinitely, expressing the passage of time as empty space between the frames, without limit. Webtoons can also employ optical illusion for animation, by allowing the use to scroll a sequence of still images to produce dynamic movement. Pages in a comic book are divided, limiting their utilization compared to the mobile screen in webtoons. As a result, it is difficult for comic books to freely configure a sequence of still images and empty space between the frames, as is done in webtoons. In comic books, the passage of time is expressed by scenes rather than through the empty space between the frames in webtoons. In Captain Underpants [12], FLIP-O-RAMA, which thumbs through the current and next two pages iteratively, uses techniques appropriate to comic books, such as showing animation movements like a flip book. It is necessary to have a mutually complementary layout configuration and layout design when transferring between two media, and this information can be obtained by identifying the characteristics of webtoons and comic books. Through these analyses, this study contributes to suggesting the appropriate direction when producing trans-media between two media, taking into account their differences. This study has a limitation in that only heat map results were analyzed. Thus, in future research, the results of the fixation time, the gaze plot, and the cluster will be derived and analyzed statistically.

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# Classification of Longan fruit Based on Leaf Image Using RGB Feature Extraction, GLCM and Shape Features with Decision Tree Method

Abstract— The Longan fruit is easy to find in a few regions in Indonesia. In addition to its sweet and fresh taste and fragrant aroma, the Longan fruit is relatively easy to cultivate. High market demand makes the fruit that comes from mainland India and Burma is cultivated massively. Cultivars of Longan fruit is very much and has its own characteristics on its morphology, including the characteristics on the leaves. This study aims to classify the cultivars of Longan fruit based on leaf morphology. The author uses the RGB color extraction feature, GLCM and Shape feature to get the value of some of the attributes used on each cultivar. Furthermore, the value is processed by using decision tree algorithm to obtain accuracy value used as a classification determinant of the image of the Longan leaf.

Keywords—Longan, RGB, GLCM, Shape Features, Decision Tree, Image Processing

## I. INTRODUCTION

Heterogeneous fruit crops in the archipelago are a natural wealth that should be grateful. One type of fruit can have several cultivars with their own characteristics. One of the fruits that has many cultivars is the Longan fruit. Longan fruit or in the scientific language Dimocarpus Longan Lour, is a fruit originally from northern eastern India, mainland China and Burma [1]. Longan fruit has several types of size, skin color and leaf morphology in some cultivars. To be able to classify the cultivars of Longan fruit, the authors conducted research focused on digital image processing methods by making Longan leaves as the main object of research. The extraction of features on the leaves is not an easy study. Thus, studies in this field are interesting things to study. Some researchs mention that the results of computer processing on plant imagery can not be immediately applied. [2] unassuming dimensional form factor can be an ideal identification of leaf type in conducting image analysis. [3] development of leaf shape determination mechanism.

Longan fruit, (Dimocarpus Longan Lour), is a tropical fruit tree from the soapberry family (Sapindaceae), originally from Asia and introduced in another warm regions. Delicious white chubby fruits are somewhat like lychee and are generally sold fresh, dried, or tinned in syrup. The luscious meat has a sugary taste.

Research [4] states that Grey Level Co-occurrence Matrix (GLCM) is a high performance feature extraction method compared to other methods. This method was previously also applied by [5] with a combination of Speed Up Robust Features (SURF) and k-NN classification algorithms resulting in higher accuracy than previous studies. However, in research [6] using a combination of Scale-Invariant Feature Transform (SIFT) features extraction and Support Vector Machine (SVM) algorithms gained higher accuracy than other features as comparisons such as bag-of-feature and RGB. A combination of other feature extraction techniques is performed by [7] and results in higher accuracy than other techniques in comparison.

Pattern recognition is widely done in the field of botany for the identification of certain types of plants. The shape and edge of the leaves are widely used as objects that are processed for reference identification. Different leaf patterns can be used as identifiers [8].

## II. THEORETICAL FOUNDATION

### A. Red, Green, Blue (RGB)

Fair RGB color models: red, green, and blue light are added together in various proportions to produce a variety of colors.

RGB color space is commonly applied to CRT monitors and most computer graphics systems. This color space uses three basic components: red (R), green (G), and blue (B). Each pixel is formed by all three components. The usual RGB model is presented in the form of a three-dimensional cube, with red, green, and blue in the corner of the axis (Fig. 1). Black is at the point of origin and white is at the opposite end of the cube. Fig. 2 shows a real color cube with a resolution of 24 bits. Please note, using 24 bits, the number of colors reaches 16,777,216 [12].

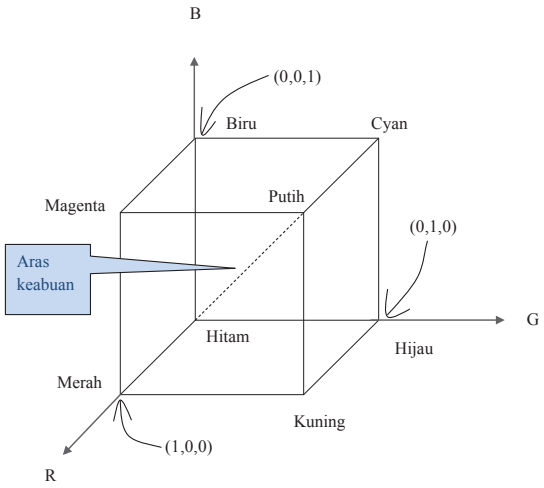
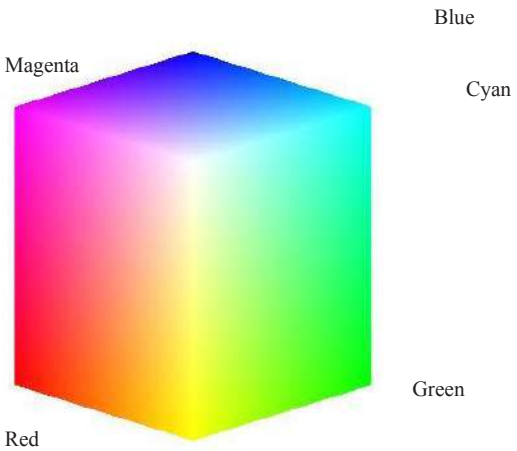



Fig. 1. RGB color space scheme in cube form



Yellow

Fig. 2. Color cube with 24 bit

Color feature used to use color moment feature consisting of mean, standard deviation, and skewness on each RGB channel.

1) Mean

Mean is the average pixel value that will be searched on each RGB channel. The formula for obtaining the mean feature is used in equations:

$$\mu = \frac{1}{MxN} \sum i = 1\ M \sum j = 1\ _N P_{ij}$$

Description:

μ = mean M x N =

image size

P = image pixel

2) Standard Deviation

To obtain this feature use this equations:

$$\sigma^2 = \sqrt{\frac{1}{MxN}} \sum i = 1\ M \sum j = 1\ N\ (X_{ij} - X_j)$$

Description:

σ = standart deviation

M x N = image size

$X$ = image pixel

$\bar{X}$ = mean

3) Skewness

Gets skewness values using following equations:

$$\theta = \frac{\frac{1}{MxN} \sum_{i=1}^{M} \sum_{j=1} N\ (Xij - Xi)^3}{\sigma 3}$$

B. Grey Level Co-occurrence Matrix (GLCM)

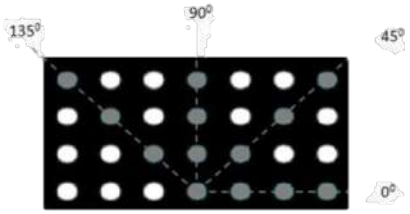
GLCM is a type of texture feature extraction. Haralick proposed GLCM in 1973 with 28 features to explain spatial patterns. GLCM uses texture calculations in the second stage. Texture measurement in the first stage uses statistical computing based on imagery pixel values only, such as variants, and does not pay attention to pixel proximity relationships [12].

For example, f (x, y) is an image of Nx and Ny sizes that has pixels with possibilities up to L level and (r) $\vec{}$ is a vector of spatial offset direction. 〖GLCM〗_r $\vec{}$ (i,j) is defined as the number of pixels with j∈1,..,L occurring in offset (r) $\vec{}$ against pixels with i∈1,.., L values, which can be expressed in formulas [12]:

$$GLCM_{r\vec{}}(i,j) = \#\{(x_1, y_1), (x_2, y_2) \in (N_x, N_y) \times (N_x, N_y) | f(x_1, y_1) = j^{r\vec{}}$$

$$= \vec{}(\vec{}\vec{x}_{2\ \vec{}\vec{}\vec{}\vec{}} - \vec{}\vec{}\vec{}\vec{}\vec{}\vec{x}_{1\ \vec{}\vec{}\vec{}}, \vec{}\vec{}\vec{y}_{2\ \vec{}\vec{}\vec{}} - \vec{}\vec{}\vec{}\vec{}\vec{}\vec{y}_{1\ \vec{}\vec{}\vec{}})\vec{}\}$$

In this case, the offset (r) $\vec{}$ can be an angle and/or distance. For example, the following Fig. 3 shows the four directions for




GLCM.

Fig. 3. GLCM pixel angle direction

1) Angular Second Moment (ASM)

ASM is a method of measuring image homogeneity that can be calculated by formula:

$$\sum_i L = 1 \sum_j L = 1 (GLCM(i,j))^2$$

Where L is used to specify the number of levels used for computing.

2) Contrast

Contrast is a measure of the presence of gray level pixel image variations calculated by the formula:

$$\sum_{n=1} L\ n \{\sum [i-j]\ GLCM(i,j)\}$$

3) Inverse Different Moment (IDM)

IDM is used to measure homogeneity. This feature is calculated by formula:

$$\sum L \sum L \frac{(GLCM(i,j))^2}{1 + (i-j)} \quad {}_{i=1\ \ j-1}^{2}$$

4) Entrophy

Specifies a measure of gray level irregularities in the image. Formula for calculating entropy as follows:

$$\sum_{i=1} L \sum_{j=1} L\ (GLCM(i,j)\ log(GLCM(i,j)$$

5) Correlation

Measure linear dependencies between gray level values in an image. Correlation is calculated by the following formula:

$$\sum_{i=}^{L} \sum_{j=1}^{L} (ij) \qquad (GLCM(i,j) - \mu i` \mu j`$$

$$\sigma i` \sigma j`$$

with:

$$\mu i' = \sum_{i=1} L \sum_{j=1} L \; i * GLCM(i,j)$$

$$\mu j' = \sum_{i=1} L \sum_{j=1} L \; j * GLCM(i,j)$$

$$\sigma j' = \sum_{i=1} L \sum_{j=1} L \; GLCM(i,j)(i-\mu')^2$$

$$\sigma i' = \sum_{i=1} L \sum_{j=1} L \; GLCM(i,j)(i-\mu')^2$$

C. Shape Feature

The shape feature is a feature obtained through contours, areas and transformations and can be used as a leaf type identifier [9].

D. Decision Tree

According to [10], a decision tree is a tree where each node shows afeature (attribute), each link (branch) shows a decision (rule) and each leaf shows an outcome (categorical or continues value).

Decision Tree is using a following formula to calculate accuracy and precision:

$$Accuracy = \frac{(TP + TN)}{(TP + TN + FP + FN)}$$

$$Precision = \frac{TP}{(TP + FP)}$$

TP = True positive, TN = True Negative
FP = False Positive, FN = False Negative

## III. RESEARCH METHODOLOGY

This study used datasets in the form of images of Longan leaves from 6 different cultivars. Here is an example of a Longan fruit dataset image.



Fig. 4.
Itoh



Fig. 5.
Crystal



Fig. 6.
Local







Fig. 7. Fig. 8. Fig. 9. Matalada Red Pimpong

The methods proposed in this study are as follows Fig. 10 below:

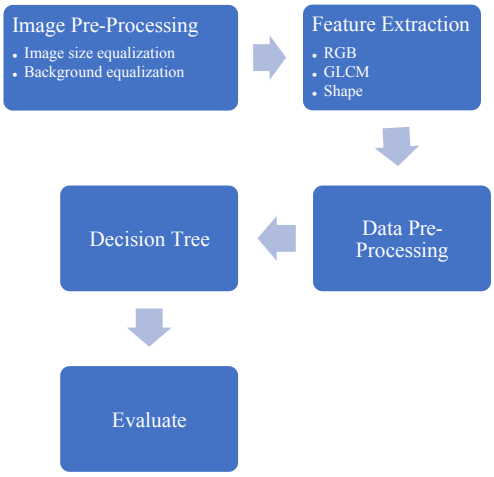



Fig. 10. Proposed methods

The extraction approach features used are color and shape. The color feature uses RGB features with attributes: Mean, Standard Deviation and Skewness as well as GLCM features with attributes: ASM, Contrast, Entrophy, IDM and Correlation. While the features of the form use attributes: Diameter, Perimeter, area, width, roundness, and slimness.

After the values of these attributes are obtained, then preprocessing the data to avoid missing value and data duplicate.

## IV. RESULTS AND DISCUSSION

A. Data Collecting

The dataset collected amounted to 300 leaves with a breakdown of 50 leaves on each cultivar. The process of shooting leaves is done using an Apple XR smartphone camera with a resolution of 12 megapixels, auto mode. Shooting time is done during the day utilizing natural sunlight.

The first step is to pre-process the image, which is to separate the object and the background. Example of image pre-processing results as shown below.



Fig. 11.
Leaf image before pre-processing



Fig. 12.
Leaf image after pre-processing

The second step is to process the pre-processing image into a gray scale. The third stage is to change the gray image to a black and white or binary image where the object in the binary image is represented with the number 1 and the background is represented with the number 0. The last stage in image processing is to look up the values of the attributes of rgb, GLCM and form extraction features.



Fig. 13.
Grayscale Image



Fig. 14.
Binary Image

B. Dataset

Value lookups are performed on 14 attributes already mentioned from the extraction feature used with details, 3 attributes on RGB features, 5 attributes on GLCM features and 6 attributes on form features.

C. Testing

After obtaining the value of each attribute, then done data mining process to get the level of accuracy, recall and precision. The testing process is performed seven times by combining one or more of the extraction features used. The test results achieved the highest accuracy score in the experiment using a combination of RGB and GLCM features, which was 87.78%. Here is the testing result that show in the Table 1 below.

## V. CONCLUSION

The tests that have been done in this study yield some value. Of the seven experiments performed by combining one or more extraction features, it produced the highest accuracy

TABLE 1. Testing with RGB and GLCM

| | true Crys. | true Local | true Mata. | true Red | true Pimp. | true Itoh. | class precision |
|---|---|---|---|---|---|---|---|
| pred. Crys. | 15 | 0 | 0 | 0 | 0 | 0 | 100% |
| pred. Local | 0 | 15 | 1 | 1 | 1 | 0 | 83.33% |
| pred. Mata. | 0 | 0 | 11 | 1 | 0 | 0 | 91.67% |
| pred. Red | 0 | 0 | 3 | 12 | 0 | 0 | 80% |
| pred. Pimp. | 0 | 0 | 0 | 1 | 12 | 1 | 85.71% |
| pred. Itoh | 0 | 0 | 0 | 0 | 2 | 14 | 87.50 % |
| class recall | 100% | 100% | 73.33% | 80% | 80% | 93.33% | |

value in the combination of RGB and GLCM features, which was 87.78%. This suggests that by combining multiple extraction features, it can affect the level of accuracy in an experiment.

The advice that the author can give is that further experiments need to be done by adding Longan fruit cultivars so that the results obtained are more diverse and can better represent the whole Longan fruit. The use of data mining attributes and methods can also affect the result so further research is needed.

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# Korean Sentiments Korean Fans of Global Idols Expect from Foreign Members

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**Abstract**
Current transnational popularity of K-pop idols exemplified by BTS suggests that the presence of foreign members is not an essential factor. it is necessary to inspect the validity of the global strategy that Korean entertainment management companies has taken when establishing overseas expansion strategies. The purpose of this study is to present an effective strategy for the recruitment of foreign members of entertainment management companies in response to the changing K-POP market by analyzing fans' perceptions of foreign members of idols. The research raises three particular questions about the definition of an idol and the perception of foreign members in the opinion of Korean fans of idols. Q 1. What kind of image do Korean fans feel from Korean idols, and what are the desired capabilities? Q 2. What is the attitude of Korean fans to accepting foreign members of Korean idol groups? Q 3. How do Korean fans understand idols singing in foreign languages in the sense of Korean sentiment? Case study method was used among the qualitative research methods in order to acquire in-depth understanding and analysis of how the ideas and values formed from individual life are projected onto the idol fandom experience and, in particular, the perception of foreign members of idols. Nine idol fans were selected as research participants and in-depth interviews were conducted. The collected data were transcribed, analyzed, and categorized. First, ‘expected competence’, second, ‘Koreanization of foreign members’, and third, ‘historical view through Gukppong’. Based on the derived categories, three effective strategies for recruiting foreign members of entertainment management companies in response to the K-POP market were presented. First, the necessity of recruiting foreign members should be inspected. Second, psychological management of foreign members must be implemented. Third, Korean cultural education program must be developed for foreign members. This study has a limitation in that the gender ratio of the study participants is female-centered. For a multi-faceted analysis of social phenomena related to idol fandom, a follow-up study is in progress, which examines ways of enjoying idol culture through idol fans' definitions of Korean idols, evaluation of Korean idols' overseas activities, and thoughts and ideals of idols that serve as political and diplomatic mediators

**Keywords:** Fandom, K-POP Idol, Foreign Member

## 1 Purpose of the Research

As K-pop idol group’s members are becoming multinational, ‘Koreans’ are no longer an absolute component of K-pop. K-pop idol fans expect Korean elements, namely, ‘Koreaness’, from foreign members. Usage of the Korean language through Korea's idol training system is perceived as 'Koreaness' and those who have well digested these Korean characteristics are recognized as K-pop singers[1].

Korean fans of idols struggle between the importance of foreign members and pure blood customs in member formation. In addition, while accepting the existence of foreign members as a stream of times, fans’ opinions differ when idol members sing in their native language on Korean music programs, and some even actively protest. After a foreign member of the K-pop idol group NCT U sang some of the song lyrics in Chinese and Japanese on a Korean music program, complaints were posted on the viewer's bulletin board of the program. Petitions condemning the entertainment management company and broadcasting network appeared on the Blue House National Petition website. Many complaints were not because they were foreigners, but because they did not sing in Korean. There are conflicting opinions on those in favor of accepting the use of multinational languages in broadcasting by respecting the diversity of the world and those who are against the use of multinational languages due to recent political and diplomatic friction between Korea, China and Japan[2]. There are also skeptics about the recruitment of foreign members due to the past history between countries, political and diplomatic friction, and the success story of BTS, which consists only of Koreans. Therefore, it is necessary to analyze and discuss the causes of negative evaluations of foreign members of idols who were expected to have a positive effect on the globalization of idols.

## 2 Previous Studies

Prior to this study, the global success factors of K-Pop and the significance of foreign members were examined through the analysis of previous studies.

The idol training system and managing ability of Korean entertainment are evaluated at a high level, and the skills of the debuted singers have improved significantly compared to the first-generation idols [3]. Trainees who have not only basic

singing and dancing but also appearance, personality, and foreign language skills are intensely trained for their debut. Therefore, some K-pop Korean fans have doubts about the necessity of recruiting foreign members.

The study of Dong-Seok Shin[4], and Seok-Wol[5], analyze the factors for overseas success of Korean idols as the training system and management, the recruitment of foreign members, proficient singing and dancing skills, appearance, fashion, foreign language ability and improved accessibility through social media such as YouTube. In the study of Hayama Shinsuke[6], it was found that Japanese members of idols had a positive effect on cultural exchange and helped Japanese fans to understand and gain interest in Korean culture.

However, recent issues related to foreign members are causing the public to change their perception of foreign members. For example, Korean fans turn away because of an idol's political remarks, or after unilateral notice of withdrawal from the group due to interests with the management company, the idol uses his or her fame to perform activities in their home country. Junui Lee[7] attributed the management company's unfair treatment to the Chinese members of boy group EXO's as the cause of withdrawal from the group, and evaluated the improved contract system as a product of the mature entertainment industry. It is necessary to view this phenomenon in different perspectives because although the management company's unfair treatment of singers has certainly been an issue, there was also the public opinion that the member's behavior, who unilaterally refused entry to Korea after leaving China, was an immature behavior.

Other studies discuss the limits of K-pop development. Yang-Xi[8] and Xiao-Han[9] analyzed political conflicts between countries as an obstacle to the development of K-pop. These factors cause controversy with the remarks of overseas members defending their own country, which even lead to the discussion of member withdrawal. Seo-won Choi[10] compared and analyzed the strategic cases of EXO, Twice, and BTS among 3rd generation idols. It was analyzed that in the case of BTS, unlike the localization strategy adopted by the other two groups, there were no foreign members and all members took part in writing lyrics and composing, which was a differentiated strategy. However, there is a limitation that the global strategy of idols cannot be generalized using the examples of the three groups because the research subject is limited to only three idol groups.

Previous research suggests the need to check whether the recruitment of foreign members for idols is strategically effective, but studies on foreign members are lacking. Therefore, this study aims to show how the perception of foreign members is expressed from the perspective of Korean fans through Korean fans of various idol groups.

## 3 Research Purpose and Method

Foreign members are recognized as an important strategy for the globalization of Korean idols, and fans who accept and consume them have an absolute influence on the survival of idols. Although active research is being done on the factors of idols' success in overseas markets and their fandom, research on the perception of Korean fans on foreign idol members has not been properly conducted.

Current transnational popularity of K-pop idols exemplified by BTS suggests that the presence of foreign members is not an essential factor. it is necessary to inspect the validity of the global strategy that Korean entertainment management companies has taken when establishing overseas expansion strategies. The purpose of this study is to present an effective strategy for the recruitment of foreign members of entertainment management companies in response to the changing K-Pop market by analyzing fans' perceptions of foreign members of idols.

Among the qualitative research methods used as research methods, case study focuses on specific situations, events, and phenomena, and are used to obtain a deep understanding of a specific case and the meaning of the case through a rich and in-depth description of the research subject[11]. Therefore, a qualitative research method was used to deeply understand and analyze how the ideas and values formed from an individual's life are projected onto the idol fandom experience and, in particular, the perception of the foreign member of the idol.

Research participants were selected and in-depth interviews were conducted for data collection. The interview was conducted for about 1 hour at a time, and was conducted face-to-face or using the video conferencing system ZOOM, depending on the wishes of the participants. During the interview, data was collected through recording, recording, and on-site memos, and after the interviews, they were transcribed and analyzed.

## 4 Research Questions and Subjects

This study aims to analyze the Korean sentiments required for Korean idols, including foreign members. The purpose is to find out how Korean fans define idols, what ideals they expect, and what attitude they take in accepting foreign members and their singing in foreign language. The research questions are as follows.

Q1. What kind of image do Korean fans feel from Korean idols, and what are the desired capabilities?

Q 2. What is the attitude of Korean fans to accepting foreign members of Korean idol groups?

Q 3. How do Korean fans understand idols singing in foreign languages in the sense of Korean sentiment?

The study participants were selected as 9 idol fans who have high interest in understanding the idol culture and are actively engaged in fan activities. Prior to the interview, explained to the study participants were explained the purpose of the study, the right to refuse answers, anonymity, the right to use and discard personal information after the study, and the right to stop participating in the study. In addition, prior consent was obtained for recording for the study. The characteristics of the study participants are shown in [Table 1].

**Table 1** Study Participants

| Characteristics of Study Participants | | | | | |
|---|---|---|---|---|---|
| Participant | Gender | Age | Idol Name | Fandom Name | Fan Activity Period |
| A | F | 36 | GOT 7 | I GOT 7 | 5y |
| B | F | 31 | Ha Sung Woon | HA:NEUL | 3y |
| C | F | 30 | Ong Seongwe | WELO | 2y |
| D | F | 38 | Shinee | Shinee World | 13y |
| E | F | 29 | TVXQ | Cassiopeia | 16y |
| F | F | 26 | VERIVERY | Verrer | 1y 3m |
| G | F | 24 | VERIVERY | Verrer | 2y6m |
| H | M | 26 | (G)I-DLE | NEVERLAND | 6m |
| I | M | 36 | Red Velvet | RevelUp | 7y |

## 5 Interview Analysis and Categories

Recordings of in-depth interviews of study participants were transcribed and categorized after line-by-line analysis. As a result, three categories were derived. First, the expected competence as an idol desired by Korean fans. Second, Koreanization of foreign members with an understanding of Korean sentiment and identity as a Korean singer. Third, historical view through Gukppong, the background for Korean fans wishing the foreign idol members to have Korean sentiments.

## 5.1 Expected Competence

The professionalism the public demands of singers is excellent singing ability. These standards are also applied to idols, and it has been shown that various abilities other than singing are required. The result of the interview analysis indicated that Korean fans' evaluation of the current idol's ability was considered to be singing, dancing, and appearance as essential elements, and they expected the idols to be well equipped each element. In addition, foreign language proficiency for global activities was evaluated as an important ability.

In addition to the essential elements as a singer, acting skills and chemistry between members shown in entertainment programs were cited as characteristics of Korean idols, suggesting that fans expect the idol members to perform not only as a singer but also in various activities.

Idol trainees receive systematic training from a young age and debut through fierce competition to satisfy these various needs from fans. Korean fans who watched the idol's training process exposed through the mass media felt the sincerity of the idol trying to succeed and were more immersed in fandom activities.

## 5.2 Koreanization of Foreign Members

The multicultural nature of Korean idol groups can be said to be a product of global activities. Korean entertainment management companies are actively recruiting foreign members as one of their global strategies. Foreign members play a pivotal role in fan expansion because they are fluent in the local language and culture. Foreign members also receive training in singing, dancing, and rapping as trainees in Korea, and learn Korean through Korean language classes. They are recognized as important positions within the group because they are proficient in foreign languages as well as singing and dancing.

Korean fans of idols were expecting foreign idol members to have a full and correct understanding of Korean culture as well as the aforementioned competence as an idol. They felt more connected to foreign members to possess these qualities.

On the contrary, negative views about the recruitment of foreign members exist. The current generation of idols' activities are expanding transnationally, and the position of entertainment management companies that recruit foreign members as a global strategy is well understood. However, with foreign language education received by Korean members and their assimilation of foreign cultures naturally through media, fans are expressing doubts about the necessity of foreign member recruitment.

The attitude of Korean fans to accepting the use of foreign languages in foreign members' broadcasts appeared in three different aspects: positive opinion, negative opinion, and selectively positive opinion. As K-Pop is popular all over the world, it is common for Korean idols to sing in Korean on overseas stages. In line with this international trend, there is a positive stance that Korea should also accept foreign language singing. Contrastingly, there was a negative opinion that using as a Korean idol actively performing in Korea, using a foreign language would create animosity, apart from foreign singers performing in Korea. Lastly, the selectively positive opinion was a case of showing animosity toward a specific language, and most of them were tolerant in the use of English, but felt negative about Japanese or Chinese.

## 5.3 Historical View through Gukppong

Gukppong is a jargon that combines the Korean word “Guk(national)” and the drug “Hiropon(Philopon)” to express an excessive amount of pride in one’s country. In the early days when this slang was coined, it was used in a rather negative sense. Recently, it is also connoted as an expression such as 'intoxicated with Gukppong,' in the sense of being proud of the country. When Korean athletes won medals at the Olympics or Korean films received awards at prestigious overseas film festivals, even when the initial quarantine system received excellent evaluations abroad due to the recent outbreak of COVID-19, Koreans felt proud as if the

# Virtual persona and their digital storytelling on social media

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**Abstract**
Within social media, users can develop anonymous personas who are not bound by the social conventions of the offline world. This possibility extends to the birth of digital characters on social media, using the platform like any other human. The purpose of this research is to examine how virtual persona could serve as a unique alternative for digital storytelling on social media. This study combines literature review, comparative study, and questionnaire in its process. A literature review was conducted to provide researchers with a theoretical background. Virtual personas who conducted digital storytelling, Miquela Sousa (@lilmiquela), Seraphine Song (@seradotwav), and Liv (@livinthefuture), are selected for the comparative study of this research. From the literature review and comparative study, 27 questions were designed for the questionnaire with six themes and factors in mind. Later, the questionnaire data were analyzed with Principal Component Analysis (PCA) method to investigate how virtual persona conducts digital storytelling on social media. Results show that five factors play a part in virtual persona and their digital storytelling on social media – interactive narration, humanely content, positive behavior, realistic setting, and character design. The results of this study provide a reference for those interested in designing virtual persona for digital storytelling alternative on social media.

**Keywords:** virtual persona, digital storytelling, social media

## 1 Background

Currently, there are more than 4.2 billion social media users worldwide [1]; which means that more than half of the world's population uses social media to communicate. Within social media, users can develop anonymous personas who are not bound by the social conventions of the offline world. This possibility extends to the birth of digital characters on social media, using it just like any other human. Some of the characters look more realistic than others, and some have more fictional settings and bear little resemblance to "real life". Nevertheless, all of them have a story to tell.

As a new phenomenon that is slowly becoming more relevant, there is a considerable lack of research involving virtual persona. Studies related to virtual persona have mainly focused on the marketing potential of virtual influencers. It was rarely the case that virtual personas were imagined to be an alternative for digital storytelling on social media. In that sense, we would like to contribute to the discussion of virtual persona with our study.

The primary concern in this research is digital storytelling told by virtual persona on social media and how it helps to make a character feels alive. The characters are fictional, yet people believe in them and treat them as real. Another goal is to discover the elements that play a part when creating a virtual persona. The purpose of this research is to examine how virtual persona could serve as a unique digital storytelling alternative on social media.

## 2 Literature Review

### 2.1 Virtual Persona

Before social media exist, the blog is one of the most popular and accessible journal formats on the internet. According to Alexander [2], bloggers are characters, and each blogger demonstrates a persona to a varying degree of fiction. Their personalities are shown over time, consistent with the serial nature of digital storytelling. Travers [3] calls a virtual persona a *virtual influencer,* a persona developed in computer software, then given a personality, and made available on digital medias for the purpose of influencing. Based on these explanations, "virtual persona" in the context of this thesis is used to talk about digital characters that exist on social media, whose personality is shown through digital storytelling.

In practice, a virtual persona does not seem too different from human influencers. They mimic four cultural scripts that are practiced by human influencers: (1) calibrated amateurism, authenticity, and relatability; (2) branding and self-commodification, (3) being "cool"; and (4) selfies [4]. While these fabricated identities may cause uneasiness at first, there is nothing morally significant that distinguishes them from natural, 'real life' influencers [5]. Research by Hoang and Su [6] found that virtual celebrities are consumed the same way normal celebrities are being consumed. Zanbaka et al. [7] pointed out that virtual characters were as effective as real people at persuasion. The result even shows that virtual speakers have more favorable ratings than human speakers.

Since virtual persona exists strictly as online identity, how they represent themselves on social media greatly influences how other people perceive them. Research shows that an

avatar's lack of androgyny and anthropomorphism have a substantial impact on perceptions of virtual avatars [8]. Additionally, more humanoid avatars were deemed to be more appealing and believable; masculine avatars were perceived to be less attractive than their feminine counterparts. Another study shows that people perceive attractive virtual agents as significantly more persuasive than unattractive ones [9]. They were also perceived to have more positive personalities.

Seeing how virtual persona mimics human influencers and more anthropomorphic avatars are favored, it seems realism is a key to designing a virtual persona. However, a study found that virtual agents that are *too* human-like elicited the least positive reactions compared to human influencers and anime-like virtual agents [10]. The reason may be because when a human interacts with a human-like robot, the response would abruptly shift from empathy to revulsion as it failed to attain a lifelike appearance and interaction, as told by the idea of the uncanny valley [11]. Thus, when creating virtual agents, careful attention must be paid to the balance of making them feel human, but not *too human* at the same time.

To bring a virtual persona to life, digital storytelling is needed. Rasmussen [12] argues that virtual persona needs a story that could give context and motivation on what they do. This is due to the fact that a story is linked to emotions, which is linked to action and motivation [13]. The story connects people. People relate to story through a process known as "dual empathy", in which they engage in intensive personal processing while also "feeling through" characters [13]. For a virtual persona, a story helps to connect its fictional self to its audience. As storytelling plays an important factor to the virtual narrator for it to be persuasive [14], a story could make a virtual persona believable and feels real, even if it does not exist in real life. It can also be a diversion, where the virtual persona's storyline may serve as an escape from the people's seemingly mundane life. Since virtual persona bridges real and imaginary worlds, they provide additional entertainment or escapism benefits. Virtual persona allows the user to immerse themselves in an alternate reality, albeit one sufficiently similar to, and still based in, the real world.

**2.2 Digital Storytelling on Social Media**

Digital storytelling is the use of digital media to tell stories, both fiction and non-fiction [15]. More than a means to fulfill people's hedonic needs for fun and diversion, it is a method that can be used to create a personal link between the audience and the content of the stories. People's emotions, ideas, and intentions to behave in their social and personal life are linked to the story worlds they enjoy [13]. When individuals interact with characters and narrative worlds, they have social experiences—they relate to connections or social thoughts and sentiments while meeting certain wants and gratifications. Storytelling as a medium to convey information is shown as an essential component to reaching the targeted audience at an emotional and personal level [14]. People often respond to a story by telling one of their own, which means stories can be used to grab the attention of the audience and make them relate to personal situations [16]. Other times, enjoying a story can help a person have a better grasp in life, particularly in ways that might shape social thinking, feelings, and decision-making [13]. Therefore, narrative consumption may be highly personal, social, and adaptive.

Due to the unique format of social media, the method of presenting story elements such as narrative, story sequence, characters, point of view, story setting, and nuances is also different [17]. The format encourages content compression into microcontent [2]. Stories are broken up into smaller chunks and told in the form of status updates. Thus, digital storytelling on social media has a serial nature in which the story unfolds little by little.

The serial nature of digital storytelling told on social media is a skillful way to create suspense. Its temporality triggers active audience contributions, making the story interactive. They can comment, share the story with others, discuss and make theories about how the next story will unfold. This two-way communication between the audience of the story and the narrative content is what distinguishes digital storytelling from ordinary storytelling [15], where the audience can be active, even influencing the narrative. With interactivity, immersive storytelling is achieved.

Social media as storytelling devices can be used as a diary for character exploration [2]. Through the contents posted over time, a character's personality is revealed slowly. Characters can also communicate with their followers directly [15], usually through comment features found on almost all social media. As a public diary, comments will appear on it to offer suggestions, criticisms, or protestations of what just happened, which characters can respond to. Therefore, followers may feel that they are developing an intimate relationship with the characters on social media, where they can do two-way communication with the characters [10]. Blurring the boundary of fiction and nonfiction, stories on social media gives an immersive story experience through its combination of content authorship and audience co-creation. Through this process of identification and parasocial interaction (as well as the related idea of parasocial relationships; the illusion of a relationship with someone in the media is real [18]), the audience would be absorbed in the story world, and therefore, get attached to the characters and their story [13]. This makes the concepts given in the story more compelling and further aids to help to make a character feels alive.

As has been explained, digital storytelling on social media is naturally interactive and thus engaging, even more so for the stories that are told by the characters themselves with a first-person point of view. People's interaction with characters may be an extremely way for them to become involved in the narrative [13]. Research shows that fans would make comments about a story on social media and approach fictional characters as if they actually existed in the real world [13], expressing their expectations for character development. They also had strong sentiments for the characters and their choices or behaviors, and they found similarities in the story and their beliefs, feelings, and actions.




Figure 1: From left: Miquela Sousa, Seraphine Song, and Liv.

## 3 Comparative Study

Instagram is our focal social media platform because it is one of the most used social network sites. In Indonesia, it is third place in the most-used social media platform list by We Are Social & HootSuite [1]. The profession called influencer itself was born on the platform [19] and a lot of virtual personas are active on the platform, too. Instagram, unlike other social media networks, focuses on visual communication [20]. As a platform that prioritizes visual content, Instagram values creative and authentic content that is pleasing to the eye. Hence, given that influencers came to prominence primarily via Instagram and attractive visual representation of the virtual agent is an important factor [9], this platform is particularly well suited for this research.

To understand how virtual personas tell stories on Instagram, the author conducted a review of three existing virtual persona accounts, Miquela Sousa (@lilmiquela), Seraphine Song (@seradotwav), and Liv (@livinthefuture). These Instagram accounts were chosen because they have accumulated more than 150.000 followers and the authors consider them to have conducted digital storytelling on social media. All three personas have a different degree of realism, from 3D computer-generated image (CGI) that is hyper-realistic, semi-realistic 2D CGI combined with photos from the real world, and 2D CGI that is more anime-like.

### 3.1 Miquela Sousa (@lilmiquela)

With the advancement of digital technologies, CGI is more and more human-like, and virtual agents are increasingly capable of simulating human content. Making use of these technological advancements, a Los Angeles-based digital company, brud, introduced digital personas on social media called Miquela. Although the creators say she is a robot, Miquela is just a CGI. Her identity as a robot is part of her complex story that makes her feel more “real”. Her “secret” identity as a robot was the core of her storyline. The team behind Miquela enhances Miquela’s realism by “shooting” her in the real world, sometimes with other humans as well, to show that Miquela is present in the real world. With over three million followers on Instagram, her main platform, Lil Miquela has received press coverage in various prestigious news sites and collaborated with major brands such as Chanel, Balenciaga, Prada, and Samsung.

### 3.2 Seraphine Song (@seradotwav)

Seraphine is a virtual persona created by Riot Games to promote a new character in a game called League of Legends, Seraphine Song. Currently, she has approximately 426,000 followers on Instagram. In the game, Seraphine is a character who has magical powers in her singing. But on Instagram, Seraphine is just an ordinary girl trying to achieve her dream of becoming a singer. Her followers were invited to follow her journey to stardom when she was discovered by a member of the virtual idol group K/DA. Although she is a painted 2D CGI, the creators mixed her visual with photos from the real-world environment which further enriches her realism.

### 3.3 Liv (@livinthefuture)

Liv can be easily identified as a fictional virtual persona active on Instagram because of her 2D, anime-like appearance and science-fiction story. After graduating from high school with no plans to enter university, Liv feels like she does not know what to do with her life. Until one day, she falls into a portal that sends her into the future. This premise is effectively described through Liv’s username, *Liv in the future* and *living the future.* While looking for her way back home, she befriends people on Earth 3000, often asking her followers for their opinion whenever she encounters a problem—ranging from serious matters like friendships to something lighter such as food she should try. At the time of this writing, Liv had approximately 167,000 followers and posted visibly computer-generated drawings/photos reflecting vaporwave aesthetics.

### 3.4 Discussion

The three virtual personas show themselves on Instagram like ordinary people who use social media, not as characters who have a team running the account. Their personality can be seen from their username, profile photo, and bio. They mimic the way human influencers present themselves on Instagram by doing 4 aspects: (1) calibrated amateurism, authenticity, and relatability; (2) branding and self-commodification; (3) being “cool”; and (4) selfies.

The compared virtual personas use digital storytelling to bring the characters to life. Since their story is told over time, it is understandable that digital storytelling on social media using virtual persona takes a relatively long time. However, this gives the reader time to respond actively to the content. They can comment, share, and discuss the story with others.

This increases their engagement, which helps virtual personas form a parasocial bond with their followers. That way, even if they are fictional, virtual personas feel believable and real.

Digital storytelling of virtual personas on Instagram is mainly done through the post feature, while other features such as stories can be used to increase follower engagement. Stories can be conveyed and understood only through photos (illustrations) and captions, and the use of multimedia is not mandatory. But the addition of motion and sound elements can be used to enrich immersion. The personality of virtual personas can be seen through the way they write captions and take photos. The setting of the story can also be seen through the colors used in the illustrations.

# 4 Questionnaire

### 4.1 Methodology

The questionnaire conducted in this research was used to collect information about the opinions and preferences about virtual persona. It was online and self-administered. We applied the snowball sampling method via social media distribution. We developed 27 questions in total within 6 themes (opinion, behavior, appearance, interaction, digital storytelling, and realism) based on the findings of the literature review and comparative study. The questions were close-ended and scored with a Likert scale of 5 comprising 1 – strongly agree to 5 – strongly disagree. Previous studies found that the main audience of virtual persona is those in the 18-24 age group [21]. Thus, the 18-24 age group is the intended target respondent.

A prior study by Hoang and Su [6] used factor analysis with principal component analysis (PCA) model to analyze their data about how virtual celebrities are consumed in the East and West. A similar method was used by Faddoul and Chatterjee [14] to find a quantitative measurement model for persuasive technologies using storytelling via a virtual narrator. PCA is a technique that is commonly used for finding patterns in data of high dimensions and to eliminate the ones that are not considered relevant. In this study, we performed the same PCA to identify various elements about virtual persona and their digital storytelling on social media.

The questionnaire was distributed for 5 days with a total of 276 people responding. Firstly, the data was imported to SPSS and the negatively worded questions scores were reversed. Then, respondents who are not the target respondent of this research was deleted. Out of a total of 276 respondents, 170 are valid with clean data ready to be analyzed. There are 64 male respondents and 106 female respondents. After running an Independent Samples T-Test on these two groups, our survey reports no significant difference between them.

A reliability test was run on the entirety of the data collected via 27 questions, with the Cronbach's Alpha coefficient at 0.553. The value is less than 0.6, which means the data is not consistent. Four questions that could increase the Cronbach's Alpha value the most were then abandoned to increase the data reliability. Another reliability test was run on the rest of the 23 questions data, with the Cronbach's Alpha coefficient at 0.725. This means the data is reliable enough to be analyzed.

### 4.2 Principal Components Analysis

The PCA was run via SPSS with the VARIMAX rotation model. During the first analysis factor, Questions 10, 13, 22, and 23 could not be sorted to any factor, which made them irrelevant. Therefore, the four questions were abandoned. Another PCA was conducted with the remaining 19 questions.

The KMO and Bartlett's Test aims to measure the sampling adequacy for analysis. The Kaiser-Mayer-Oklin (KMO) value is 0.766, which is greater than 0.5, thus satisfying the requirement of factor analysis. The data was then tested by Bartlett Sphericity, the significance value of 0.000 ($p<0.05$) indicates that the study data was suitable for factor analysis as well. The 19 questions have been divided into five components through PCA. The cumulative variance explained rate value is 58.207% (>50%), which means that the degree of explanation is high. We will present the results of Rotated Component Matrix[a] indicating which questions are included in which factor.

**Factor 1**

Questions (will be referred to as Q from now on) 14, 20, and 25 were designed under the theme "digital storytelling". These questions show that the target audience understands and is interested in digital storytelling told by a virtual persona. Q12 was designed under the theme of "opinion". However, Q12 can also be interpreted as the target audience being interested in stories related to fashion. Thus, this question can support the theme of digital storytelling. Q19 was designed under the theme "interaction" because this is a form of interaction in social media. But it can also be seen as a form of digital storytelling, in which virtual persona reveal more their point-of-view when responding to the comments. Therefore, Q19 can support the theme of digital storytelling.

However, since this factor consists of questions from different themes, the theme "digital storytelling" should be expanded. Considering Q12 and Q19, they offer different aspects of digital storytelling. Then, factor 1 can be interpreted as "interactive narrative".

Table 1: Rotated Component Matrix[a] for Factor 1

| Questionnaire Questions | Value |
|---|---|
| 20. I can understand the story told by a virtual persona that unfolded bit by bit through posts on social media. | 0.761 |
| 12. I want to know the virtual persona's opinion about the latest fashion trend. | 0.728 |
| 25. I am more interested in a virtual persona that has an interesting story. | 0.615 |
| 15. I realize that there is subtle continuity from one post to another. | 0.595 |
| 19. It is important for me that the virtual persona responds to my comments. | 0.530 |

**Factor 2**

Q1 and Q7 were designed under the "opinion" theme, Q4 "interaction", Q5 "digital storytelling", and Q6 and Q11 "realism". To understand this factor better, we examined the

questions per theme, starting from the most relevant.

Q5 as the most relevant question in this factor was designed under the theme "digital storytelling". But as this was sorted into factor 2 instead of factor 1, it could be that the respondent understood this question from another perspective. Just Q5 only cannot explain factor 2, so further analysis is needed.

Q11 shows that respondents prefer a humanoid virtual persona compared to a non-humanoid one. And Q6 also shows that respondents indeed prefer a virtual persona who is human. But it should be noted that Q6 only has a value of 0.443 which means it has low opinion strength. It could be that rather than human, target audiences prefer virtual personas that show themselves as human.

Q1 and Q7 show that respondents like virtual persona that talks about light topics, but also like those who talk about their problem. Q1 has a higher value at 0.628 compared to Q7 at 0.493. This means that they prefer small talks, but also do not mind a more serious topic.

Q4 was designed under the theme of "interaction". This could also be understood as content, which respondents want to influence. For example, a virtual persona could ask which outfit to wear, and the followers could give input by voting. This mimics how humans could influence one another.

At a glance, this factor does not seem to have anything in common. After studying the factor more closely, we could see that respondents want to know the daily life of virtual persona, from lighter topics such as small talks to the more serious ones. Respondents also prefer a virtual persona that shows themselves as human. In addition, respondents want to be able to influence virtual persona. All of these seem to mirror how virtual persona in practice mimics human influencers and is consumed just like any other celebrities. In conclusion, factor 2 can be interpreted as "humanely content".

Table 2: Rotated Component Matrix[a] for Factor 2

| Questionnaire Questions | Value |
|---|---|
| 5. I follow virtual persona because I am interested in their daily life, more than their aesthetic posts. | 0.727 |
| 11. I am more interested in humanoid virtual personas compared to non-humanoid ones. | 0.663 |
| 1. Virtual persona can still be interesting even if they only talk about light topics such as the weather. | 0.628 |
| 4. It will be very interesting if I can make a virtual persona do something. | 0.518 |
| 7. Virtual persona who tells their problem on social media is more interesting to me. | 0.493 |
| 6. I am more interested in a virtual persona who is human compared to the non-human. | 0.443 |

**Factor 3**

Compared to Factor 1 and Factor 2, Factor 3 is simple since the questions that fall under this factor were all designed under the "behavior" theme. It should be noted that the negatively worded questions scores were reversed at the beginning, so the opposite of these questions is the statements. It shows that respondent prefers a virtual persona who is polite, follow the social norm, nice, and friendly. Factor 3 can be interpreted as "positive behavior".

Table 3: Rotated Component Matrix[a] for Factor 3

| Questionnaire Questions | Value |
|---|---|
| 2. I want to see a virtual persona that can talk back and is impolite. | 0.856 |
| 17. Virtual persona character that loves to challenge the rules and social norms is more interesting to me. | 0.784 |
| 8. Virtual persona that always acts nice and friendly is boring. | 0.724 |

**Factor 4**

Q16 and Q21 were designed under the theme "realism". The theme was at first designed with four questions, however, two of them were sorted to Factor 2. Thus, Factor 4 explains "realistic setting" instead.

Table 4: Rotated Component Matrix[a] for Factor 4

| Questionnaire Questions | Value |
|---|---|
| 16. I am more interested in virtual personas that exist in the real world compared to those in a fictional world. | 0.821 |
| 21. I am more interested in virtual personas that exist in the present than those in the past or the future. | 0.794 |

**Factor 5**

Q9, Q13, and Q18 were designed under the theme of "appearance". Factor 5 explains that the target audience prefers cute, female virtual personas that look young. Factor 5 can be interpreted as "character design".

Table 5: Rotated Component Matrix[a] for Factor 5

| Questionnaire Questions | Value |
|---|---|
| 18. I am more interested in a female virtual persona than a male virtual persona. | 0.716 |
| 13. I like a virtual persona that looks cute and has big eyes. | 0.698 |
| 9. I think it's fascinating that virtual persona will never age. | 0.541 |

## 5 Conclusion

In this study, we provide several insights for creating virtual persona in social media platforms. Firstly, we propose that virtual persona may serve as an alternative for digital storytelling. We did a literature review about virtual personas and digital storytelling on social media to provide a theoretical background specific for the research.

In practice, indeed, virtual personas are not too different from human influencers. Realistic and attractive visual is important when creating a virtual persona, however, they can't be too human-like as it may give the audience an uncanny valley feeling. Digital storytelling could help to bring a virtual

persona to life. As social media is naturally interactive and engaging, digital storytelling on social media is immersive.

Next, we compared three virtual persona accounts on social media to find how they conduct digital storytelling on social media. Based on the findings found in the literature review and comparative study, we developed 27 questions with six factors in mind. The data from the questionnaire was then analyzed with the PCA method via SPSS software. The result was only 19 questions proved to be relevant and those can be sorted into five factors that matter in virtual persona and their digital storytelling on social media.

The five elements are interactive narration, humanely content, positive behavior, realistic setting, and character design. These guidelines may be useful in the planning stage of creating a virtual persona. In future studies, we would like to test whether the guidelines we propose here function effectively in the practical process of creating a virtual persona and conducting digital storytelling on social media through a virtual persona.

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# Evaluation of Presence and Cybersickness in 360° Virtual Reality (VR) Video

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**Abstract**

Virtual Reality (VR) has become a major disruptive technology that influences various industries most prevalently, the entertainment sector. The number of 360° video content has grown exponentially on YouTube and Facebook as VR video has become the first immersive VR experience a typical user will have [1]. With this innovative technology, a side effect has also appeared and proven to be unpleasant physical discomfort called cybersickness [2]. Symptoms of mentioned discomfort include headache, nausea, eye strain and dizziness. There are multifactor theoretical causes of cybersickness; however, there is the influence of other important factors such as "presence", or the sense of "being there", in the Virtual Environment [3][4]. Recent research findings have recorded positive, negative, or null presence and cybersickness correlations [5]. This study aims to measure the influence of (a) 360° video (computer screen (2D) and head mounted display (3D)), (b) 360° stereo sound (2D) and spatialized (3D) on the users' presence and its effect on cybersickness in a 360° VR video. The Igroup Presence Questionnaire (IPQ) to measure the presence and the Simulator Sickness Questionnaire (SSQ) for cybersickness were used. The results revealed no statistical difference between video and sound on cybersickness. However, there was a significant difference between the computer screen and HMD (Head Mounted Display) experience on presence. It was also observed that presence and cybersickness had a weak negative correlation.

**Keywords:** virtual reality, 360° video, presence, cybersickness, motion sickness

## 1 Introduction

Virtual Reality (VR) is one of the relatively new technologies that has recently emerged within the industry. There has been a large uptake of the technology and adoption rates have been proven to be promising. A large amount of content for various applications are being produced at an exponential rate. VR has been used in different fields ranging from marketing, education, healthcare, sport, entertainment, and other industries [6][7]. One of the largely dominated VR fields is entertainment, in particular games and movies. VR is a new way of entertainment technology that satisfies consumers' demands. In comparison with normal media entertainment, VR allows users to experience new dimensions that allows the users to be fully immersed in the experience.

One of the well-known VR applications is 360° video. Companies like Facebook and Youtube have invested in VR streaming due to its popularity [8]. The immersive experience with 360° VR video and spatial sound are becoming regular to the average consumer, as proven by the mass adoption of users. The definition of an immersive experience in the context of a 360° video content is where users experience the feeling of "being there" by watching a full field of view scene [9][10]. Bleumers et al. (2012) described 360° video as moving images that are captured in a way, so VR viewers can look around from any angle as if controlling the camera themselves. 360° videos have become very popular as a type of immersive experience following the release of well-received low-cost VR headsets [10]. Although there have been numerous studies about 3D displays, there has yet to be a substantial amount of literature that contribute to the study of 360° video content on immersive 3D displays [12].

Throughout all these years of VR development, the goal for this technology is to create a simulation of a realistic experience. Regardless of the visual realism that has been achieved, VR technology comes with an unpleasant side effect for some viewers called Cybersickness (CS) [2]. Discomfort caused by the continued use of VR applications happen to be one of the biggest challenges in VR development over the past decades. According to Rebenitch and Owen (2016), CS is an undesirable side effect caused by the virtual environment (VE) exposure and could last from minutes to days. Common symptoms include eye strain, nausea, and disorientation [14][15][16].

There are multifactor theoretical causes of CS, such as sensory mismatch conflict, postural instability, and poison theories. However, there are influences of other factors that are also important to note [17], especially 'presence', the feeling of *being there* in the VE [3][4]. It has been identified as a probable factor that influences CS. Another prominent barrier that prevents the goal of VR is to constantly elicit a sense of presence for VR viewers [5]. With VR rising in popularity and demand to the everyday user, it is of utmost important to pay attention to the user experience (UX). Commonly, the user experience in VR is evaluated through a

sense of presence [7]. An important aspect of presence is the feeling of being physically located in VE, which is also referred to as spatial presence, an integral part of immersion.

Further development of understanding how to maximize the sense of presence in VE, and how to minimize unwanted feelings of CS is essential to take advantage of VR's promising potential. According to Weech et al. (2019) reviewed literature, several studies have reported a negative correlation between presence and CS that outweighs the number of studies that reported the opposite.

## 2 Methods and material

### 2.1 Experimental setup

This is a quasi-experimental, explanatory sequential mixed-method study. The main goal is to study the influence of the 360° VR video viewing methods, 360° video formats and VR sound formats on presence and cybersickness in 360° video. Three groups were gathered which are control group and two treatment groups. The 360° video titled "Do Not Touch" [21] was selected from Youtube and was created by SokrispyMedia (See Figure 1). The video selection was according to the factors that enhance sense of presence.

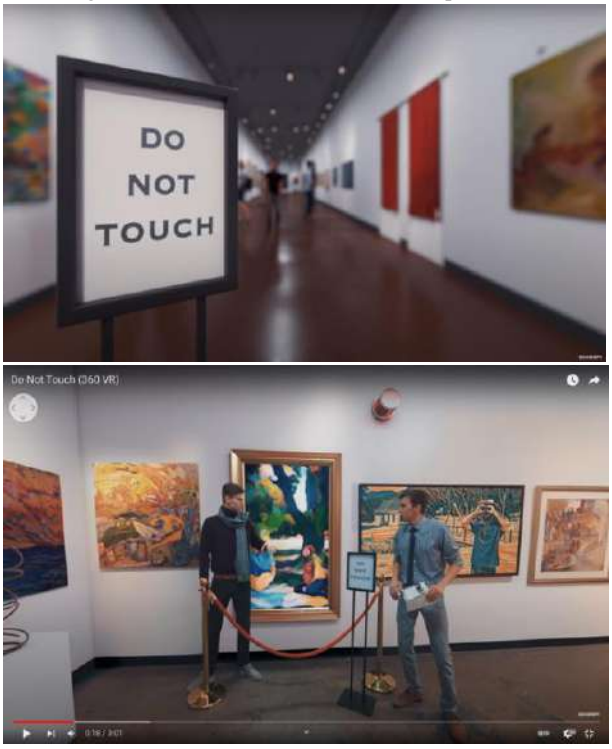



Figure 1: "Do Not Touch" by SokrispyMedia

### 2.2 Sampling

The sample consisted of 60 participants between the ages of 18-54. After obtaining approval from the university ethical committee, the participants were gathered through convenience sampling, which included students of Taylor's University and working adults from various occupations in Malaysia. They were randomly assigned into three groups: the control group (N=20) viewing 360° VR video on the computer screen with 2D non-spatial sound; the first treatment group (N=20) experienced 360° VR video with the Oculus Quest headsets and 2D non-spatial sound; and lastly, the second treatment group (N=20) experienced 360° VR video with the Oculus Quest headsets and 3D spatial sound. The participants were asked to fill up a questionnaire on demographics before the experimental procedure. For the treatment groups participants were asked to share whether they have had experienced VR before, where 25 participants had experienced and 15 had never experienced it.

### 2.3 Experimental procedure

#### 2.3.1 Control group

The control group was used as a baseline for this study. Participants were contacted through email and were asked to fill up an online survey on demographics, before the experimental method was explained to them. Participants watched the 360° video on YouTube by using their own computer screens. Upon completion of the experiment, participants were asked to fill up the IPQ and SSQ questionnaires. All 20 participants filled questionnaires successfully and there were no withdrawals from the experiment.

#### 2.3.2 Treatment groups

The experiment for the treatment group was face-to-face due to use of the VR Oculus Quest headsets. The experimental procedure began by welcoming participants in the experimental room and briefing them on what the experiment was about and their participation without revealing the purpose of the study to avoid bias. Before the VR exposure, participants were asked to sign a consent form and fill up a socio-demographic questionnaire that collects data such as age, gender and previous experience with the VR technology. Once completed, the participants were provided with disposable VR eye masks for hygiene purposes before providing them with the Oculus Quest headset, and ensuring the headsets were positioned comfortably and the vision wasn't blurry. Once the participants finished watching 360° VR videos, they were instructed to take off the headset and fill-up the SSQ and IPQ questionnaires. At the end of the session, participants were debriefed to make sure they were feeling well after the VR exposure. The entire procedure, including questionnaires, took approximately 15 minutes per participant. All 40 participants have filled the questionnaires successfully and there were no withdrawals from the experiment.

## 3 Results

### 3.1 Cybersickness

SSQ values were weighted and scored according to Kennedy et al. (1993), with the minimum score of SSQ being 0 and the maximum 1.31. There were no significant differences in cybersickness amounts between the groups (See Table 1).

Table 1: SSQ Descriptive analysis

**Descriptives**

| | | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | | |
| SSQ | 1.00 | 20 | .4094 | .36073 | .08066 | .2405 | .5782 | .00 | 1.31 |
| | 2.00 | 20 | .3750 | .34946 | .07814 | .2114 | .5386 | .00 | 1.13 |
| | 3.00 | 20 | .2719 | .27377 | .06122 | .1437 | .4000 | .00 | 1.00 |
| | Total | 60 | .3521 | .32991 | .04259 | .2669 | .4373 | .00 | 1.31 |

The Levene's F Test for Equality of Variances, which is the most commonly used statistic (and is provided in SPSS), is used to test the assumption of homogeneity of variance. Levene's test uses the level of significance set a priori for the ANOVA (e.g., $\alpha = .05$) to test the assumption of homogeneity of variance.

Table 2: SSQ Test of homogeneity

**Test of Homogeneity of Variances**

| | | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|---|
| mean_SSQ | Based on Mean | 1.398 | 2 | 57 | .255 |
| | Based on Median | 1.492 | 2 | 57 | .234 |
| | Based on Median and with adjusted df | 1.492 | 2 | 56.725 | .234 |
| | Based on trimmed mean | 1.512 | 2 | 57 | .229 |

The homogeneity of variances assumption for the SSQ was met, where the Levene statistics were not significant ($p > 0.05$) (Table 2). These implies that there were no significant differences between the group's variances. Therefore, the one-way analysis of variance (ANOVA) is conducted to measure the difference in SSQ mean scores between three groups (control with computer screen, Oculus Quest headset with 2D non-spatial sound and Oculus Quest headset with 3D spatial sound).

A one-way ANOVA was performed to compare the SSQ means scores between the three different groups (Table 3). The mean score results of SSQ revealed there is no significant difference between the three groups; $F(2, 57) = 0.564$, $p = 0.572$ ($p > 0.05$). Therefore, the post-hoc comparison was not performed.

Table 3: SSQ One-way ANOVA

**ANOVA**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| mean_SSQ | Between Groups | .206 | 2 | .103 | .564 | .572 |
| | Within Groups | 10.424 | 57 | .183 | | |
| | Total | 10.630 | 59 | | | |

## 3.2 Presence

IPQ values were scored and weighted. The results show that Group 1 (control) had the lowest IPQ mean score (*M*=2.9,SD=.64) in comparison with Group 2 (2D) (*M*=3.52,SD=.38) and Group 3 (3D) (*M*=3.45,SD=.47). (Table 4)

Table 4: IPQ descriptive analysis

**Descriptives**

| | | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | | |
| IPQ | 1.00 | 20 | 2.9000 | .64198 | .14355 | 2.5995 | 3.2005 | 1.43 | 4.36 |
| | 2.00 | 20 | 3.5250 | .38450 | .08598 | 3.3450 | 3.7050 | 2.93 | 4.21 |
| | 3.00 | 20 | 3.4536 | .47112 | .10535 | 3.2331 | 3.6741 | 2.50 | 4.36 |
| | Total | 60 | 3.2929 | .57545 | .07429 | 3.1442 | 3.4415 | 1.43 | 4.36 |

The homogeneity of variances assumption for IPQ was performed and the results revealed that the variances were equal. Thus, the homogeneity of variances assumption was met, where the Levene's statistics were not significant ($p > 0.05$) (Table 5). These implies that there were no significant differences between the group's variances. Therefore, the one-way analysis of variance (ANOVA) was conducted to measure the difference in IPQ mean scores between all groups of the study (control with computer screen, Oculus Quest with 2D non-spatial sound and Oculus Quest with 3D spatial sound).

Table 5: IPQ Test of homogeneity

**Test of Homogeneity of Variances**

| | | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|---|
| mean_IPQ | Based on Mean | 1.535 | 2 | 57 | .224 |
| | Based on Median | 1.573 | 2 | 57 | .216 |
| | Based on Median and with adjusted df | 1.573 | 2 | 48.842 | .218 |
| | Based on trimmed mean | 1.541 | 2 | 57 | .223 |

A one-way ANOVA was performed to compare the IPQ mean scores between the three different groups (Table 6). The results revealed that there was a significant difference in mean score of IPQ between the three groups; $F(2, 57) = 8.980$, $p = 0.001$ ( $p < 0.05$).

Table 6: IPQ One-way ANOVA

**ANOVA**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| mean_IPQ | Between Groups | 4.681 | 2 | 2.341 | 8.980 | .000 |
| | Within Groups | 14.857 | 57 | .261 | | |
| | Total | 19.538 | 59 | | | |

Post-hoc test of Tukey's HSD was performed to further evaluate the differences between the three groups in IPQ mean score (Table 7). It was found that the IPQ mean score was significantly different between Group 1 (control) and Group 2 (2D) ($p = 0.001$, 95% C.I. = [-1.0135, -0.2365]), as well as Group 1 (control) and Group 3 (3D) ($p= 0.003$, 95% C.I. = [-0.9421, -0.1651]) ($p < 0.05$). However, there was no significant difference in IPQ mean score between Group 2 and Group 3.

Table 7: IPQ Post Hoc Tukey test

**Post Hoc Tests**

**Multiple Comparisons**

Tukey HSD

| Dependent Variable | (I) GROUP | (J) GROUP | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| mean_IPQ | 1.00 | 2.00 | -.62500* | .16144 | .001 | -1.0135 | -.2365 |
| | | 3.00 | -.55357* | .16144 | .003 | -.9421 | -.1651 |
| | 2.00 | 1.00 | .62500* | .16144 | .001 | .2365 | 1.0135 |
| | | 3.00 | .07143 | .16144 | .898 | -.3171 | .4599 |
| | 3.00 | 1.00 | .55357* | .16144 | .003 | .1651 | .9421 |
| | | 2.00 | -.07143 | .16144 | .898 | -.4599 | .3171 |

## 3.2 Cybersickness and Presence correlation

Before the correlation test the SSQ results were standardized by shifting the scale from 0-3 to 1-5 in order to equalize the range and data variability with IPQ scores which are on a 1-5 scale. A Pearson correlation coefficient was utilized to assess the overall relationship between IPQ and SSQ mean scores. The results showed a weak, negative correlation between the two variables, $r$ = -.254, and the results were significant ($p$ = .050). (Table 8.) The correlation implies that the lower the cybersickness (SSQ mean scores), the greater the increases of presence (IPQ mean scores) among the participants and vice versa. Decreases in cybersickness (SSQ scores) were correlated with the increase of presence (IPQ scores).

Table 8: Pearson's correlation

**Correlations**

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| mean_IPQ | 3.2929 | .57545 | 60 |
| mean_SSQ | 1.4711 | .42446 | 60 |

**Correlations**

| | | mean_IPQ | mean_SSQ |
|---|---|---|---|
| mean_IPQ | Pearson Correlation | 1 | -.254 |
| | Sig. (2-tailed) | | .050 |
| | N | 60 | 60 |
| mean_SSQ | Pearson Correlation | -.254 | 1 |
| | Sig. (2-tailed) | .050 | |
| | N | 60 | 60 |

## 4 Discussion

This study aimed to measure the influence of 360° video, 360° stereo sound (2D) and spatialized sound (3D) on the users' presence and its effect on cybersickness in a 360° VR video. The results showed that there were differences in the sense of presence between the control group (computer screen with 2D non-spatial sound), the treatment group 1 (Oculus Quest headset with 2D non-spatial sound) and treatment group 2 (Oculus Quest headset with 3D spatial sound). It was predicted that treatment group 2 will have the highest level of presence due to the 3D spatial sound and Oculus Quest headset. However, the results revealed otherwise that treatment group 1 that had a non-spatialized sound have a slightly higher level of presence. Interestingly, the results showed no statistically significant differences in cybersickness for all three groups, as they all had low scores. Nevertheless, the computer screen had the highest cybersickness score, which was unexpected. Compared with the previous studies found in the literature, it was observed that for SSQ, in [18], computer screen presented low rates of cybersickness which was the opposite in this study. Overall, treatment group 2 (Oculus Quest headset with 3D spatial sound) had the lowest cybersickness scores and high presence scores which means that enhanced presence could influence the level of cybersickness.

Based on the review of the literature by Weech et al. (2019) concluded that presence and cybersickness share a negative relationship. The results of the current study support this hypothesis, as a significant but weak negative correlation was found between presence and cybersickness.

## 5 Conclusion

The study presented in this paper compared 360° VR video viewing experience on the computer screen, the Oculus Quest headset with 2D non-spatial sound and the Oculus Quest headset with 3D spatial sound to examine presence effect and whether enhanced presence would influence the level of cybersickness.

Unexpectedly there was no significant difference in cybersickness scores among the three groups. The influencing factor could be due to the 360° VR video content, which was shot with a mounted and static camera that resulted in low cybersickness scores. Added, the participants were all seated with limited body movements. However, there was a significant difference in presence between the control group with computer screen and the Oculus Quest headset groups.

The results of this study might not agree with several of the papers from the literature review due to factors that were related to the limitations of technology in the past, where the causation of cybersickness has yet to be established. Outcomes of the baseline were not precise to the predictive assumptions that were formulated based on previous studies [19,20]. The cybersickness score results were found higher for the computer screen control group than initial figures based on the literature review.

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# ARYou: AR Avatar UX design for Streamers

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**Abstract**
The study presented in this paper shows the process of developing UX design of AR avatar for the people who wants digital self-presentation(surrogate) to communicate online, as a part of the investigation into designers' role and domain in Extended Reality (XR) field. The main purpose of the project is to create avatars which communicate online more active, creative and interactive without showing users' actual appearance. It aims to develop avatar characters in non-human figures and movements which create various animation that responds to users' actions. Users' movement will be tracked and translated in a maner that reveals the attraibutes of a avatars identity. Decoded movements trigger special effects which is a means for expressing emotions. Since as much as a person's appearance, his movement also plays a significant role in revealing person's identity, The project attempted to reveal the user's persona through the movement of the avatar and its expressive effect. This is expected to allow the users to experience a distinctive body language which is more flexible and creative in variety. The project is constist of two parts to practice: 1. designing avatar and user interaction for online communication in the XR environment and 2. content design for interaction which enriches the whole experience. However, this paper will focus on the former part and leave the latter for a follow-up study. Technical research is practiced to realize the project as well. Unity software and MicroSoft Kinect motion tracking camera are used for AR simulation of 3D modeling characters. The study has been practiced in the realm of ambiguous boundaries between designer and engineer to explore how designers can pursue design principles in the XR field where the technological threshold is high for designers.

**Keywords:** UX design, AR avatar, interaction design

## 1 Introduction

The consumption of online contents has galloped ahead due to the spread of COVID-19. People have gradually become accustomed to working at home, spending time on the digital world.[1] Inevitably, the demand for new content and platforms is also increasing. Online creators keep searching for new ways to satisfy subscribers. Based on this context, this paper executes a UX research project on the Extended Reality realm to explore the new possibilities of interactive content for creators.

ARYou (short title of 'AR avatar for Youtubers') is an AR Avatar UX design project for the people who want digital self-presentation to involve in more creative and interactive online communication. Using a motion tracking camera, users can manipulate their avatars to create movements and interactive effects in real time. The distinctive features of ARYou avatars compared to other metaverse characters are that characters does not take the shape of a human, showing different physical movements from humans and generate interactive effects. The reactive movement and special effects would lead the user to experience a special kind of body language which is more flexible and creative in variety.

## 2 Project detail

ARYou has three distinct characteristics in character design and communication. Unlike other metaverse characters (refer

to fig.1), ARYou avatars do not take the shape of a human, showing different physical movements from them and interactive effects to motions are generated as a part of communication.(refer to fig.2) Non-humanic figure character design is an attempt to present an anima of a persona emphasizing a unique individuality. It is close to amplifying the signature attribute of a persona symbolically. For example, someone who has a flexible body can be illustrated in a limpy figured character like mollusks. A melting type of character, resembling colorful ice cream that looks delicious, can signify the characteristic of a person who sweats a lot. This characteristic may be inferior to someone, but it becomes the character's specificity in ARYou world.

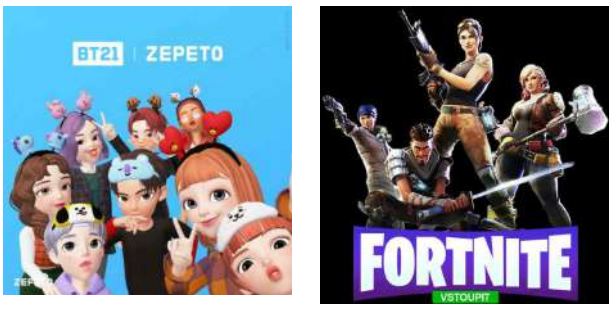



fig.1 metaverse characters of Zepeto(left) and Fortnite(right)

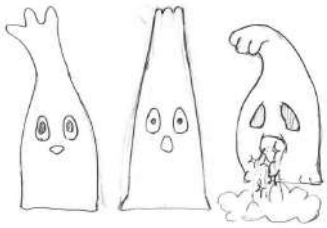


fig.2 example of ARYou character design

Non-humanic figure character design is also an effort to avoid aesthetic preconception. Most of the avatars' figures in other metaverse platforms, besides Roblox, seem to have bias to a certain degree in character design which reflects the users' desire to have ideal beauty or preferable appearance influenced by media. Corporates started developing digital humans, an AI avatar which acts like real humans, instead of actual human models to represent their brand. The advantage of producing digital humans is that companies can embody the ideal beauty which fits their brand image. Having an AI avatar, there is no need for taking risks of scandals that a human model could be implicated in, nor to worry about privacy invasion or mental damage by being targeted by the media.[2] Whereas ARYou attempts to design various forms of characters, without having an inclined aesthetic agenda of appearance, yet maintaining the benefit of privacy projection.

Non-human movement of ARYou avatars refers to one like animals or objects. It is a device to build up a persona and enrich its expression. Since body language is a sign of emotional and informational expression and afterall is a factor that forms an identity of an individual. The program will track users' actions and transform them in a non-humanic maner but still capturing their essence. For instance, if users move their arm limply, the avatars' arms will be animated like octopus. When they swish their arms, avatars' arms will behave like a cane which has a little elasticity and more of firmness. (refer to fig.3)

Interactive components which react to the user's behaviour is another tool for creative communication in the ARYou project. Overlapped 3D effects and manipulative camera movements are two elements planning to realize. The special effects can be an intuitive sign or creative means of expression that decode an emotion from movements.

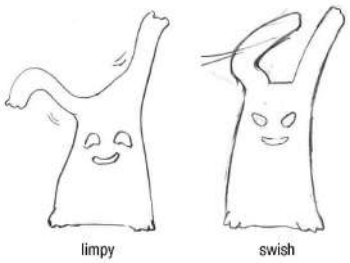



fig. 3

The tracked motion is analyzed by the trigger factor and control factor. Trigger factor is a predefined motion that triggers a particular event. Control factor is an element such as the duration or intensity of motion that controls the degree of a triggered event.

For example, if a user shows a disgusted face and opens his mouth, it triggers an effect like a rainbow waterfall pouring out of his mouth, suggesting vomiting in a humorous way. When he raises his arm and hurrahes, stars appear in the background and sparkle. (refer to fig.4)

Interactive components can be expanded by the form of non-humanic avatar. Let's say an avatar has long ears like a rabbit but with no arms. They sway gently when the user's state seems calm and neutral. Then, if the user makes a surprised face or gesture - enlarged eyes, sudden recline, "what!" gesture, etc. -, the avatar's ears stand upright. (refer to fig.5)




fig.4

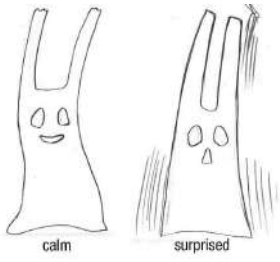



fig.5

Furthermore, manipulative camera walk will let the user have freedom of camera movement during the performance. Unlike filming an actual actor, an AR avatar doesn't need to be filmed several times to get different angles and shot size since it is rendered in 3D real time. Users can select the perspective as they intended or it can actively react to their action and change the angle and the shot. For instance, when the avatar's neck grows longer and tries to escape the screen, the (programmed) camera gets close-up to the face of the avatar instead of shooting the whole scene.

Significance of the UX design of the project lies in the basic human nature for expression and curiosity to unfold unexplored territory. Digital surrogate with extended body interaction enriches the means of online communication and

serves various preferences. Emoji are commonly in use to express feelings more vividly than text message on social media or games. To do this, you have to click an icon to make your avatar play the Emoji. However, ARYou takes a more natural way of expressing emotion by translating users' movements. Even Though, the interpretation may not be perfect as the user has intended and create ludicrous scenes, it can also be a part of amusement as a happening.

## 3 Technical study and realization

The project will attempt to simulate several scenes using Unity software and MicroSoft Kinect camera. The equipment and software was selected after testing three different motion tracking cameras and researching feasible softwares for designers who have intermediate level of programming. It was tested whether a general 3D modeling character moves according to motion tracking. Next, it will be tested whether the animation effect is properly interactive to the movement. Meanwhile technical research will also continue to seek whether there are more suitable methods.

There are a few softwares and SDK for engineers and technical artists to realize AR, and specific hardware is needed to detect body movement. Unity and Unreal Engine are well known softwares to render and program 3D images for AR. Both have steadily advanced the development environment more designer-friendly, but still need to program for better performance. Unity was chosen for the simulation since it had an inexpensive Kinect asset to roughly demonstrate AR Avatar which could be a starting point.

MS Kinect v2, Azure Kinect and Intel RealSense D435 are the cameras tested for motion tracking. Each provides a free SDK (software development kit) which allows accessing body and face tracking data. Using Kinect v2 and Azure Kinect SDK was preferred over Realsense SDK to import kinematic skeletal data of body movement into Unity. Realsense required additional Skeleton Tracking SDK by CubeMos which costs extra charge.[3] Among Kinect v2 and Azure Kinect, the latter had better performances of body tracking and resolution.

The study will continue to find a way to use a regular web camera or smartphones instead of somewhat expensive motion tracking cameras or other equipment. There are a few alternatives softwares and platforms that allow face recognition or motion tracking such as Deep Motion[4] and Alchera[5]. Apple has launched iPhone 12 Pro and iPad Pro with a lidar sensor installed and released ARKit which enable 3D scanning, analysis of a space and implementation of AR.[6] Unity released AR Foundation which is an integrated development environment to make ARKit more accessible.[7] Therefore, further study will be conducted on whether the above technology can be applied to the current project to present a better solution.

## 4 Conclusion

This paper presented the framework of UX design study for interactive avatar for users who want proactive, digital surrogate. It described how the avatar design is distinctive from other metaverse platforms, illustrated where the UX design is grounded, design of interaction components and the significance of the project. Also it explained the technical possibilities to realize the project.

It is expected to have technical limitations to fully embody the idea. Body tracking may not be sophisticated as intended. Programming algorithms that analyze motion and transform it into reactive animation may be insufficient. However, the study would like to leave perfecting the technical aspect to a role for engineers or AI. There is no doubt that engineers will implement better computational performance. Machine learning technology could be a better solution for improving the accuracy of reading facial expressions. The project may venture into advanced technology in the further study but for now it will focus on designing user experience.

In the early stage, the study will focus on designing intuitive interpretation of movements and interactive components. After this progresses to some extent, it will investigate the design of content, such as narratives and the pictures of the world which are suitable for the format. Interactive elements can be expanded when they get associated with narratives. Narrative will provide a context that enables more flourish expression which can also lead to another metaverse world.

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# Conduction of Real-time Usability Testing in a Post COVID-19 Environment

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**Abstract**
Due to the COVID-19 pandemic, on-site usability testing for research has become problematic. In order to increase participant count, we conducted a hybrid of remote and on-site tests for our ongoing research, using both local and overseas participants. In this paper, we describe the remote testing set-up and flow that we employed and fine-tuned, as well as guidelines for experiment design that we discovered were necessary, primarily relying on third party software. This will make it so that this flow can be applied in a wide range of applications, for both researchers as well as usability testers.

**Keywords:** usability, game design, interaction design

## 1 Introduction

For empirical game research, especially game research that focuses on design methodology, usability testing is of utmost importance as experiments revolve around users directly interacting with a piece of interactive software specifically developed for a particular research goal. However, with the start of the COVID-19 pandemic, usability testing has become relatively hard to do primarily because a large pool of potential participants are now operating remotely and would rather not leave the confines of their home. While the situation around COVID-19 has become a bit more manageable due to the development of a variety of vaccines, such as the Pfizer and Moderna vaccines, the situation is still not entirely resolved yet due to elements such as the Delta variant of the COVID-19 virus. This has meant that either we would have to limit the sample size of our research or that we would have to look towards remote testing solutions. In this paper, we describe a work flow for remote testing that we used for our own research, using available solutions to create a work flow that can work for a large number of researchers.

## 2 Approach

In the period from July 2021 until August 2021, we conducted an experiment with 30 participants for usability research. Of these participants, 20 participants were unable to join the testing site and thus conducted the experiment remotely. When we conducted usability testing remotely, we found that in order to accommodate participants, the following set up was required (see Figure 1).

- A host computer with remote access software and the software for the experiment installed.
- A remote computer with remote access software and troubleshooting software installed.
- A separate device on the host side with troubleshooting software installed. In our experiment, we chose to rely on a smart phone for troubleshooting.

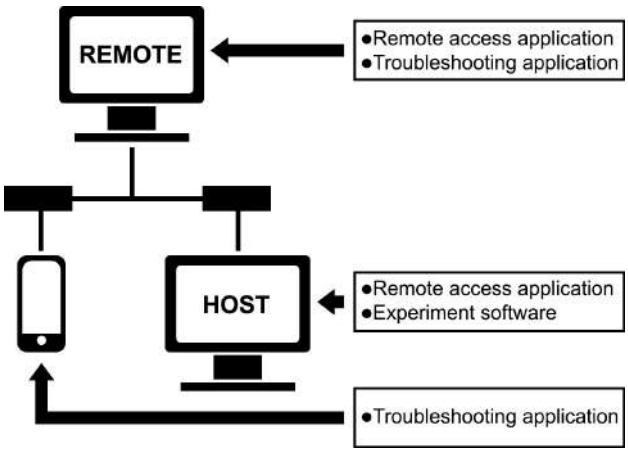



**Figure 1** The required set up for remote usability testing.

During our research, we found the flow as seen in Figure 2 to be effective in conducting the experiment. While experiments took on average 15 minutes longer compared to experiments conducted on-site, how much of this could be attributed to the remote nature of the experiment was unknown. In the following chapters, we will proceed to explain this work flow.

## 3 Remote Access Application

The core of this work flow involves using remote access software, which is software that lets the user access his or her computer remotely. While normally this means that users can access their own computers through a remote terminal, in our work flow we use it to have participants using their own computer (the remote

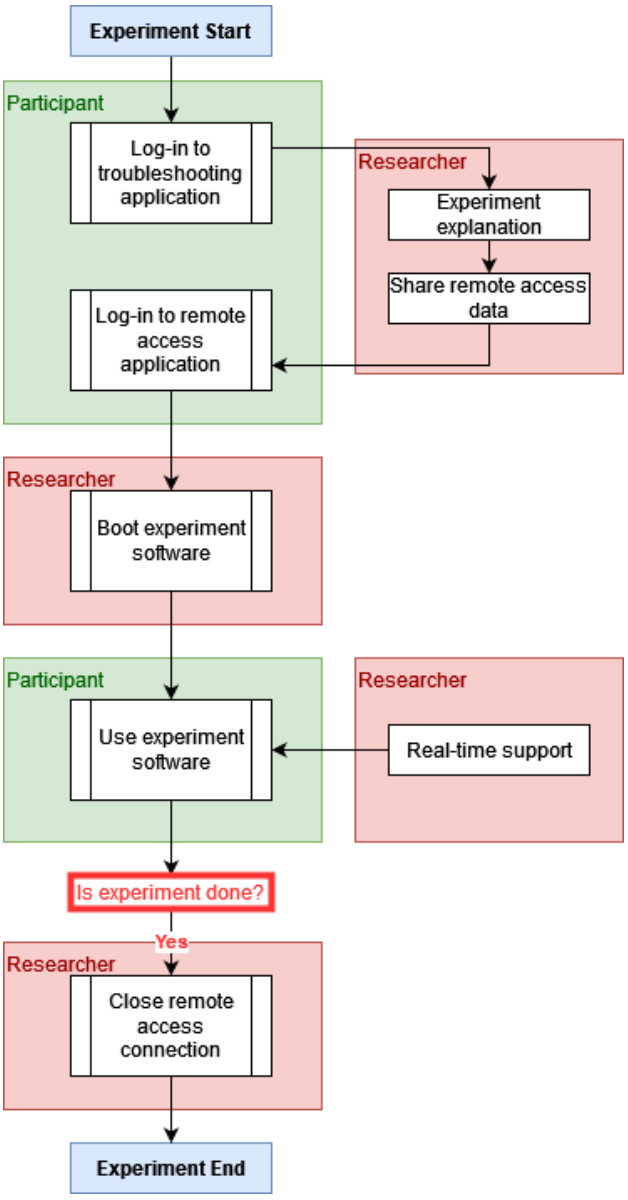



**Figure 2** Remote experiment flow.

computer) to log into our computer (the host computer). After logging in, they will then use our host computer to use the software required for the experiment. For security reasons, we try to limit the time participants use the remote access application as much as possible, so that participants don't have much opportunity to explore the host machine.

While we examined options like allowing participants to download an installer of the experiment software to install on their own machine, this would bring with it a number of problems.

- Problems may arise during the installation process and require further instructions.
- Participants may not understand the operation of the experiment software, even with instructions.
- Results from the participants need to be uploaded to a central entity, which requires functionality to communicate with servers, write data or in the event that data exists, merge the old data with new data.

While all of these issues can be solved, they require specialized knowledge that researchers may not have. Using remote access software, we can solve these problems in a more simple manner. Since we use the host computer as the place the experiment software is used from, no installation is required. Any problems participants may have with the software itself can be directly observed by the researcher. Finally, using remote access software negates the need for an on-line directory for research results, since all the data can easily be saved and merged within the host computer. While this does still require the researcher to merge data, the process is much easier compared to having to communicate with servers as well.

## 3.1 Remote Access Application Options

Since remote access software is crucial for this work flow to work, we examined a number of commercially available remote access software.

### 3.1.1 TeamViewer

TeamViewer[1] is one of the more well-known remote access applications and offers a number of options making it useful for usability testing as well. In our testing, we found that TeamViewer has good speed on remote connections, especially when the quality is set to optimize speed. The color output on the remote device is fairly good as well, meaning participants will see the experiment software the way the host will see it. While there are paid plans, TeamViewer can be used for free. While a number of options are not available in the free version, in our experience it doesn't affect the connection speed or the necessary features. A major downside is that a large number of keyboard keys are not replicated real-time, a limitation that is by design [2]. In the case of game software, this means those keys cannot be used for, for example, movement related input, as those inputs require that a pressed button will continuously be called. Keys representing singular actions, such as jumping, are functional as normal. In our experience, we found that ¡insert button story if we can find it, otherwise skip it¿. Mac OS based computers are also problematic, as with Mac OS based computers, even the keys that worked continuously when pressed for Windows based computers seem to be incapable of continuous input.

### 3.1.2 RemotePC

RemotePC[3], like TeamViewer, offers high speed connections, with options to favour either the quality or the speed of the connection. Compared to TeamViewer however, RemotePC does allow real-time replication of all keys, even for continuous presses. However, RemotePC is available for free as a trail only and otherwise requires a paid license to work. On top of that, if RemotePC is used to have participants log into the host computer, the Enterprise license is required, which is not a license that can be tested using a trial version of the software. Finally, an SSO (Single Sign On) service is also required for this feature, meaning an additional license will need to be acquired for this software to operate optimally.

#### 3.1.3 Windows 10 built in remote desktop

While Windows 10 users can also access a built-in remote desktop functionality[4], this seems to be limited to Windows 10 Pro only. Other versions of the operating system don't have this functionality, like the more common Windows 10 Home. Furthermore, this means this functionality is also inaccessible to Mac OS users.

#### 3.1.4 SupRemo

SupRemo[5] is another free to use remote access application with both Windows and MacOS support. Like Remote PC, it has no lag on continuous inputs. Furthermore, it allows for customized passwords, which could be useful in certain circumstances. However, performance-wise SupRemo is lacking. Compared to Remote PC and TeamViewer, the lag on SupRemo's remote sessions was significant, with a frame-rate hovering between 10-20 frames per second. SupRemo also doesn't have settings that allow the user to set the preference of the connection to either quality or speed, meaning there are very little options to improve performance. One thing that makes SupRemo questionable is that running SupRemo gives the impression that it is a standalone application that can be run without installation. However, upon running SupRemo installs files that it requires without any notification, making it hard to remove unless you specifically search for it. Since it doesn't install through traditional methods, it also is not registered as an installed application, meaning you have to delete all the installed files by hand. At first we suspected that SupRemo was a virus or something similar, but on closer inspection the SupRemo executable had a valid digital signature.

#### 3.1.5 Iperius Remote

Iperius Remote[6] can be used freely and allows for custom passwords on the host side. A unique feature in Iperius Remote is that the application requires both the remote applicant to login and the host to confirm this login, before any actual remote connection was established, giving an extra level of security that may be a boon when using Iperius Remote for remote usability testing. We found no lag on keyboard inputs. Performance wise, Iperius Remote is even lower than Supremo. The video quality of the connection was also severely lacking, with color being output at 8bit meaning a lot of color information is lost. Iperius Remote is a standalone executable, requiring no install. Unlike Supremo, it also doesn't install any supplemental files without notification either.

### 3.2 Software used for remote connections

In our experiment flow, we found that performance was the most important feature in remote access software. Therefore, TeamViewer and Remote PC are both the most recommendable when it comes to remote usability experiments, as their performance is much higher than the other surveyed applications. While TeamViewer's key press limitations may make software design more cumbersome, it is free and relatively easy to use. Remote PC however is more highly recommended in case the researcher has the budget to acquire the necessary licenses as well as the time to set it up.

## 4 Remote Troubleshooting Application

During the experiment, the usage of a remote troubleshooting application was deemed necessary. Going by our experiments, we found that this application needs to have at least 3 features: text chat, audio chat and screen sharing functionality.

We found that lag is unavoidable and that at least 1 in 2 participants had some amount of lag while conducting the experiment, even with high performance remote access software. Since remote testing relies partly on the internet connection of the participant, it's a variable that cannot be entirely solved. While we found that a participant doing nothing is typically a sign of lag, this is not always the case. Sometimes, the participant is just doing nothing, which looks on the host computer as lag as well. To solve problems and communicate, screen sharing and oral communication is necessary. The application in our flow is not only used for troubleshooting, but also for orally explaining the experiment flow and closing the experiment when the participant has finished. It also serves to share the data for logging into the remote access application, for which a text chat function is necessary.

Finally, in our flow we found that while the participant was required to have the troubleshooting application installed on the remote computer, the researcher needed to have it installed on a separate piece of hardware. The reason for this is that the moment the remote access application is used, troubleshooting applications will hinder the participant and the experiment. Keeping the two separated is necessary for a smooth experiment flow, which is why relying on potential troubleshooting options found within remote access applications is not recommended.

In our experience, we found two applications to be particularly useful as a troubleshooting device.

- Zoom.
- Google Meets.

Both applications have similar functionalities and both applications are free to use (though paid plans exist). Both applications have audio and text chat options as well as screen sharing options, which are most important to the experiment flow. Since both applications are similar in functionality and both have desktop as well as mobile versions of their software, the choice depends on what type of application the participants are more likely to use. In our experiment, we relied on Zoom, as our institution's primary video conferencing software is Zoom.

## 5 Guidelines for software design

When developing experiment software for remote testing, a number of specific designs have to be kept in mind.

### 5.1 Safety of the testing environment

A major downside to using remote access software to conduct experiments is that participants need to log in to the researcher's computer. Since the participant has direct control over the host

computer after logging in, it may lead to situations where the participants opens or views something that may contain sensitive information. In order to improve the safety of the testing environment, especially concerning the safety of the researcher's host computer, we took the following measures to make sure no data was compromised while ensuring the flow of the experiment was as smooth as possible.

#### 5.1.1 Preparation of the log-in environment

We found that starting the experiment software before the participant logged in using remote access software was not preferable. This is because of troubleshooting during the remote access log-in phase. While the vast majority of participants had no trouble logging in, a few participants required additional help, meaning we couldn't boot the software before the participant logged in. Due to this, we had to make sure that no desktop icons were visible so that participants could not open any unwanted software. Furthermore, since we used Windows, we also had to hide the task bar to make sure that could not be operated by accident either. What was left was the remote access software as well as a folder with the experiment software, to lessen the chance of anything happening.

#### 5.1.2 Full screen experiment software

On starting the experiment software, we found it's best if it has a full screen function that is enabled by default. With a full screen function, the software will absorb all potential input (though there may be exceptions) and make it impossible for the participant to interact with other software. However, this also means that preparations are necessary to make sure the software can remain in full screen window mode. For instance, if there are any tests that need to be conducted during the experiment flow, such as questionnaires, we found it to be most optimal if those tests are incorporated into the software environment itself to avoid having to minimize the software and opening additional software. Especially with game software, using modern game engines makes it relatively easy to incorporate these tests into the software environment (see Figure 3), though this will require functionality to read and write to and from files. Having a uncommon shut down option makes it so participants cannot close the software by accident (for instance, by remapping either the escape button or ALT+F4 combination to something less common).

#### 5.1.3 Debug control options

Since lag in remote experiments cannot be prevented, it's of the utmost importance that the software environment has options to deal with lag. This is especially the case in timed experiments, since due to lag the participant may not even see the environment before the allotted time is up. In such cases, we found that having the means of pausing timers is a necessity (for instance, by using a dedicated key), using the troubleshooting application to determine necessity at any given time. Furthermore, since we cannot determine the gamut range of the participant's monitor, options to allow participants to adjust color are also required. In our experiments, we found that brightness options that could freely be set by the participant were necessary.




**Figure 3** For our experiment, we required the use of the game experience questionnaire. To smooth the flow and keep full screen window mode active, we incorporated the questionnaires directly into the software environment.

## 6 Conclusions

Through our own research, we were able to optimize a potential work flow for remote usability testing and were able to conduct remote experiments without significant problems. We found that in order to conduct experiments remotely, certain guidelines have to be taken into mind, especially in regards to the design of the experiment software. Since this flow uses third party software for remote testing, this flow should be usable for other researchers as well. While our chosen remote access application has limitations to what type of inputs can be used, other software that allows a more broad selection of keys are available, albeit for a price. While this flow will allow participants to conduct the experiment that were unable to join in person, it should be noted that this approach can also be beneficial for incorporating overseas participants, thus increasing options for usability testing as well.

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# Digital Nudging Concept Using Haptic Signals Under the Feet for Pedestrian Crossing

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**Abstract**
This study considered the design of the haptic floor to influence a person's feet using the floor surface so that the person can observe the change in the environment caused by nudging. We aim to create a new type of interaction among digital functions and people that do not require intentional commands. We attempted to build a system that intuitionally "nudges" a person to react to environmental changes by performing a specific task. This approach differs from that of informing or instructing a person to perform action. We implemented the haptic floor interface for a person's feet that embeds a haptic effect. Wave motions can be formed using actuators equipped underneath the surface. The idea is to generate a subtle-like movement on the floor surface. We examined the application scenario whether our approach can appropriately nudge a person in a specific situation. The obtained results show the potential and current design shortage of the proposed system. We expect these insights serve as a valuable basis for researchers and practitioners who aim to study or design systems that assist people in daily activities.

**Keywords:** Digital nudging, haptic floor interface design, human–computer interaction

## 1 Introduction

Smartphone usage has been one of the important issues in the modern society. Nowadays, most people tend to spend their time using smartphones. This causes serious issues, for instance, texting while walking and not being aware of the surrounding context [1]. In the human-computer interaction (HCI) domain, digital functionalities, such as applications or digital signage are provided by smartphones, PCs, tablets, or LCD walls. They require intentional interaction through operations or commands. Against this background, Thaler et al. [2] introduced the design of intentionally selected environments that influence human actions while preserving their freedom of choice. Selected environments can be designed using nudges, which help make relatively minor decisions. Using this background, the concept of digital functions and the nudge theory are being developed. The concept of nudge is gaining traction in the digital sphere according to certain studies [3], as nudging is being widely applied is digital media via websites or mobile applications. For example, nudge is applied to user interface (UI) design elements to influence the decision-making of users in digital environments. However, limited empirical research has been conducted with regard to digital nudging in the physical environment. Hence, this study addresses the aforementioned challenge by developing digital nudging in a physical environment. We impacted a series of vibrations as nudging to a person's feet from the floor surface to notify them about changes in the environment using the proposed Haptic Floor. We used an actuated floor surface that can move upward and downward to produce various wave patterns. The idea is to create a subtle-like movement on the floor surface, which can prompt a person who stands on it to take a specific action unintentionally. This differs from informing or instructing a person to act. As an early phase of the study, our objective is to create a new type of interaction among digital function and people that does not require intentional interaction and to augment the real world by integrating digital function. We aim to digitize human lives with digital functions that facilitate daily human activities. We examine the haptic floor prototype to determine whether the information is perceptible by humans for basic understanding of the effectiveness of our approach. This provides a basis for us to improve mechanics and interaction of our design.

## 2 Related work

### 2.1 Human behavior and digital nudging

Fundamentally, individuals use different cognitive systems to assess information during the decision-making process [4] according to dual process theories, which are dominant in the field of social psychology: there is intuitive System 1, which is fast, automatic, effortless, and emotionally charged; and on the other hand, there is reason-based System 2, which is slower, effortful, and deliberately controlled. The main empirical studies in the field have concluded that everyday activities are primarily driven by System 1, making human decision-making vulnerable to heuristics and biases. Nudging is a concept based on behavioral economics insights that aim to change environments to improve the likelihood of certain behaviors. When applied to the digital context, digital nudging is defined as the use of user-interface design elements to guide choices or influence inputs of users in online decision-making environments [5]. However, limited empirical research has been conducted that underlies digital nudging in a physical

environment. Hence, this study addresses the aforementioned challenge by developing the haptic floor to apply vibrations to a person's feet from the floor surface to notify them about changes in the environment for daily activities using nudge.

### 2.2 Ambient haptic interface for the feet

Several haptic interfaces involve constant hand interactions to receive feedback from a system or require additional devices (e.g., shape displays [6]) or (e.g. shape-changing mobile phones [7]). This barrier restricts the research community to prototype and explore applications beyond human intervention. Our study addresses the aforementioned challenge by developing the haptic surface for foot soles and aims to explore possible applications. The conventional haptic interface for the foot sole has been evaluated in the study on vibrotactile display. Visell et al. [8] explored possible uses of such floor interfaces in daily environments. Magaa et al. [9] presented an on-shoe tactile display to examine the human interpretation of the information through their feet. However, Magaa et al. addressed the haptic feedback with a conventional method applied to the feet is insufficient for accurate recognition of shapes because the vibration cannot deform the structure if it is excitated by dynamic force, which has the same frequency as the natural frequency of the structure. The shape has no unit. In this study, the proposed method is based on the shape-changing interface theory [9]. It allows specific deformations as physical changes of a floor surface range from the basic height that presents more detailed physical haptic feedback than haptic feedback with a conventional method regarding shapes.

## 3 Concept

We considered to nudge people by impacting a person's feet from the floor surface to notify them about changes in the environment. We proposed to create a new type of interaction among digital function and people that does not require intentional interaction. We developed haptic floor as a mechanism provide the nudge signals. Few simple end-user scenarios may be helpful in guiding the discussion. For example, while people are waiting for the traffic light changing in a crosswalk, they are using a smartphone without realizing that the signal is changing (Figure 1). Afterward, people feel about the surrounding, we assume that the person start to go forward. The proposed method, considered producing such stimulus by applying vibration under the feet using the forward wave pattern (Figure 6). We proposed the haptic floor to notify people of the changing signal based on nudging. People will be nudged by the subtle-like movement on their feet (Figure 1, below). This will notify them about the change in signals, people can take an action unintentionally. This differs from informing or instructing a person to do the action.

## 4 System design

### 4.1 Hardware

Figure 2 shows the haptic floor, we prepared the active floor for three units and six dummy floor units. We designed the changeable resolution of the haptic floor surface that can be calibrated along horizontal and vertical lines (Figure 3). We configured the resolution of the actuator on the floor surface by considering the size of the actual solenoid as it has a minimum interspace of 3 cm among them. Which still has a suitable range of mechanoreceptors in the foot's sole [10]. Based on our observation and preliminary experiment, increasing the force intensity can provide a sensation to participants. However, regarding limitations of the solenoid that cannot increase the force load. Hence, we configured the resolution of the based of the actuator to calibrate the force intensity from the rod's height in the plane vertical of all the rod's stages (Figure 3). We measured the force value in each rod's stage using a force sensor placed above the rod. We applied force load by actuating the rod in each level through the user's foot at (1) low stage at 23 *gf* (0 cm), (2) medium stage at 37 *gf* (0.5 cm), and (3) high stage at 86 *gf* (1 cm) (Figure 3). The force intensity following the closest range of mechanoreceptors in the foot's sole [10]. The actuator rods are controlled by 1 Arduino. It can control 75 solenoids of 5 columns and 15 rows of solenoid rods and regulate the solenoid beneath, sending data from the computer. The computer transmits tactile data to an electronic module via the RS232 protocol, where a controller interprets command strings and sets each actuator of the display. To receive the AC input voltage from a wall power source, an AC-to-DC converter has been adapted as a power source. We developed durable and autonomous materials using a stainless steel base; it can well support the full body weight.

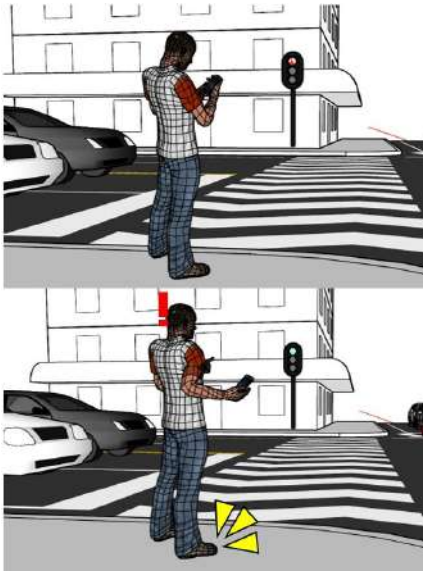


**Figure 1** Nudging a person about signal change



**Figure 2** Overview of the Haptic Floor

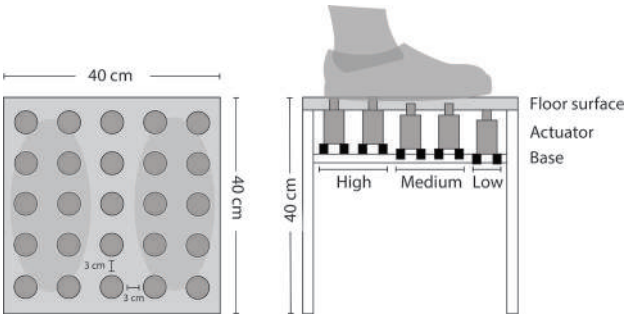



**Figure 3** Assembly components of a floor unit

### 4.2 Software

The control software for the haptic floor is entirely procedural (Figure 4). The system was executed on a Windows computer at a frequency of 60 Hz and was developed in a C++ environment. We store the actuator rod's position data (up and down) of the rod's sequences in the multi-dimensional array functions. We store the delay time of each solenoid rod to create a movement, corresponding to any wave pattern. We control the rod's movement by the software interface that generates tactile data. We can input the data into a GUI generator (such as shapes, pictures, patterns, sequences, and others) by selecting any tactile actuators to be activated and setting their desired interval speed; then, we store all the information in array functions (Figure 5). The interval speed of the wave pattern is designed in three levels: (1) low wave speed (1000 ms) (1 Hz), (2) medium wave speed (500 ms) (2 Hz), and (3) high wave speed (100 ms) (10 Hz). The interval wave speed is designed following the closest range of mechanoreceptors in the foot's sole [10]. For example, in Figure 6, the directional wave pattern indicates the movement along forward direction with varying speed, wide-range areas, and force intensity.

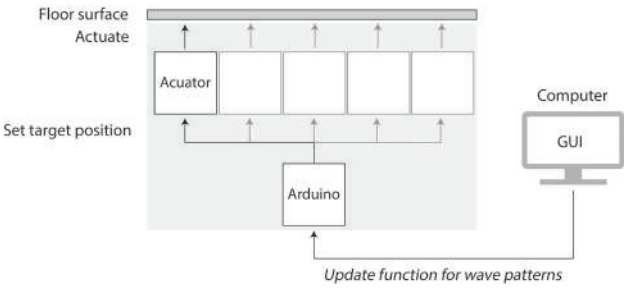



**Figure 4** Working order in the controller system

## 5 Experiment

### 5.1 Situation

The purpose of the experiment is to examine if the system can "nudge" the examinee of a signal change. We simulated the situation when people are waiting for the traffic light to change in a crosswalk. While they are focused on their smartphones without realizing the change in signals (Figure 1). In this experiment, we considered producing the stimulus using vibration under the feet. We proposed the haptic floor to notify people of the change in signals.



**Figure 5** Software interface that generates tactile data

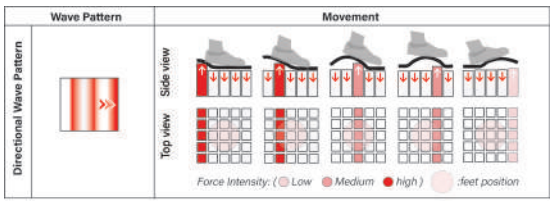



**Figure 6** Directional wave patterns of the haptic floor

### 5.2 Experimental condition

In this section, we set experimental conditions for the application scenario.

**Table 1** Experimental conditions

| Condition | Configuration |
|---|---|
| 1 | Wearing shoes-on |
| 2 | Using smartphone and headphone |
| 3 | Standing in front of the default red signal without receiving notification at the start (Figure 7). |
| 4 | The defined three interval wave speeds at (1) low (1 Hz), (2) medium (2 Hz), and (3) high (10 Hz). We chose 3 different interval speeds to validate the impact of each parameter on the examinee. |
| 5 | Each stimuli is presented twice, it takes about 30 s, to be completed |
| 6 | The forward wave (Figure 6) will be generated with the changed green signal (Figure 7). |
| 7 | The participant is allowed to move in the desired direction. |
| 8 | The experiment involved 10 participants (1 female and 9 males; average age: 21.2 years, *SD*: 2.56). |
| 9 | We collected 1 (directional lines) $\times$ 3 (interval speeds) $\times$ 1 (times) = 3 trials per participant |

We defined that the threshold when the participant moving forward after the activation of the actuator is considered to be nudged by $n$, and the total number of participants is $N$. The feasible number of participants who are nudged can be expressed as $(n \times 100) / N$.

### 5.3 Results

Figure 8 shows the experimental results of the participants who were nudged the results indicated that a low-speed condition is superior to others. The average rate was 76.66% (*SD*: 15.27%). The result was not highly rated. We suspected that the low rate

was the result of the individual perception based on each wave speed parameter. Difference in interval wave speed and traffic light stimulation can nudge participants as they look around to recognize the situation. We expect to further improve and investigate favorable wave speed ratio by designing various speed parameters.

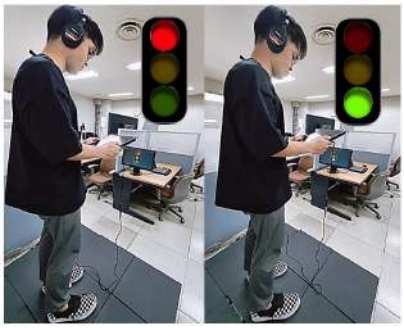


**Figure 7** Simulated environment

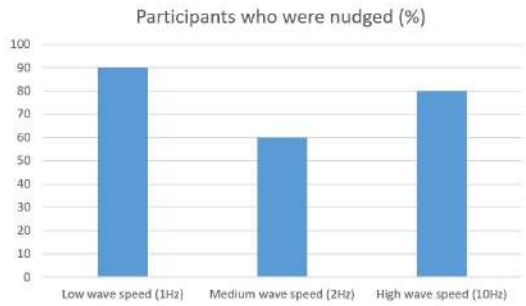



**Figure 8** Results of the field experiment

## 6 Discussion

To assess how effectively haptic floor can nudge a person in a crosswalk situation, we compared it with three interval wave speed parameters. When the participant who is nudged is $n$, the total number of participants is $N$. We defined the participants who were nudged while moving forward can be expressed as $(n \times 100) / N$. We implemented the haptic floor with 75 solenoid rods with three active floor surfaces. We display the directional wave pattern along the forward direction (Figure 6) to nudge a person in a crosswalk scenario. To successfully perform the experiment, we validate whether the examinee reacts to the nudge. Results shown in Figure 8 indicated that the Haptic Floor can effectively notify a person that reacts to the nudge as they look around to determine the situation. The major advantage is that the haptic floor can nudge a person in a changing environment. Another advantage is that it can produce directional wave patterns considering interval wave speed and force intensity. The challenge of the designed wave pattern in a crosswalk scenario. We first considered to provide a stimuli as something coming from back make a person go forward, but considering the nudging nature, it could be a stimuli of something coming in front that makes a person looking up for frontward. We expect to design various wave patterns to improve the way of providing stimulus for this scenario.

## 7 Conclusion

This study considered the design of the haptic floor to influence a person's feet using the floor surface so that the person can observe the change in the environment caused by nudging. We evaluated the application scenario whether our approach can appropriately nudge a person in crosswalk situations. The overall average rate of the participants who were nudged was 76.66% (*SD*: 15.27%). The proposed system showed that it can nudge a person by informing them about environmental changes. However, in the current stage, it is challenging to implement haptic floor owing to magnetic field. When the hydraulic solenoid gets stuck and the rod is unable to move to the target position after the electromagnet is energized, the coil temperature rapidly rises and pulsing ignition occurs; few solenoid actuator coils fail at this stage. This is caused by the low response rate. We expect to improve solenoid mechanism by creating a partition between an actuator coil and rod to reduce magnetic current interference. In future, we need to elaborate on the way of providing the stimulus and improve the system. We must improve the application scenario by examining it with various speed parameters. We can design and highlight various scenarios to nudge a person in border situations.

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# Designing of Nanbu Tekki for Export to Asian Regions

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**Abstract**
In order to develop new Nanbu tekki (Nanbu iron kettle), in efforts to expand sales channels for export to Asia, this study examined the reasons for buyers' design preferences of Nanbu tekkis across different Asian regions. In this study, a questionnaire on the preferences for Nanbu tekkis concerning 46 design proposals in Iwate Prefecture, Japan, was administered along three countries/regions in Asia: China (mainland), Taiwan, and Thailand. The questionnaire was released on the sns platform for a duration of one week, 424 people participated in the questionnaire (265 people in China (mainland), 96 people in Taiwan, 63 people in Thailand). Each participant selected the five most preferred options from the 46 design options. The 46 design options in the questionnaire were randomly distributed, and the participants were seeing the designs for the first time. The top five options with the highest number of choices per region were analyzed and compared using the chi-square test. The analysis shows that there is consistency in the reasons for choosing Nanbu tekki designs across these three countries/regions. To inform product design positioning, these findings will help designers and manufacturers understand the needs of users in different regions and facilitate the development of products that target the majority of user preferences.

**Keywords:** Nanbu tekki, Customer preference, Export products

## 1 Introduction

Nanbu Tekki is a general term for the iron castings made since around the 17th century in the cities of Morioka and Oshu in Iwate Prefecture, Japan. Iron casting is a technique in which molten iron is poured into a mold to create a shape and is mainly used to make tea kettles, teapots, iron kettles, pots, and other household utensils [1]. It was said to be free of the smell of iron and to give a mild taste to the boiled water when brewing tea. It is rust-resistant and durable, so if you take care of it, you can use it for a lifetime. In addition, because the inside of a Nanbu tekki is also iron, the iron content dissolves when the water is boiled. The amount of iron contained in the water is approximately 15 to 19 times greater than that of aluminum or stainless steel; thus, drinking water boiled in such a kettle is a great way to replenish one's iron.

As manufactured in the traditional method (known as the yaki-mold method), it tended to have rotational shapes and uniform designs owing to the existing technical limitations [2][3]. The traditional pattern of Nanbu tekkis is to have evenly distributed circular projections on its surface as shown in Figure 1.

To make these patterns line up beautifully on the spherical Nanbu tekki, the circular projections are deliberately made smaller as they move upward. The shape, depth, and spacing of the circular projections vary from one craftsman to another. Nanbu Tekki has been loved by many people for its quality, and has built an unshakable position and brand as a representative and traditional Japanese craft. In recent years, Nanbu Tekki's reputation has been further enhanced as one of the achievements of traditional Japanese beauty. The foreign demand for Nanbu tekkis has increased, as has the number of variations in the typical shapes of the kettle, its surface decoration patterns, and the colors used. Among Nanbu tekki's products, it has attracted a lot of attention [4]. Demand in Asia, and especially in China, has grown so rapidly that there is a waiting list for reservations up to six months in advance. This is due to the success of the promotion of local companies at the 2010 Shanghai World Expo. Nanbu tekkis as works of art are also highly regarded, and they are spreading, especially among the wealthy. For handmade products, the price range is from the low 20,000 yen range to the high 300,000 yen range. Although the products are relatively expensive, they are gaining popularity – mainly among the wealthy in Shanghai and other parts of China. It is well known that the Nanbu tekki is an excellent match for Pu'er tea.



Figure 1: Traditional pattern and shape of Nanbu tekki




Figure 2: Design sketches of 46 types of Nanbu tekki

Iwate Prefecture is currently focusing on selling its specialty, the Nanbu tekki, in Asia. To expand foreign sales channels and to develop new products, it is necessary to study the design preferences of overseas buyers for the Nanbu tekki.

## 2 Research Method

The purpose of this study was to develop new products of the Nanbu tekki for export to Asia. To expand sales channels, it is necessary to study the reasons for buyers' preferences for Nanbu tekki designs in different regions of Asia. Due to the differences in the use of Nanbu tekkis and design preferences among countries and regions, the author redesigned (based on free thinking without considering mass production) with a total of 46 variations were proposed. Each variation is labeled, ranging from No.1 to No.46 as shown in Figure 2.

In this study, a questionnaire on preferences of Nanbu tekki design proposals were conducted for countries/regions in Asia – particularly that of China (mainland), Taiwan, and Thailand. Each participant selected the five most preferred options out of the 46 design options. The top five options with the highest number of choices were compared and analyzed. The reasons for choosing an option more often were analyzed. The 46 options of desgins in the questionnaire were randomly distributed, and the participants were seeing the designs for the first time. Consumers' personal preferences, cultural backgrounds, social movements, and psychological factors can influence their purchasing behavior [5]. These three Asian countries/regions have some similarities in terms of their culture, food, etc. Here, a hypothesis was put forward: There is consistency in the reasons for choosing the Nanbu tekki. This hypothesis was verified by the following analysis.

Specifically, these findings will assist designers and manufacturers in understanding the needs of users in different regions and in facilitating the development of products that target the preferences of the majority of users.

## 3 Discussion and Conclusion

The questionnaire was released on an SNS platform for one week. According to the results of the questionnaire, the age group of the participants of the questionnaire ranged from 10 years old and above to people over 60 years of age. A total of 265 participants (116 males and 149 females) were validated for China (mainland), 96 in Taiwan (40 males and 56 females), and 63 in Thailand (37 males and 26 females).

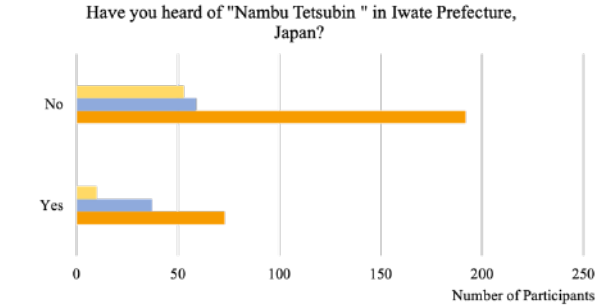
The number of participants in each age group in the three regions are as follow:

For China (mainland), there were 4 participants in their 10s, 55 participants in their 20s, 48 in their 30s, 23 in their 40s, 92 in their 50s, and 43 in their 60s or above;

For Taiwan, there were 2 participants in their 10s, 37 in their 20s, 12 in their 30s, 32 in their 40s, 9 in their 50s, and 4 in their 60s or above;

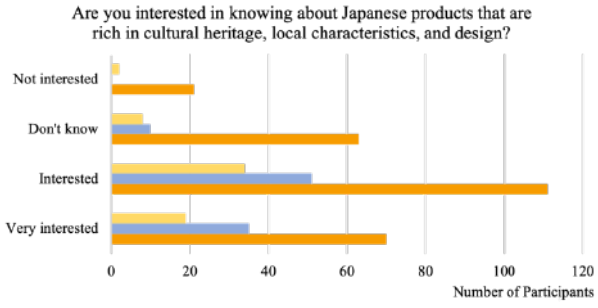
For Thailand, there was 1 participant in their 10s, 9 in their 20s,

33 in their 30s, 18 in their 40s, 2 in their 50s or above.




| | Yes | No |
|---|---|---|
| Thailand | 10 | 53 |
| Taiwan | 37 | 59 |
| China | 73 | 192 |

Figure: 3 Have you heard of “Nanbu tekki”




| | Very interested | Interested | Don't know | Not interested |
|---|---|---|---|---|
| Thailand | 19 | 34 | 8 | 2 |
| Taiwan | 35 | 51 | 10 | 0 |
| China | 70 | 111 | 63 | 21 |

Figure 4: Be interested in Japanese products

| Top 5 Rankings | China(mainland) Options | China(mainland) Number of times selected | Taiwan Options | Taiwan Number of times selected | Thailand Options | Thailand Number of times selected |
|---|---|---|---|---|---|---|
| 1 | NO.7  | 108 | NO.5  | 34 | NO.5  | 19 |
| 2 | NO.6  | 70 | NO.7  | 29 | NO.14  | 18 |
| 3 | NO.18  | 68 | NO.6  | 25 | NO.6  | 16 |
| 4 | NO.16  | 57 | NO.14  | 21 | NO.7  | 16 |
| 5 | NO.4  | 51 | NO.46  | 21 | NO.19  NO.37  | 14 |

Figure 5: Top 5 ranking

The results in Figures 3 and 4 show that, although fewer participants in all three regions have heard of Nanbu tekkis than those who have not, it was clear that participants in each region are interested in Japanese products that are rich in terms of their cultural heritage, local characteristics, and design. Therefore, it can be considered that it is feasible to sell Nanbu tekki to other Asian countries. Figure 5 shows the top five designs that were liked the most. The top five for China (mainland) were No.7, No.6, No.18, No.16, and No.4 – the number of times these options were chosen among the 265 participants was 108, 70, 68, 57, and 51, respectively.

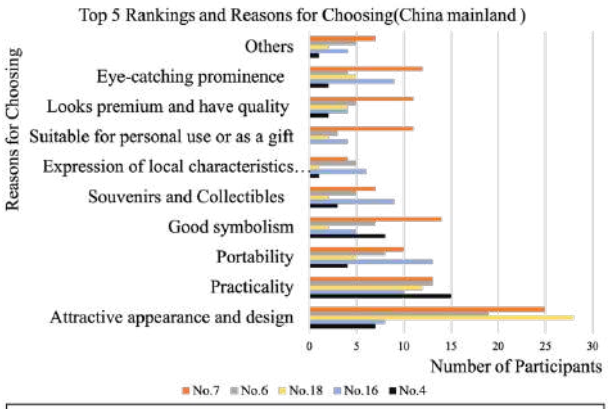
The top five in Taiwan were No.5, No.7, No.6, No.14, No.46 – the number of times these options were chosen among the 96 participants was 34, 29, 25, 21, and 21, respectively. The top five in Thailand were No.5, No.14, No.6, No.7, No.19, No.37 (tied for fifth place due to both No.19 and No.37 being selected 14 times) – the number of times these options were chosen among the 63 participants was 19, 18, 16, 16, and 14 (twice), respectively. Among them, No.6 and No.7 ranked in the top five in all three countries/regions. The top five for Taiwan and Thailand also contained two of the same options – No.5 and No.14. It can be seen that the three countries/regions have similar product preferences.

After each participant chose their preferred five options, they provided the rationale for their choices.

The reasons were listed below:

1. Attractive appearance and design.
2. Practicality.
3. Portability.
4. Good symbolism.
5. Souvenirs and collectability.
6. Expression of local characteristics and cultural heritage.
7. Suitable for personal use or as a gift.
8. Looks premium and have quality.
9. Eye-catching prominence.
10. Others.

We believe that there is consistency in the reasons for choosing the Nanbu tekki in these three countries/regions. To test this hypothesis, a chi-square test was used to analyze the reasons for choosing the top five options across these three countries/regions.

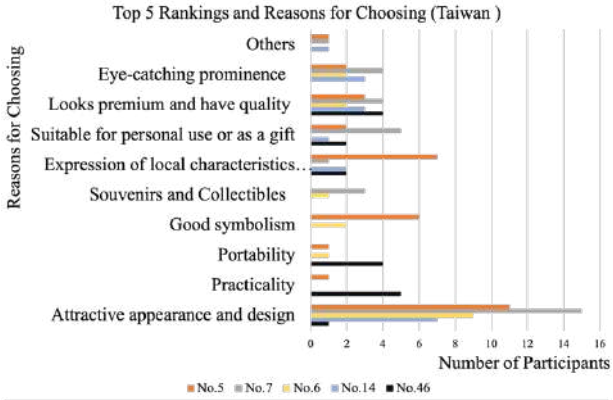



| Chi-Square Tests | | | |
|---|---|---|---|
| China | Value | df | Asymptotic Significance (2-sided) |
| Pearson Chi-Square | 63.173a | 36 | .003 |
| Likelihood Ratio | 62.632 | 36 | .004 |
| Linear-by-Linear Association | 2.743 | 1 | .098 |
| N of Valid Cases | 366 | | |

Figure 6: Results of the chi-square test (China mainland)

Figure 6 shows the results of the chi-square test analysis for China (mainland). The mean difference is significant at the level of 0.05. The sample included 10 reasons, and the number

of times each reason was selected – China (mainland): p = 0.003 (< 0.05). From the chart, we can briefly conclude that Chinese participants care more on "portability", "practicality" and "attrictive appearance" more than other factors comparatively, for example the moden arched handle without connected to the body, which believed that can made their aesthetic even more satisfied, and the unibody-styled shape may associated with luxury along with high functionality and mobility, especially for personal use.




**Chi-Square Tests**

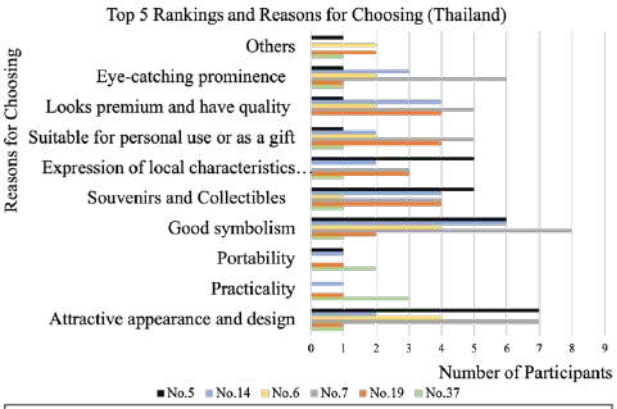
| Taiwan | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 77.912[a] | 36 | .000 |
| Likelihood Ratio | 80.202 | 36 | .000 |
| Linear-by-Linear Association | .099 | 1 | .753 |
| N of Valid Cases | 119 | | |

Figure 7: Results of the chi-square test (Taiwan)

Figure 7 shows the results of the chi-square test for Taiwan. The mean difference is significant at the level of 0.05. The sample included 10 reasons, and the number of times each reason was selected – Taiwan: p = 0.000 (< 0.05). From the chart, we can noticed that "portability" and "practicality", which Chinese participants prefers a lot is much more lower. Especially the first three preferences. "eye-catching prominence" "looks premium" "attrictive appearance" and "expression of local characteristics" are comparatively being chosen more. It may reflects that compares with high portability and functionality, Taiwanese participants are tendency to care more about first impressions towards the traditional style products.

Figure 8 shows the results of the chi-square test for Thailand. The mean difference is significant at the level of 0.05. The sample included 10 reasons, and the number of times each reason was selected – Thailand: p = 0.088 (> 0.05). We can noticed from the chart that Thai participants tend to care about "Expression of local characteristics" "souvenir and collectibles" and "good symbolism" more than other factors comparatively, especially "good symbolism", which is way higher than other two countries, this may related to the rich buddhist culture in Thailand, people will naturally associated with symbolic features when they saw such luxury craftworks. The handle's shape of No.5 and No.15 has a motif of the element of Japanese shrine, we think this may have influence to their decision.

These frequencies were significantly different between China (mainland) and Taiwan. This means that there is consistency in the reasons for choosing the Nanbu tekki in both China




**Chi-Square Tests**

| Thailand | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 58.309[a] | 45 | .088 |
| Likelihood Ratio | 57.312 | 45 | .103 |
| Linear-by-Linear Association | 1.490 | 1 | .222 |
| N of Valid Cases | 143 | | |

Figure 8: Results of the chi-square test (Thailand)

(mainland) and in Taiwan. Although these frequencies did not differ significantly in Thailand, the two-dimensional bar chart shows that the number of reasons chosen by participants in Thailand is relatively evenly distributed. In the two-dimensional bar charts for China (mainland) and Taiwan, reason 1. Attractive appearance and design were chosen most frequently as reasonings, while other reasons were relatively infrequent. In the two-dimensional bar chart for Thailand, reason 1 was also selected a lot, but the frequency of the other reasons increased.

Although the number of samples in each countries/region varied, such clear results are possible to consider that there is consistency in the reasons for choosing Nanbu tekkis in these three countries/regions. These findings will assist designers and manufacturers in understanding the needs of users across different regions and facilitate the development of products targeting the preferences of the majority of users, For example, adding iconic and symbolic Japanese features to the handle, spout or other parts in Nanbu tekkis for attracting the cosumers especially those who have religious beliefs such as Thai will be more easier being accepted. Besides, adding more sense of luxury by thinking out adding premium color or material factors and balancing the attractive appearance level during design will be more easier being acceptable for Taiwanese consumers. Last but not least, the Chinese consumers intended to have high functional value being added to the Nanbu tekkis, in other words, compared with other two countries, taking advantages of the components of the teapot such as handle, spout even the body, to enhance the mobility and storability to suite different usage scenarios is seems more easier to be accepted.

## 4 Future Works

This study provides valuable data for the final design direction of the Nanbu tekki, allowing us to gain more insight into the consistency of users' preferences for Nanbu tekkis across these three countries/regions in Asia, increasing our knowledge of consumer choice preferences in parts of Asia, which can then

be used as a strong reference for final decision making. Based on this, matching consumer preferences with needs will be the next key research direction.

To discover and obtain more comprehensive conclusions, it is necessary to continue exploring and confirming the final solution in conjunction with actual production. A detailed investigation on the production process of the Nanbu tekki will be carried and needs to be discussed separately. To meet both the production process and the needs of consumers, we need to continue in-depth research in the future.

To achieve this, First of all, it is required to clarify from behind the data we have collected from this experiment for "the reasons for choosing" of each country's consumers which seems essential. Besides, it is also required to analyze the differences between people with Nanbu tekki experience and those without for collecting more objective data.

This study explores the level of consumers across different regions; the actual manufacturing and production aspects also need to be researched and analyzed. Depending on the shape of the Nanbu tekki, there are different manufacturing methods. The production direction is determined by combining the recommendations of Japanese Nanbu tekki manufacturing experts. From the 46 variations of Nanbu tekkis the author presented were sketches in grayscale, however, we believed that without materiality, it is still a weakness to achieve further research goal. The form Nanbu tekkis is obviously not only specialized in its shape but also the material in cast iron, to this end, we will consider presented combining with CG models rendered with material in the next step of the study for collecting more precise guideline for designers and in-depth understanding of the consumers' culture in the three countries.

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# Creation of Fluid Art under Microgravity Using Free-Fall

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**Abstract**
The time is approaching when space travel will become a reality. What kind of new art will emerge in the space age is an important issue. We have been creating art called “fluid art” using fluid dynamics. Since what kind of new fluid art could be created under zero-gravity is one example of the way art should be in the space era, we plan to create fluid art under zero-gravity or microgravity. As a method of creating microgravity on the ground, we designed and constructed a system that creates microgravity using free-fall. This system can create microgravity for about 0.5 seconds by freefalling a device that generates fluid art from a height of about 1.5 m. “Sound of Ikebana,” one of the fluid art we have been creating using the vibration of sound, uses a phenomenon that occurs in a short time of about 0.5 seconds and matches well with the constructed microgravity generation system. It was confirmed that a new type of fluid art was generated using this system, where the height the fluid jumped up was significantly larger than under normal gravity.

**Keywords:** zero-gravity, microgravity, high-speed camera, fluid art, free-fall

## 1 Introduction

Recently, there have been many topics related to space. NASA succeeded in launching the spacecraft on Mars [1]. SpaceX's spacecraft sent four civilians to a four-day flight to orbit around the earth in September 2021 [2], making us realize that space travel is becoming reality to us.

Although the day when ordinary people can easily go out into space is still a long way off, we need to think seriously about our space travel in the future. Given that space travel will become familiar to the public, it is necessary to think about how the culture that we have built up in our society will change in the space age.

Art has been deeply linked to human spirituality since ancient times, and what art will become in the space age is an important and interesting issue [3].

The authors are interested in what art will look like in the environment of zero-gravity or microgravity, which is an environment peculiar to space travel. We have been producing fluid art [4] [5], which is an art utilizing fluid dynamics. Since the behavior of fluid would be significantly different under zero-gravity, it is necessary to investigate fluid art under a zero-gravity environment. However, it is quite difficult to achieve zero gravity on the earth.

In this paper, firstly we describe the concept of fluid art production under zero-gravity. Then, we propose a method to realize microgravity with a relatively simple system and describe its development process. Finally, the results of a fluid art production experiment using the system will be described.

## 2 Related Research

JAXA (Japan Aerospace Exploration Agency) has a Japanese laboratory called "Kibo" on the ISS and uses it to carry out various experiments not only in the scientific field but also in art areas. From 2008 to 2011, the first theme was solicited and implemented, and nine experiments related to art were conducted in "Kibo" [6]. From 2011 to 2013, eight themes were implemented in the second phase [7]. For example, the "Hiten Project" is an experiment to verify what kind of dance a person can perform under zero-gravity [8].

## 3 Fluid Art

### 3.1 Fluid art "Sound of Ikebana"

Fluid behavior is a large part of natural phenomena. Water flow, wave behavior, ocean currents, etc. are typical examples. Many natural phenomena can be thought of as the behavior of fluids. We have developed a method to visualize fluid phenomenon and make it into an artwork called “fluid art” [5]. Specifically, as one of the basic techniques for creating fluid art, we have developed a method for photographing the formation of a liquid made by the vibration of sound with a high-speed camera. We found that it is possible to create a flower-like shape with fluid by giving sound vibration to a fluid such as paint. Figure 1 shows the experimental environment. When the speaker is placed face up, a thin rubber film is put on it, a fluid such as paint is placed on the rubber film, and the speaker is vibrated by sound, the paint

jumps up and makes various shapes. And the created form is captured by a high-speed camera of 2000 frames/second [4].

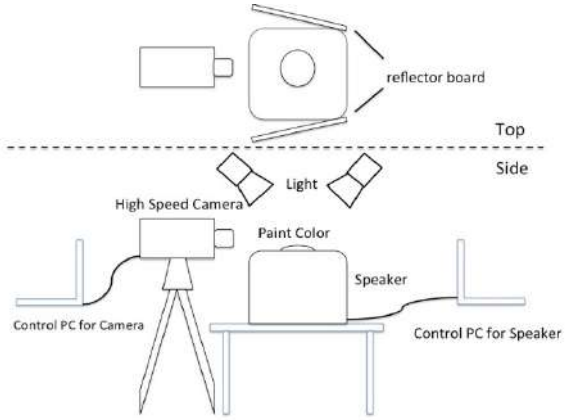



**Fig. 1.** Fluid art generation system.

### 3.2 Fluid art "Sound of Ikebana"

Using this environment, we systematically changed the shape of sound (sine wave, sawtooth wave, etc.), frequency of sound, type of fluid, the viscosity of the fluid, etc., and shot various fluid forms with a high-speed camera. Naoko Tosa, one of the authors, confirmed that Ikebana (Japanese flower arrangement) like shape is generated. and she created a video art called "Sound of Ikebana [5]" by editing the obtained video images. Figure 2 shows several scenes from the artwork.



**Fig. 2.** Fluid art “Sound of Ikebana.”

### 3.3 Meaning of fluid art generation under zero-gravity

We are currently researching to generate various fluid art represented by the Sound of Ikebana under zero-gravity. Now that space travel is not just a dream story, we believe that producing the Sound of Ikebana under zero-gravity has the following meanings.

Art is an important element of society for us. In the future where people's lives in space will become commonplace, it is necessary to think about what art will become in the space age. In the space age, new art suitable for the space age may arise. Therefore, it is necessary to search for a new form of such art from now. Also, as mentioned earlier, the behavior of fluids under zero-gravity is an important research topic. Therefore, what kind of shape of the fluid art would be produced under zero-gravity is an important issue.

## 4 Microgravity Generation Method

Zero-gravity is a normal state in outer space. However, gravity is always working on the ground. There are two typical methods to realize zero-gravity or microgravity.

### 4.1 Free-fall generator

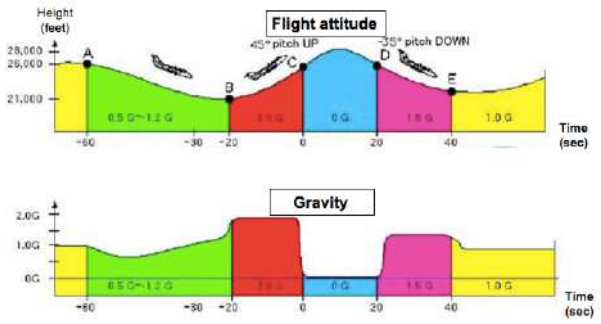
On the ground, when an object falls downward, it is in a weightless state (actually, it is not complete weightlessness due to the resistance of air). In other words, zero-gravity can be achieved by creating a free-fall state by dropping things from a high place.

The Micro-Gravity Laboratory of Japan (MGLAB) in Toki City, Gifu Prefecture, has a facility with a free fall distance of 100 m and a free fall time of 4.5 seconds. This drop tower evacuated the inside of the tower to eliminate air resistance and allow the fall capsule to fall freely [9]. Unfortunately, this facility has already been discontinued.

Overseas, the ZARM microgravity experimental facility at the University of Bremen, Germany is famous. The height is 147m (actual fall distance is 110m), and when the falling capsule is dropped in a tower that has been evacuated, microgravity for almost 4.7 seconds can be achieved [10].

### 4.2 Parabolic Flight

Parabolic flight means flying along a parabolic flight path [11]. After gaining sufficient speed by a rapid descent, the aircraft is raised and parabolic motion is performed by narrowing the thrust to the extent that it compensates for air resistance. During the parabolic flight, a microgravity environment of about $10^{-2}$G to $10^{-3}$G can be realized for about 10 to 20 seconds inside the aircraft, so it is used for microgravity




experiments and training of astronauts. Figure 3 shows the flight curve in parabolic flight and the gravity in each phase.

**Fig. 3**. Parabolic flight

# 5 Creation of Fluid Art under Microgravity

## 5.1 Concept

As mentioned earlier, we are at the beginning of the space age, and we think it is time to consider how art should be in the space age. When art is produced using natural and physical phenomena such as fluid art, the behavior of fluid in zero-gravity has a great influence on art production. Attempts to create art using fluid dynamics in the state of zero-gravity are of great significance.

We are very interested in how the art "Sound of Ikebana" created using fluid dynamics will be shaped under zero-gravity. Now we are planning to try this art creation in a zero-gravity environment using parabolic flight among the methods for realizing zero-gravity mentioned above.

At the same time, the parabolic flight is a large-scale experiment, as it is necessary to work with a company that can achieve parabolic flight using their airplane, which is costly. Based on an estimate by the company providing parabolic flight service, one experiment costs US$50K or more. Therefore, it is risky to carry out the parabolic flight experiment without knowing what kind of shape will be created. At the same time, even in experiments using free-fall devices described in 4.1, there are only a limited number of free-fall devices that can carry out our experiments that include equipment such as speakers and high-speed cameras, which also require lots of preparation and budget.

When we were wondering what to do, a researcher who used to work at JAXA advised us to develop a small-scale free-fall experimental system indoors. After studying according to this advice, we found that a small-scale free-fall in our laboratory environment very well matches with the fluid art creation that we have been doing.

## 5.2 Prototype of free-fall system

Most experiments under zero-gravity conditions require at least tens of seconds, or even a minute or more. On the other hand, the fluid art that we have been doing is to create art by shooting a fluid dynamics-based phenomenon, that occurs in a short time of 1 second or less, with a high-speed camera. This means that free-fall for a short time within 1 second would be enough for creating fluid art in microgravity. Free-fall within 1 second can be realized without the need for a large-scale device.

As is well known, the relationship between the fall distance $h$ and the time $t$ when a free-fall is started from a stationary state is expressed by the equation (1), where $g$ is the gravitational acceleration. If there is air resistance, it becomes a little bit complicated and is expressed by the formula (2). Here, $m$ is the mass of the falling object and $k$ is the air resistance coefficient.

Table 1 shows the time when free fall is performed from the

$$t=\sqrt{\frac{2h}{g}} \quad (1)$$

$$t=\sqrt{\frac{m}{gk}}\,\mathrm{acosh}\left(e^{\frac{hk}{m}}\right) \quad (2)$$

height of 1 m, 1.5 m, and 2 m, where $g$ = 9.80665, $m$ = 20 kg, and $k$ = 0.24.

**Table 1.** Free-fall distance and time

| Free-fall distance | Time without air resistance (sec) | Time with air resistance (sec) |
|---|---|---|
| 1m | 0.452 | 0.453 |
| 1.5m | 0.553 | 0.555 |
| 2m | 0.639 | 0.641 |

From Table 1, a microgravity time of 0.553 seconds can be obtained when falling from a height of 1.5 m, and 0.452 seconds can be obtained when falling from a height of 1 m. It can also be seen that even when the air resistance is taken into consideration, the fall time is only increased by about 0.001 to 0.002 seconds as compared with the case where the air resistance is not taken into consideration. This is because the velocity is low at the beginning of the transition from the stationary state to the free-fall, so it is not easily affected by air resistance. This is also a condition suitable for creating a microgravity environment by utilizing a free-fall state for a short time.

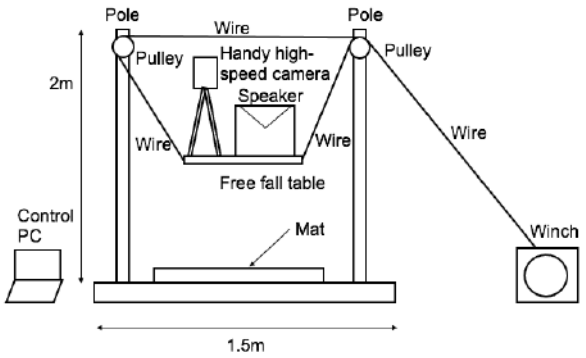



**Fig. 4.** Conceptual diagram of free fall system

Figure 4 shows a conceptual diagram of the free-fall system. The free-fall table made of lightweight iron frames with the speaker on it is prepared and set in a cubic frame made of sturdy iron pipes. The steel wires are attached to the four corners of the free-fall table, and the four steel wires are gathered and connected to the winch through the pulleys attached to the tops of the four steel poles. By winding up the

winch, the free-fall table is raised to a height of about 1.5 m, and the free-fall table is freely dropped in synchronization with the drive of the speaker on which the paint is placed and the start of shooting with the high-speed camera.



**Fig. 5.** The free-fall system.

Figure 5 shows a whole view of the free-fall system. The free-fall of the drop table can be done by removing the winch stopper, but to avoid the influence of the winch friction, it was found that it is more suitable to generate microgravity by cutting the wire every time.

### 5.3 Fluid art under microgravity

Using the above free-fall system, we are currently conducting experiments to generate "Sound of Ikebana" under microgravity. Figure 6 shows several shapes of the "Sound of Ikebana" created under microgravity using the system.

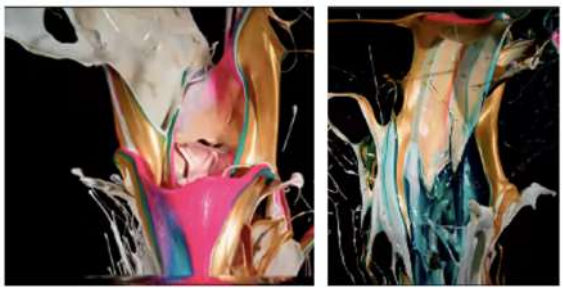


**Fig. 6.** "Sound of Ikebana" created under microgravity.

Full-scale experiments are yet to be completed but compared to the "Sound of Ikebana" made under normal gravity, we found that the liquid jumps up highly and spreads laterally, and more dynamic and beautiful liquid forms can be obtained.

## 6 Conclusion

As the space age is going to arrive, it is important to consider the future form of art in the space age. Based on such an awareness, we are interested in new forms of our video artwork "Sound of Ikebana," which are produced by giving sound vibration to liquids such as color paints, under zero-gravity and microgravity.

In this research, we investigated the method for creating zero gravity and described the concept, design, and development of a free fall system for creating microgravity in our laboratory. We also described examples of creating the "Sound of Ikebana" in a microgravity environment using the free-fall system.

In parallel with this, we are preparing to produce the "Sound of Ikebana" under more complete zero-gravity by using parabolic flight. By comparing the produced artworks using the free-fall system described in this paper with those in parabolic flight, we can improve the free-fall system so that it can create fluid art under more complete microgravity conditions.

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# Designing "Forest is Friend" Game Activation on PUBG Mobile Using the Double Diamond Method for Generation Z in City Areas.




**Figure 1:** User Interface for “Forest is Friend” PUBG Game Activation.

**Abstract**
Linking the issue of deforestation to the PUBG Mobile strategy-based game, which is loved by many young people, can be an interesting approach to build awareness about global environmental issues. Departing from forest problems in West Java Province in Indonesia, the activation of the game "Forest Is Friend: Conserve for The Future" is designed to increase the awareness of Generation Z who live in urban areas to realize the importance of the role of forests in their daily lives, despite their minimal interaction with the green areas since they are far from it. We agreed to make game activations instead of creating new games because PUBG/Playerunknown's Battlegrounds Mobile has great potential both in terms of gamification and brand awareness, thus enabling the delivery of messages about the issue of deforestation to different targets at a wider level.

**Keywords:** Game Activation, Deforestation, Generation Z.

## 1 Introduction

Mobile games are very popular in Indonesia. One of them is strategy-based games like PUBG Mobile from Tencent Games. It is still the most favorite battle royale game in Indonesia, which is played by various groups and ages. This game can be accessed for free so that it provides an opportunity for anyone to play it [1]. Overall this game is easy to play by experienced players or new players [2]. PUBG Mobile is included in the 10 most popular games with the most monthly active users and is one of the most popular games with the highest income in Indonesia [3,4]. However, what if a Strategy-based game where the key to this game is survival, which is usually just for the goods of entertainment, can be a medium of communication to raise awareness of one of the main global environmental issues, namely deforestation. Deforestation in Indonesia has a very serious impact both at the national and international levels. Indonesia is a country with a major contributor to climate change and is increasingly vulnerable to its impacts. The high rate of deforestation not only causes damage to nature but it will also have an impact on the social life of the community [5]

## 2 Design Method

In the discovery stage, we collect target user information to gain as much insight as possible to apply to the activation game, represented in the form of empathy maps and user journey mapping. For the defined stage, we analyze the information and then narrow it down to determine the problems to be solved. The analysis is carried out by comparing notes, understanding and managing perceptions of potential users, and identifying ideas which are then summarized into user personas. Furthermore, in the development stage, we focus on designing ideas and solutions. The idea is designed in the form of a navigation flow and later it becomes a design reference and then implemented in the form of a prototype of visual items, skins, and the main theme of the user interface. At the delivery stage, we conduct usability testing of the prototype to the target user to ensure the prototype design is based on the standard of the game, solved our initial problems, and also determine the level of usability by planning to get feedback from the intended target user through the google form so that it can be reached by many people with easy access [6].

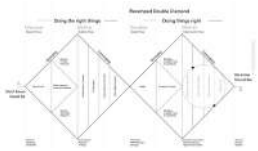


**Figure 2** Double Diamond Design Process Framework, uxdesign.cc, Nessier, D. [7]

## 3 Discussion

From our discussion under the double diamond process, we have got several groups of data which eventually became the foundation for the design of our game activation as follows [8,9,10]. In designing the activation of the Forest is Friend game, we want to combine the PUBG game where 'Survival is key' in which who survives to the end is the winner with the knowledge of forest awareness in the light of forest destruction and over-exploitation that can cause reduction to the quality and quantity of green areas as the provider of environmental services around the human vicinity and also who give an impact to the social life of the community.

### 3.1 Discovery

We take the case from the forest of West Java. The data from International Conservation Indonesia shows that currently, forest cover in West Java is only 22% with 816,000 hectares of natural forest remaining [11]. In addition to that, conservation awareness and the knowledge of understanding the importance of forests and the potential they contain for people's welfare are also still low, which is one of the main causes of natural damage caused by humans [12].

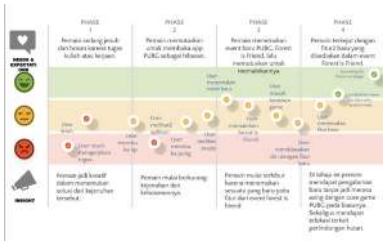


**Figure 3** User Journey map for Forest Is Friend



**Figure 4** Empathy map

### 3.2 Define

The perfect target is generation Z of productive age between 17 - 23 years old who live in big cities in Indonesia and are mostly students who spend at least 8.5 hours a day on their smartphone [13]. Attracted to new things, challenges, and hanging out with friends [14].



**Figure 5** Gen Z, From Left, Vince Fleming (Unsplash.com), Ibnjaafar (Gettyimages.com)

## 3.3 Develop

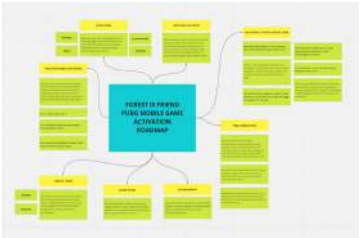


**Figure 6** Forest is Friend Game Activation Roadmap

The concept of the activation includes short stories, tree interactions, safe from climate change zones, maps of new locations, etc. But what we will discuss in this art paper is the potential feature limit on the **Special item**, **Sustainable skin series**, and **PUBG Mobile main menu theme**.Through this, players can realize that their every action is meaningful [15], affecting themselves, their lives and the forest around them. This is expected to increase player awareness which encourages players to take practical environmental protection actions in their daily lives.

## 3.4 Deliver

Visual results of game design and interactive media for Forest is Friend PUBG game activation.

**Special item**



**Figure 7** From Left, Trash, Volodymyr H, Unsplash. Special Item.

There are several interactive objects related to the theme of environmental pollution. Some are able to be used by the players like weaponry made out of recycled plastics.

**Sustainable Skin Series**



**Figure 8** Examples of PUBG Skin. (source :ONTX GAMING, Pinterest)

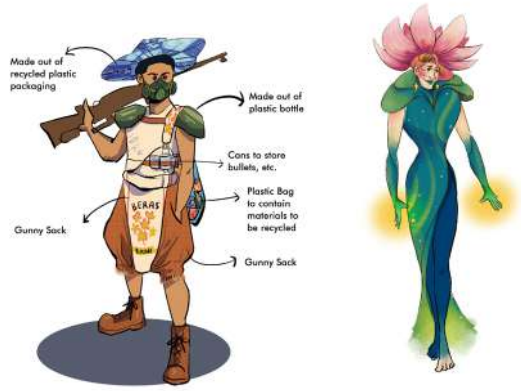



**Figure 9** Skin 1 - Made out of recycled materials: gunny sack and plastic. Skin 2 - Mother Gaea representing the Earth.



**Figure 10** Skin 3 - Made out of recycled materials: plastic and cardboard. Skin 4 - Made out of milk's carton.

We have developed some designs under the Sustainable Skin Series theme which involves skins that are made out of recycled materials like recycled cardboard and plastics. Skins are one of the most popular features that help to pick up a player's interest in playing the game.



**Figure 11** From left, PUBG Mobile Environment (Source: Alex, Medium.com), Forest Fire depiction (Source: Bay Ismoyo, theguardian.com), Forest (Source: wallpapercave.com)

Environment of the game is set in the middle of a damaged forest, it's on fire, littered, with chopped trees here and there.




**Figure 12** Game appearance, this background is taken from PUBG but we modified it again.

One of the game appearances shown in the game. The **UI** displays in an imaginative visual form but still maintains the impression of the reality of deforestation that is happening and the **UX** is for increasing awareness of pubg players on environmental issues, such as deforestation due to lifestyle and consumption which causes other problems such as waste. In this activation, players will be directed to gain insight into forest conservation for their lives on the basis of PUBG game strategy. [16]

## 4 Conclusion & Future Work

The activation of the game "Forest is friend: Conserve for the Future" for PUBG Mobile is designed to raise awareness of Generation Z players on the issue of deforestation under the perspective of urban communities with an interactive media approach using the Double Diamond method. Players are expected to become sympathetic and empathetic to the issue in order to pay more attention to their lifestyle in the real world to protect the forest around them. This activation idea can be a game changing step that can be added and also developed to enrich the variety of media that focus on environmental issues, in the future we hope it can also be a part of a fun educational program everywhere.

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# A Study of Cultural Significance in Mainland Chinese Animated Character Design



**Abstract**
Cultural significance symbolizes the essence of a culture. Hence, it is crucial to display cultural significance in animated character design to produce a memorable character with solid cultural background. However, in recent years, Mainland Chinese animations have been observed to be greatly influenced by foreign animations. Characteristics of character design from foreign animations were adapted in their domestic animations. Moreover, there is a lack of research that addresses the tangible elements to create a culturally significant character design. Therefore, the author is determined to further discuss this topic in this paper. A cross-comparison visual analysis was conducted on all three characters of *Nezha*, a well-known deity from the original Chinese mythology, with *Nezha* the animated characters produced in the Mainland China animations entitled *Nezha Conquers the Dragon King*, the 1979 version, and *Ne Zha*, the 2019 version. Based on the findings, the author observed there were changes made across all the three characters. In *Nezha Conquers the Dragon King* (1979 version), *Nezha* was seen to resemble *Nezha* from the original Chinese mythology very closely. Only minor improvisations were made, such as the face features, hairstyle, and costume. *Nezha* from *Ne Zha* (2019 version), on the other hand, was improvised further and looked very different from the *Nezha* of the original Chinese mythology but still resembled *Nezha* from *Nezha Conquers the Dragon King* (1979 version). Despite the changes, the author believed cultural significance was still present because the essence of *Nezha* was still well-defined across all three characters. Subsequently, the author observed that the changes introduced have created an interesting interpretation of the traditional character. This would be a breakthrough to observe how a traditional character was being translated in many ways. For example, the change in animation style reflected the improvement of technology in interpreting traditional mythology to address the animation preference of audiences these days. Whereas in the online survey's findings, 71.99% of the respondents agreed that "clothing" is the most influential tangible element to create cultural significance in character design. Perhaps it can be due to the "clothing" factor occupying most part of the character. Subsequent to the research, the author has designed a character prototype that has the influence of Chinese culturally significant elements within her understanding of this research topic.

**Keywords:** character design, animation, culture

## 1 Introduction

Character design is one of the most vital elements in animation. Hence, to create a recognizable character, the character needs to appeal to the audience. Identity can be established through the incorporation of cultural elements. This is because culture can reflect the era of the animation, hence creating cultural significance to the character. In this paper, the author focuses on the animated character design of Mainland Chinese animations and the tangible elements that can create cultural significance in the characters. It is believed that when tangible elements carry cultural characteristics, the cultural significance will be achieved, and the identity of a character will be well-defined. Lastly, in the Section 6 of Project (Character Design) of this paper, the author will show how she reflected and articulated the findings into a character design prototype.

## 2 Literature Review

According to Zhou (2017), Mainland Chinese animations with rich Chinese cultural elements were produced by the Wan Brothers in the 1920s. For example, Princess Iron Fan embodied cultural attributes of the era (Fang & Lin, 2017). Fang and Lin (2017) also pointed out that Chinese art styles such as clay sculpture, paper cutting, and ink painting were adapted into animation production. These techniques not only display cultural significance in the animation, but also brought great success to the animation field (Fang & Lin, 2017). However, Mainland China's animation started to face hurdles when Europe and United States entered the market (Luo, 2017). The presence of foreign animation enterprises threatened the position of Mainland Chinese animation. Other than having stronger competition in the market, the lack of incorporation of Chinese culture in the animation was an issue (Zhou, 2017).

To resolve the issues mentioned above, Gao and Zhang (2010) suggested the blending of traditional culture into the animated characters of Mainland Chinese animation. This would then instill the national spirit of ethnicity in the character design (Gao & Zhang, 2010). Similar to Gao and Zhang's suggestion, Zhou (2017) urged designers to explore Chinese culture by integrating it into Chinese animation, as the inheritance of culture is vital to the development of the Chinese animation industry.

Exploration of culture can contribute to a better understanding of a culture. To produce a convincing character design, designers would need to acquire a profound understanding of the culture to internalize culture into the work (Zhou, 2017). With sufficient knowledge of the said culture, designers would know how to incorporate certain techniques or styles which are significant to the culture. In the author's opinion, Zhou's (2017) research has highlighted the importance of conducting research and development (R&D) prior to creating an animated character design. R&D can help to establish a solid foundation of information relevant to the subject to be created. When this is practiced, only would the work be convincing enough to be publicized.

According to Gao and Zhang (2010), integrating cultural elements into the modelling and costume of character design can create cultural significance. For example, the essence of the face of *Monkey King* in *Havoc in Heaven* (1964 version) was modelled according to the characters in Peking Opera (Gao & Zhang, 2010). Besides, costumes can showcase cultural significance too. For instance, the costumes of *Hua Mulan* from *Mulan* (1998 version) are designed based on the Tang dynasty to better suit the chosen era (Gao & Zhang, 2010). In conclusion, modelling and costume design are some of the aspects that can capture the essence of a character. Hence, integration of culture in these two aspects would increase the cultural significance of a character design.

Culture can also be integrated through Chinese myths and folklores. According to Fang and Lin (2017), Chinese myths and folklores are rich sources for animators and character designers. Hence, producing animation and creating character designs based on these resources have a higher possibility to create resonance among the public. According to Fang and Lin (2017), Japan has adapted this way in their animation production such as *Princess Mononoke* (1997 version). Sugihartono (2018) also urged designers to interpret folklores in their own way to fit the needs of the present.

However, as much as traditional cultural elements are encouraged to be incorporated, Gao and Zhang (2010) reminded animators and character designers to be creative by introducing innovation to their work. Designers should develop new designs which reflect the modern aesthetic based on traditional art (Gao & Zhang, 2010). Similarly, Zhou (2017) suggested that inheritance of traditional culture alone is insufficient, as we need to have a breakthrough to further develop the Mainland Chinese animation industry.

## 3 Research Methodology

To achieve the objectives of this research, a total of two methodologies are used: visual analysis and online survey. Visual analysis was carried out to determine the tangible elements that create cultural significance in the character designs of *Nezha*. Through a thorough visual analysis, researchers will be able to comprehend and contextualize the analyzed materials (Schroeder, 2006). Understanding the analyzed materials will allow researchers to produce a more thorough visual analysis of the subject chosen. According to the original Chinese mythology, *Nezha* is a well-known rebellious protective deity. This character has inspired multiple TV shows, movies, and songs (Hamilton, n.d.). Hence, the author chose this character to be further researched since it has a rich cultural significance in Mainland China. The result of the visual analysis of *Nezha* from the original Chinese mythology was then cross compared with *Nezha* from *Nezha Conquers the Dragon King* (1979 version) and *Ne Zha* (2019 version). Both 1979 and 2019 versions are animation adaptations based on *Nezha*'s story in *Fengshen Yanyi*, also known as *The Creation of The Gods* (Hamilton, n.d.). The author extracted tangible elements such as hairstyle, facial features, clothing, and props to be compared. In the author's opinion, each tangible element

presented on the characters has its own significant meaning, which is relevant to Chinese culture. As a result, the viewers would recall the image of this character when they see any adaptation of the character in the future.

In the second methodology, an online survey was conducted to determine the most important tangible element to create cultural significance in character design. Since the author would require the public's opinion on this, online survey would be ideal as it can receive more respondents in a short period of time (Nayak & Narayan, 2019). Subsequently, the generated results based on the surveys can be downloaded into a spreadsheet for further analysis (Creswell, 2014). Characters from *Nezha Conquers the Dragon King* (1979 version) and *Ne Zha* (2019 version) were used as research subjects in this methodology. By using the same character designs throughout both methods, it would ensure a fair comparison in results. Google Forms and Wen Juan Xing, a questionnaire creator in Mainland China, were used as the research instruments to create this online survey. The target audience for this survey were Mainland Chinese and overseas Chinese. This is because with the same cultural background, they would have a better understanding of the culture, hence ensuring the accuracy of the results.

## 4 Research Findings

Based on the results of the first methodology, visual analysis, in Appendix 1, changes were made across all three characters. In *Nezha Conquers the Dragon King* (1979 version), *Nezha* was seen to resemble *Nezha* from Chinese mythology very closely, as merely minor changes were made, such as face features, hairstyle, and clothing. On the contrary, *Nezha* from *Ne Zha* (2019 version) was improvised further and looked very different from the *Nezha* from the original Chinese mythology but still resembled *Nezha* from *Nezha Conquers the Dragon King* (1979 version). Despite the differences, the essence of the character was still preserved as the tangible elements of the characters were retained with only minor modifications.

According to the results in the second methodology, online survey, in Appendix 2 Instrument 1, 67.5% of the respondents believed that "all of the above" which included "clothing, hairstyle, accessories, props, face features" would make an animated character more culturally significant. "Clothing" had the highest votes, followed by "face features, hairstyle, accessories, props". Meanwhile, in Instrument 2, 76.47% of the respondents believed that "all of the above" which included "clothing, hairstyle, accessories, props, face features" would make an animated character more culturally significant. Among the elements, "clothing" had the highest votes, followed by "hairstyle, accessories, props, face features". Based on the above results, respondents in both Instrument 1 and 2 valued "clothing" as the most influential tangible element to create cultural significance in character design.

## 5 Analysis

Based on the findings obtained through visual analysis as suggested by Schroeder (2006) in Appendix 1, the author analyzed the differences between the three characters of *Nezha* from the original Chinese mythology, *Nezha Conquers the Dragon King* (1979 version) and *Ne Zha* (2019 version) in Appendix 3. Six tangible elements that are analyzed in Appendix 3 are as follow:

1. Animation Style
2. Color Scheme
3. Hairstyle
4. Facial Features
5. Costumes
6. Weapons and Props

The results of the online survey evidently proved that "clothing" had the highest votes, followed by "hairstyle, accessories, props, and face features". The results of both research questionnaires (Google Forms and Wen Juan Xing) suggest that clothing is the main tangible element that can make a character appear culturally significant. Based on this result, the author perceived that it can be due to the "clothing" factor occupying the most part of the character. Therefore, "clothing" plays a significant role in conveying a certain culture at the viewers' first glance. As described in the Section 2 of the Literature Review, Gao and Zhang (2010) highlighted that to reflect the era and culture chosen, the costumes of *Hua Mulan* character from *Mulan*, a Disney animation production, are created based on the Tang dynasty. In conclusion, the author perceived that costume or clothing is an important tangible element contribute to a more solid persona and stronger storytelling.

## 6 Project (Character Design)

With the research findings in Appendix 1, Appendix 2 and analysis in Appendix 3, the author was inspired to explore ways to create a culturally significant character design. For her new character design, the author decided to give a twist to the personality of *Nezha*. Improvision was introduced to transform *Nezha* from a rebellious kid to a soft-spoken teenager, while preserving courage as one of the character's main personalities. This is because the author wanted to retain this defining attribute of *Nezha* to create more significance to the audience who had known him beforehand. As a result, the author has created a character named *Xu Xuan*.

To begin with the character design of *Xu Xuan*, the author referred to the 6 tangible elements mentioned in Appendix 3 and listed down how should *Xu Xuan* appearance be. The 6 tangible elements of *Xu Xuan* are shown in Table 1 below.

Table 1: Six Tangible Elements of the New Character Design (*Xu Xuan*)

| No. | Tangible Elements | Explanation |
|---|---|---|
| 1. | Animation Style | 3D animation style |
| 2. | Color Scheme | Vibrant and pastel color scheme |
| 3. | Hairstyle | Space buns |

| No. | Tangible Elements | Explanation |
|---|---|---|
| 4. | Face features | Disney animation-inspired face features |
| 5. | Costumes | Lotus-inspired costume design |
| 6. | Props | Chinese bamboo flute |

As shown in Table 1, the author decided to infuse cultural elements such as space buns, lotus-inspired costumes, and Chinese bamboo flute to create cultural significance in the character. This list of tangible elements served as a guideline for the author to create *Xu Xuan*. The character design process and digital technologies involved was then carried out according to Table 2 below.

Table 2: Process of Character Design by Stages

| No. | Stages and Digital Technologies Involved | Task in Each Stage |
|---|---|---|
| 1. | Personification (Adobe Photoshop) | 1. Concept world creation<br>2. Moodboard<br>3. Silhouette sketches<br>4. Character turnaround studies |
| 2. | Concept Development (Adobe Photoshop) | 1. Pose studies<br>2. Facial expression studies<br>3. Outfit studies<br>4. Equipment/ weapons studies<br>5. Default outfit turnaround<br>6. Alternate outfit turnaround |
| 3. | Character Creation (Adobe Photoshop and Zbrush) | 1. Hero pose<br>2. 3D Model Sculpture |
| 4. | Art Bible (Adobe Illustrator) | Progression Compilation |

Upon completion of all 4 stages in Table 1, the author compiled all her progression accordingly. The outcome compilation of the character design of *Xu Xuan* will be displayed in an art bible in Appendix 4. In Appendix 4, the author has illustrated and explained the character in detailed in the eight figures below:

1. Figure 1: *Xu Xuan*'s Character Backstory
2. Figure 2: *Xu Xuan*'s Character Profile, Props Design, Design Motives
3. Figure 3: *Xu Xuan*'s Facial Expressions, Hero Pose, Character Silhouette
4. Figure 4: *Xu Xuan*'s 3D Model Head Turnaround, Body Turnaround, Hero Pose
5. Figure 5: *Xu Xuan*'s 3D Model Costume Design Details and Explanation
6. Figure 6: *Xu Xuan*'s 3D Model Accessories Design Details
7. Figure 7: *Xu Xuan*'s 3D Model Prop and Shoe Design Details
8. Figure 8: *Xu Xuan*'s 3D Hero Pose

## 7 Conclusion

This research allows other researchers or practitioners of relevant research to understand the importance of cultural significance in character design. This is because cultural significance can provide depth and persona to a character. Besides, it is important to learn to identify the tangible elements of a character. Character designers can focus on the tangible elements while developing a character as audience would perceive them at the first glance. In conclusion, the author would encourage the infusion of cultural elements in tangible aspects of a character. However, designers should also be creative by introducing innovation and breakthroughs into character design. This would bring about diversity and advancement in character designs that will suit the taste of current audiences.

Culture tells the stories of a nation. Hence, let the characters bring those stories alive with the power of cultural significance.

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## Appendix

**Appendix 1 (Visual Analysis)**:
The Results of Cross Comparison between all three characters of *Nezha* from the original Chinese Mythology with *Nezha* from *Nezha Conquers the Dragon King* (1979 version) and *Ne Zha* (2019 version)

| | | | |
|---|---|---|---|
| **Images of Character Design** | <br>Character design of *Nezha* from the original Chinese mythology | <br>Character design of *Nezha* from *Nezha Conquers the Dragon King* (1979 version) | <br>Character design of *Nezha* from *Ne Zha* (2019 version) |
| **Animation** | N/A | *Nezha Conquers the Dragon King* (1979 version) | *Ne Zha* (2019 version) |
| **Animation Style** | N/A | 2 Dimensional | 3 Dimensional |
| **Colour Scheme** | Vibrant colour scheme | Vibrant colour scheme | Red colour scheme |
| **Tangible Elements** | **Features of Tangible Elements** | | |
| **Hairstyle** | Wedge-shaped patch and space buns | Space bun | Space bun |
| **Facial Features** | Slanted eyes | Slanted but large eyes and red tattoo mark on forehead | Westernised eyes and red tattoo mark on forehead |
| **Costume** | Dark green lotus leaves | Pink lotus petals and dark green lotus leaves | Kung Fu style costume |

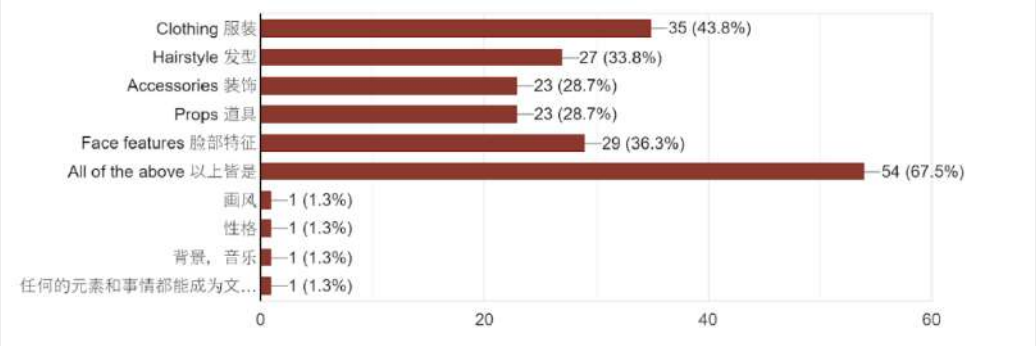
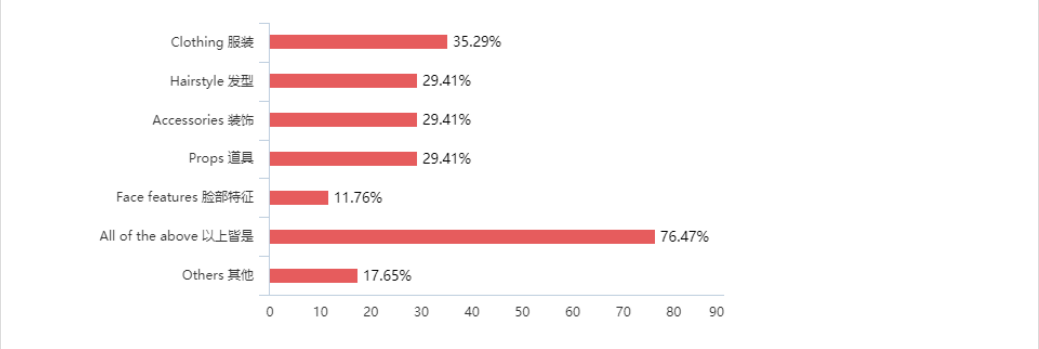
| | | | |
|---|---|---|---|
| **Weapon 1: Fire-tipped Spear** | Present | Present | Present |
| **Weapon 2: Wind Fire Wheels** | Present | Present | Present |
| **Weapon 3: Universe Ring** | Present on wrists | Present on wrists | Present on neck |
| **Weapon 4: Red Armillary Sash** | Present | Present | Absent |

**Appendix 2 (Online Survey):**

The Bar Chart Result of the Tangible Elements to create Cultural Significance in Character Design on Instrument 1 (top) and Instrument 2 (bottom)

Online Survey Question:

What do you think are the tangible elements that will make the characters shown above look culturally significant?

| Types of Instruments | Bar Chart Results |
|---|---|
| Instrument 1: Google Forms | <br>Bar Chart Results on Google Forms |
| Instrument 2: Wen Juan Xing | <br>Bar Chart Results on Wen Juan Xing<br><br>(With the constraint of the Mainland China government, the author decided to utilize Wen Juan Xing as the second research instrument to reach out to the Mainland Chinese respondents living in Mainland China.) |

**Appendix 3 (Analysis)**:
The Analysis of Cross Comparison between all three characters of *Nezha* from the original Chinese Mythology with *Nezha* from *Nezha Conquers the Dragon King* (1979 version) and *Ne Zha* (2019 version)

| **Images of Character Design** |  Character design of *Nezha* from the original Chinese mythology |  Character design of *Nezha* from *Nezha Conquers the Dragon King* (1979 version) |  Character design of *Nezha* from *Ne Zha* (2019 version) |
|---|---|---|---|
| **Tangible Element** | Explanation | | |
| **Animation Style** | 3D animation style in *Ne Zha* (2019 version) creates a more intricate design as compared to the 2D animation style in *Nezha Conquers the Dragon King* (1979 version). Even though 2D animation style is one of Mainland China's well-known animation styles, the animators and character designers decided to introduce a breakthrough in its style. | | |
| **Colour Scheme** | The character designs of *Nezha* in the original Chinese mythology and the (1979 version) version adapted more of a colourful and vibrant colour scheme, which reflects the look and feel of the traditional animation style in Mainland China. On the other hand, the (2019 version) has a more reddish colour scheme. Red is the most culturally significant colour of the culture as it is a symbol of good luck and prosperity to the culture. Both colour schemes have its cultural significance, however, red appears to be more culturally significant. This red scheme would create more resonance to the viewers which not only are the viewers in Mainland China but also viewers from all around the world. Hence, understanding what is considered culturally significant worldwide is important. | | |
| **Hairstyle** | The change in hairstyle from a wedge-shaped patch to space buns gives a refreshing look to the character. Despite the change of hairstyle in the animation adaptation, it still appears culturally significant as the other tangible elements of the character have been preserved nicely. | | |
| **Facial Features** | Facial features of *Nezha* in the (1979 version) is different from the (2019 version), as the latter has a more westernised look, which resembles the face features of Disney characters. Since Disney animated character designs | | |

| | |
|---|---|
| | have gained worldwide audiences, this creates a sense of familiarity with the audiences. They can quickly relate to the story without being overwhelmed with foreign cultural references. |
| **Costume** | The clothes of the characters are observed to be very flexible in design. The character designers of *Ne Zha* (2019 version) introduced a Kung Fu suit in contrast to the lotus costume design featured in the first two characters. The changes in costumes do not seem to affect the cultural significance of a character drastically. Hence, the author would suggest character designers to try out a variety of costume designs which are still relevant to the culture for a new look. |
| **Weapons and Props** | This tangible element of the character is noticed to only have minor adjustments. Since exclusiveness of the weapons is established by giving specific names to them, character designers did not make overly drastic changes when designing this character in different animation adaptations. |

**Appendix 4 (Art Bible Compilation):**




Figure 1: *Xu Xuan*'s Character Backstory

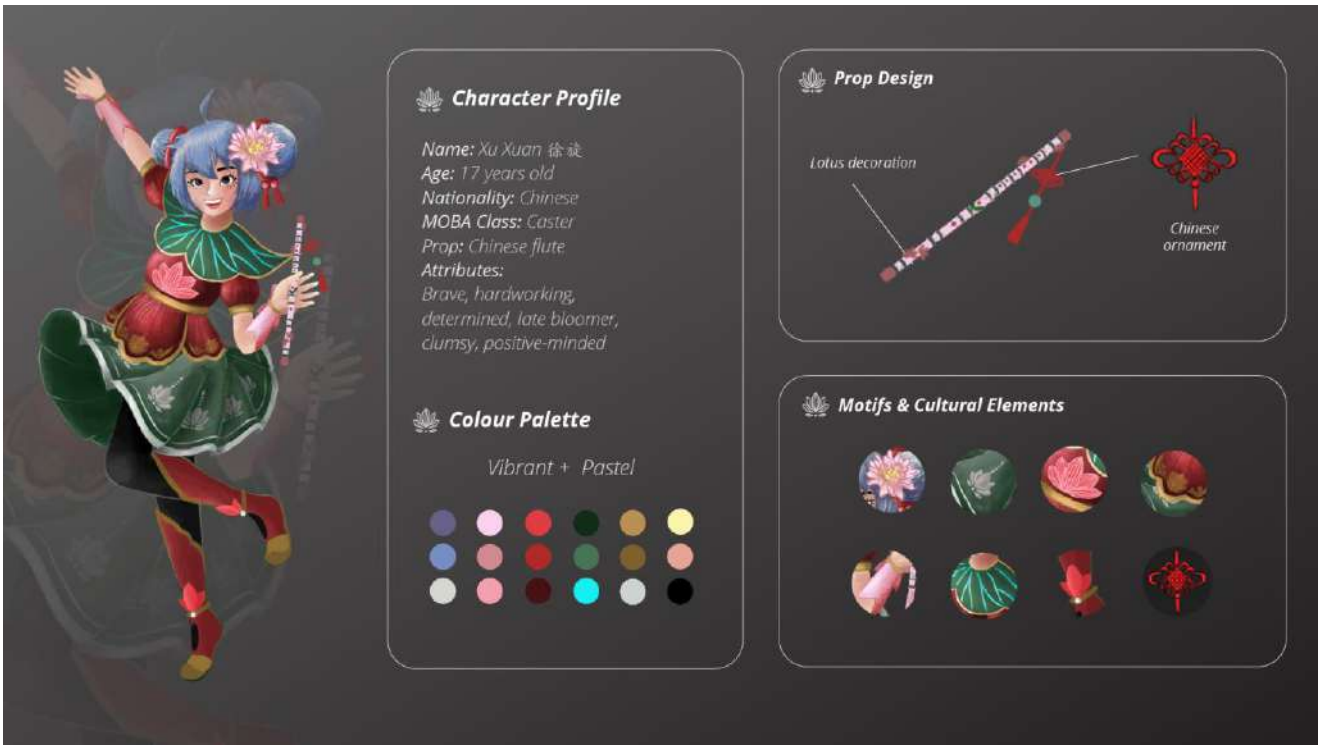



Figure 2: *Xu Xuan*'s Character Profile, Props Design, Design Motives

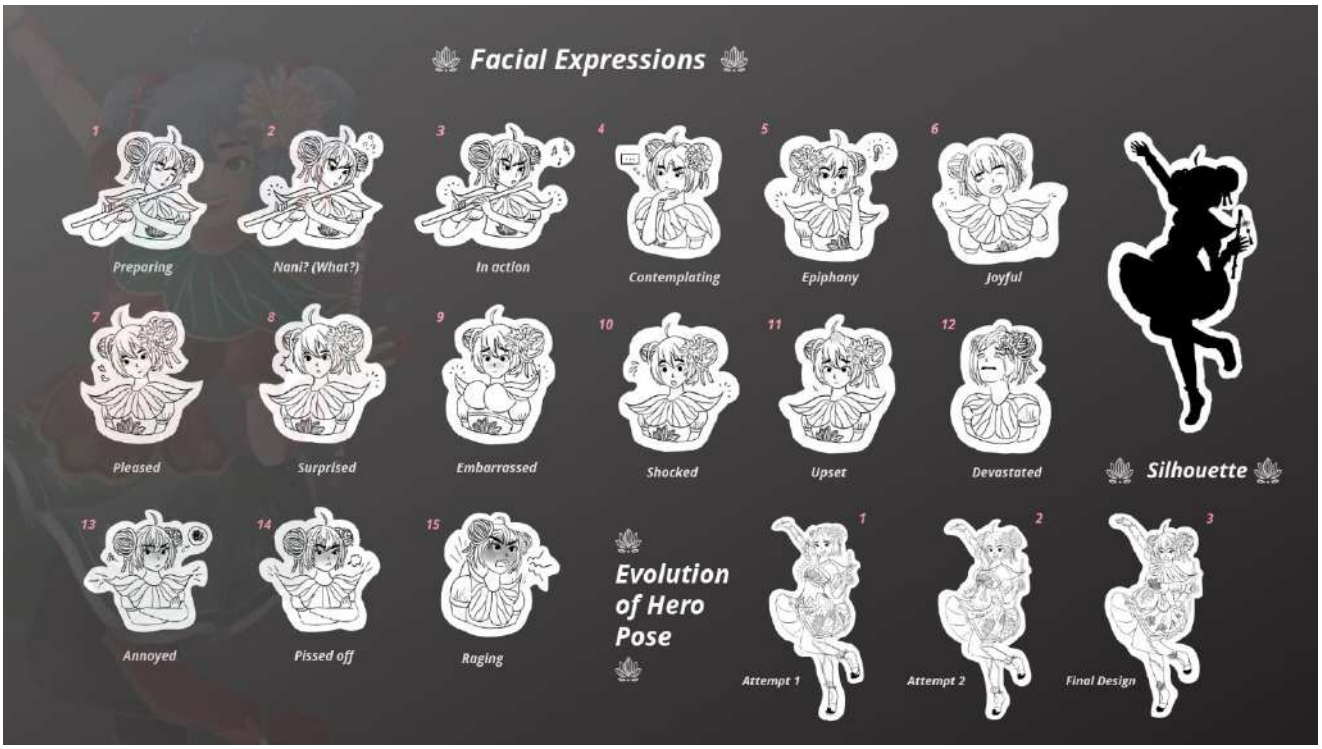



Figure 3: *Xu Xuan*'s Facial Expressions, Hero Pose, Character Silhouette

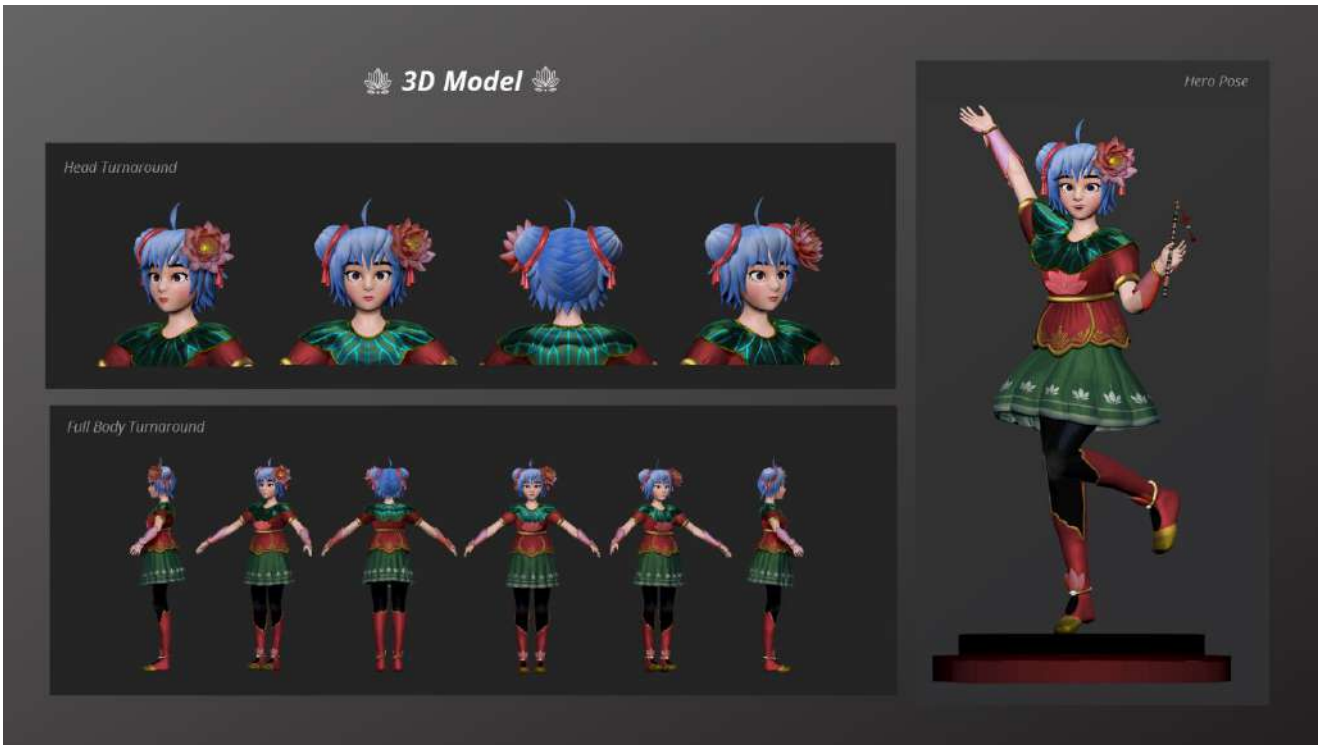



Figure 4: *Xu Xuan*'s 3D Model Head Turnaround, Body Turnaround, Hero Pose




Figure 5: *Xu Xuan*'s 3D Model Costume Design Details and Explanation




Figure 6: *Xu Xuan*'s 3D Model Accessories Design Details

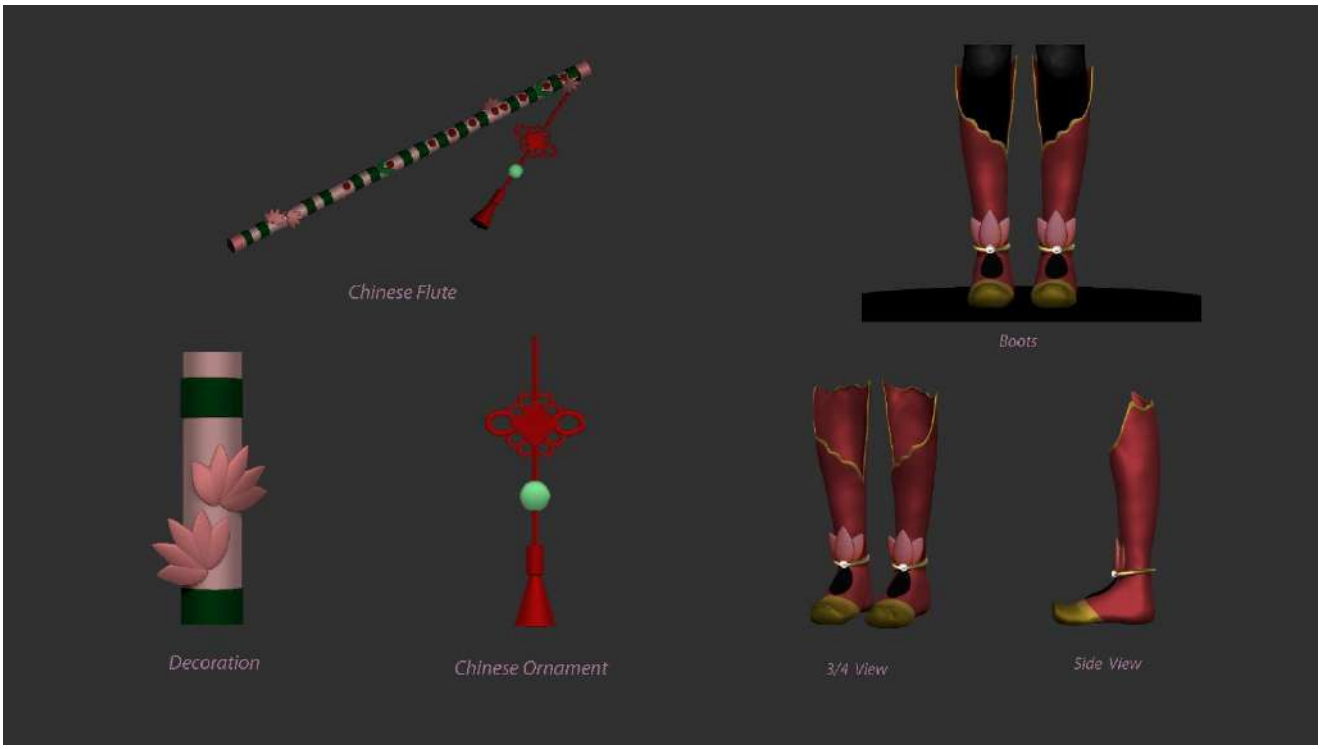


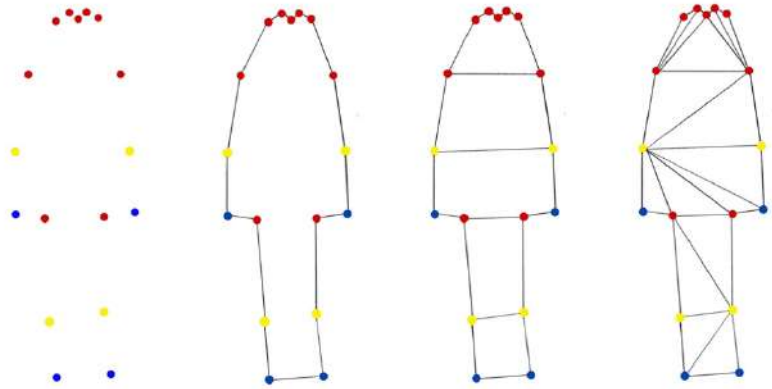

Figure 7: *Xu Xuan*'s 3D Model Prop and Shoe Design Details




Figure 8: *Xu Xuan*'s 3D Hero Pose

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# Body as moving structure in Fashion Design processes



**Abstract**

The human body movement is idiosyncratic and always challenging to document. This research explores ephemeral body movements and their documentation through the body-machine interface. The aim is to explore the body's aesthetics and find possibilities of the use of the body as a moving structure in fashion design processes. These ephemeral body movements are documented through an installation setup consisting of a computer, posenet (the machine learning model), camera both video and computer screen. This reflects on how the machine interface translates the body and its movement through embodied interaction. The human body is translated into seventeen dots forming new bodily expressions based on the spatial level and structural characteristics of it while moving. The installation setup serves as a method in general or in fashion design processes to create alternative design expressions.

**Keywords:** Design methodology, embodied interaction, kinesthetics, fashion design processes

## 1 Introduction

The human body has a significant role in the design process. With the developments in HCI (human-computer interaction), the available technology recognizes and documents the aesthetic experience of bodily gestures and movements [1]. With the advancement in technology, many commercial examples are available when it comes to exploring gestures and movements in the form of prototypes [2]. Human embodiment reinforces the perspective of our interaction through our bodies in the world to interactive technology design [3]. Despite there has been a focus on the lived body it still lacks attention referring to the role of movement and cognition in the the world especially when it comes to our experience of it [4]. The existing research and studies of the lived body and exploration of movement in phenomenology suggest theoretical tools for the researchers exploring HCI [5]. '*To move one's body is to aim at things through it'* this claim by Merleau-Ponty suggests the moving body in acts of perception of the external world [6]. The significance of the Kinesthetic is fundamental especially when it comes to the awareness concerning self-perception [7]. These thoughts have been implemented actively in the interaction design research referring to movement-based interaction design [8]. However, there is still a need to explore more when it comes to documenting the aesthetic experience of moving the body and the use of HCI in

fashion design processes.

This paper presents an exploration of human body movements and their translation into the digital forming new bodily expressions through a body-machine interface. This is done by using a machine learning model posenet as a sketching tool in an installation setup. The experimental explorations are informed by the EDI (Embodied Design Ideation) framework proposed by Wilde et al (2017) to develop body machine interface as a method by applying the four-step structure of the selected EDI (Embodied Design Ideation) framework: Disruption, destabilization, emergence, embodiment [9]. This research contributes to both fashion design education and HCI by exploring the use of embodied interaction in fashion design processes.

## 2 Related Studies

The existing research by design scholars elicits that the bodily experience is fundamental when designing aesthetic experiences based on technology [10]. The research in fashion is still developing when it comes to exploring the potential of a human-machine interface for alternative expressions in design processes. Few researchers have started to investigate the artistic possibilities of digital technologies for fashion design. In recent years there has been a conscious effort from the researchers end to consider consequences of HCI when it comes to 'fashioning interaction' [11]. The disruptive potential of designers working with digital technologies by Douglas Atkinson has been articulated in a fashion context [12]. The body garment relations by using a 3D body scanner by Kat Theil to merge the digital material explores possibilities of the body garment into one material [13]. With the emergence of new technologies and their possibilities in the field of fashion, there is a discourse on the research level. However, the exploration of body machine interface in fashion education is still under development.

## 3 Methodology

Time: 1 min for each exploration
Exploration categories: 4

**Tools:** To investigate human body movement and machine interface, installation setup consisting of a computer, posenet (the machine learning model), camera both video and computer screen were used. Posenet offers four output options, however, in this research the following explorations are based on setting the output on show points.

**Method:** These explorations were based on a method of quick prototyping and bodystorming giving a first-hand experience for the ideation process to enhance design ideas.

Distance between the human body and machine interface was 14 feet. The documentation of the explorations was further viewed and reflected on. Following types of body, movement categories were documented by using posenet as a sketching tool and computer screen camera to record the body machine interaction outcome.

Table 1: Body movement categories

| Exploration | Body movement category |
|---|---|
| E1 | Walking towards setup |
| E2 | Bending |
| E3 | Jumping |
| E4 | Circular movement |

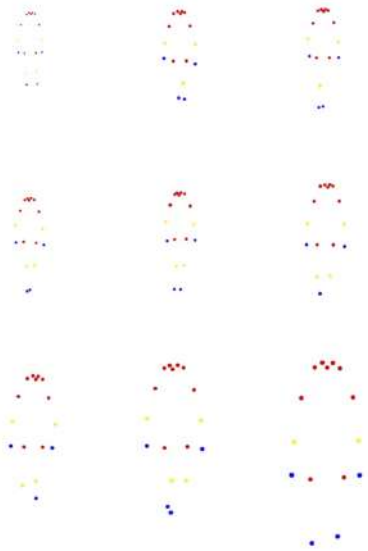


Figure 1: E1, Walking towards setup

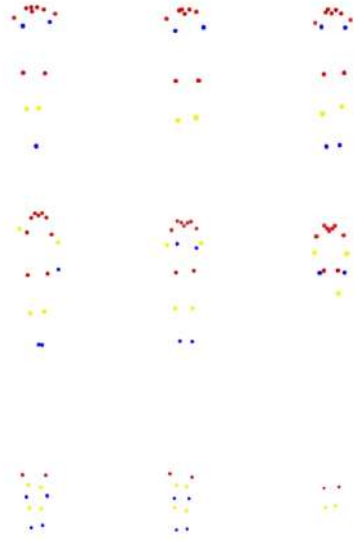


Figure 2: E2, Bending

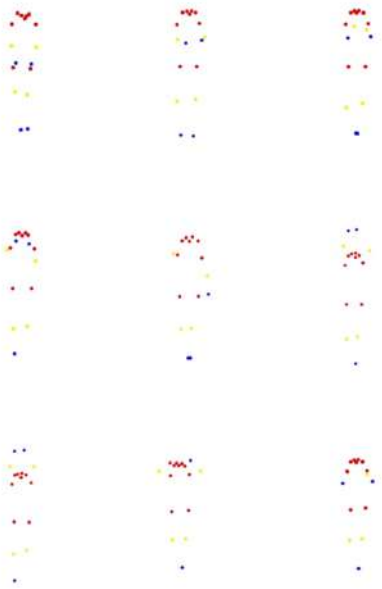


Figure 3: E3, Jumping

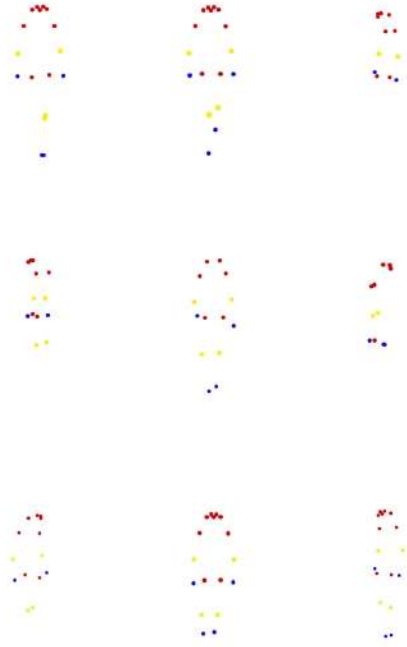


Figure 4: E4, Circular motion

## 4 Findings

The aforementioned explorations mainly focused on the aesthetics of the body in movement. During the explorations, the interaction of the body with the machine interface identified the following: How and where movement occurred. The human body was translated into seventeen small dots forming a dotted moving structure using posenet as a sketching tool. The dots involved the three spatial levels of the human body see figure (5), core (torso, shoulder, hips in color red), mid-limb (elbows, and knees in color yellow), and distal (feet and hand in color blue). These dots were formed based on the spatial and structural characteristics of the human body while moving. This further highlighted how the machine interface translated the body through embodied interaction. The explorations outcome and documentation were further observed in detail suggesting the following emerging concepts.

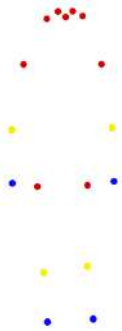


Figure 5: core (torso, shoulder, hips in color red), mid-limb (elbows and knees in color yellow), and distal (feet and hand in color blue).

## 5 Results

The aforementioned explorations led to the following concepts.

Table 2: Emerging concepts

| |
|---|
| Body as dots |
| Body as 2-D shape |
| Body as 3-D shape |
| Body as irregular geometrical shape |

## 6 Discussion

The experimental exploration documented ephemeral body movements and gave the insight to view alternative bodily expressions translated by the machine learning model posenet. Nine visuals were extracted from each explorative category showing the body movement in the dotted moving structure See figure 1- 4. This gave direction not only to view the human body as dots visually but also emerged concepts i.e., body as 2-D, body as 3-D, and body as irregular geometrical shapes while viewing the visuals see table (2). The dots were joined together making a line followed by the top-left dot in the core towards the right that culminated into viewing and developing the body silhouette into an irregular shape, see figure (6) from category E1 see table 1, Walking towards setup. The dots within the silhouette were joined horizontally that divided the existing shape into five further shapes. Within the existing shapes, the dots were further joined together splitting the overall silhouette into 15 shapes.

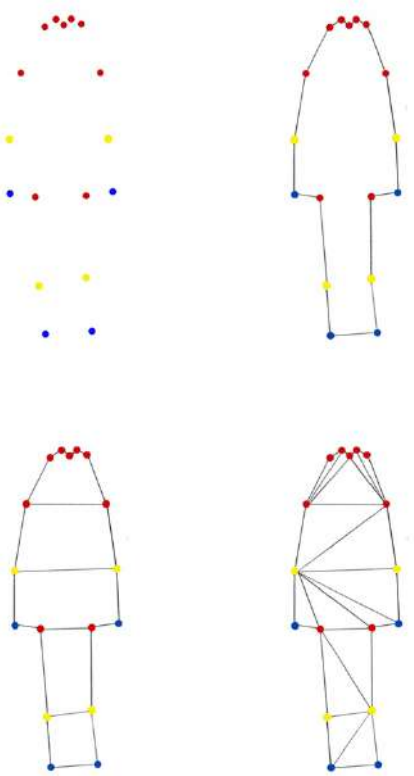


Figure 6: Joining the dots to further view the silhouette in shapes

The experimental exploration was informed by EDI (embodied design ideation framework). The machine interface brought disruption in the preconceived notion of the human body, destabilizing the existing visual expression with the emergence of alternative bodily expression. Thus, embodying new insight into bodily expressions. The observations and analysis of the documented explorations through the body movement categories suggested that the installation setup served as a method to propose alternative body expressions in fashion design processes. All four categories depict those new bodily expressions formed are irregular and geometrical shapes.

## 7 Closing remarks

The current presented research has the potential to further explore the existing output of the machine learning model. Currently, only one exploration has been shared that provides alternative body expressions that can be used as a starting point in fashion design education. This research can be further developed to provide a method that can cater to the fashion industry.

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# Tracing roots of Chinese diaspora through 3D Augmented Reality



**Abstract**
This paper presents how three-dimensional (3D) object in augmented reality (AR) can affect placemaking for Chinese diaspora. This is a qualitative research based on practice-based method. Reflections from each working process are documented and analyzed. Drawing on research conducted with younger generation as prospects of tourism based on Talad Noi, an oldest China town in Bangkok, AR prototype of both 2D and 3D of Chinese junk ship superimposed on historic site was shown to participants. Designing of data collection method is based on Immersive Conceptual Experience Framework by Shu-Pei Tsai (2020). Results from interview (N=58) shows that 3D AR has great potential to exhibit identities of Chinese ethnic groups because of its high satisfaction rate on immersive experience. However, satisfaction on deeper emotional levels such as user engagement and authenticity of place are moderate. Suggestion from this research is 3D AR might be good for educational use that focuses on accuracy of data.

**Keywords:** Augmented Reality, 3D, Chinese Diaspora, Heritage Site

## 1 Introduction

Thailand has many Chinese diasporas spreading across country. Although these ethnic groups have contributed to major economic growth nationwide, their identities have been long suppressed by Thai nation-state policy that attempting to assimilate all minorities into single homogenized Thai identity [1]. Talad Noi is an oldest China town in Bangkok. Many Chinese ethnic groups—Hokkian (Fujian), Kwangtung (Guangdong), Hakka (Kejia), Teochew (Chaozhou), Hailam (Hainan)—have settled there for more than 200 years. They have some shared identities as Chinese oversea, however identity of each ethnic group is still strong. Decade ago, local authorities and other cultural organizations has shifted their strategies to embrace more cultural diversity from ethnic groups. Various contemporary art interventions such as street arts and cultural events have been implemented to Talad Noi. Younger generation found that mixing of contemporary art and traditional Chinese art is very attractive. Graffitis, light art installations, and sculptures has been created all across Talad Noi area. From our field research, some locals find those new artworks good for community but some find them too alienated to historical site. Last year, we also developed an AR prototype of Chinese pictograms as an alternative to physical art intervention. Although overall feedback from our first attempt showed that AR content are fun and easy to use, participants find authenticity of Chinese ethnic groups in Thailand is still vague. Hence, we developed a new AR prototype focusing on three-dimensional object of meaningful history.




Figure 1: From left to right: So Heng Tai Mansion—a heritage Hokkian house at Talad Noi, street art, field research, AR Prototype from previous attempt, and red head junk (紅頭船) replica in Bangkok

Literatures related to people in Talad Noi have been reviewed. Empirical evidence that represents shared identity of Chinese ethnic groups in Thailand has been identified as a red head junk (Ang Thau Tsung in Teochew dialect). Two centuries ago, fleets of this kind of junk sailed between China and Siam (Thailand nowadays) carrying goods from China to Thailand and vice versa. This boat also brought many Chinese ethnic groups who left their homeland in China to seek a fortune in Thailand [2].

## 2 Method

This design is based on practice-based research method which is a kind of qualitative research. Reflections from making of augmented reality process have been noted and analyzed. Process begins with digitizing red head junk into three-dimensional model by using Blender software. Then, finished model has been uploaded to Adobe Aero software to create an augmented reality prototype. We found difficulty in testing the prototype with real people on real site since COVID-19 pandemic. We conducted testing by using of online interview (N=59) that shows the image of red head junk (AR) with the background of So Heng Tai house (figure 1). Besides the image, qualitative questions are also included. Measurement is based on Immersive Conceptual Experience Framework [4] which focuses on three levels:

- Immersive experience: easy to use and immerse oneself in artwork
- User engagement: selfies or share on social media
- Place satisfaction: perceive authenticity of place based on root culture from locals

## 3 Making of AR Prototyping

The process to make the AR prototype in this project can be separated into two parts: conceptual part and technical part

Conceptual part begins with selection of 3D object that can represent the sense of place for So Heng Tai mansion and Talad Noi. Criteria for selection was based on Immersive Conceptual Experience Framework. Researchers compared two types of 3D models: 3D standalone object and 3D architectural object. Researchers found that 3D standalone object is quite easy to control on mobile screen. It can be freely placed, scaled, or moved many times until users satisfy with the results. Users can also place 3D standalone object in fron of background they want to take a selfie. This might lead to good opportunities for user engagement such as selfie and share on social media. In contrast with 3D architectural object, incorrect perspective and wrong scale might decrease level of user's satisfaction and user engagement. When it come to place satisfaction, researchers tried to find the object that could be symbolized as the origin of So Heng Tai building and Talad Noi district. Red head junk has been chosen because it can represent the trade between China and Thailand—the business run by So Heng Tai family in the past. Moreover, various kinds of Chinese minorities—Teochew, Kejia, Hainan, and Cantonese—immigrated to Thailand by this ship. Therefore, correlation between Red head junk and So Heng Tai mansion and ethnic groups in Talad Noi is very strong.

The technical part is pretty straight forward. It starts from 3D modeling in Blender software then export 3D file to Adobe Aero, a tool to develop AR prototype. However, implementing the detail of 3D model needs a lot of justifications—from artistic to technical. For 3D modeling phase, we tried our best to keep traditional look of red head junk as much as we can. Our AR in-depth interview and prototype testing from past year shows that all Talad Noi's travelers (N=6) prefer traditional style of AR over modern style of AR because the reason why they visit Talad Noi is to experience authentic Chinese oversea culture. Therefore traditional form, texture, and decoration are carefully preserve during 3D modeling process. Cartoonish or low poly art style are not be considered in this project. However, this prototype has to concern with compatibility with mobile device which is the handiest tool for young tourists [3], opposed to older generation who heavily relies on physical map. Although historical accuracy of junk proportion is very important, the width of AR junk is slightly shorter than real one due to nowadays mobile users that tend to use mobile app with vertical-oriented screen. If the junk is too long (horizontally), AR object shown on screen might be too small. Daylighting has been chosen for the scene since most of travelers visit Talad Noi during the daytime. However, this causes a problem that shading of AR object might not match real shadow direction from the sun when travelers use app on different times and angles. Light estimation of 3D AR world is a function found in other software such as Unity's RealSunAR [5] or ARLightEstimate in Apple's ARkit [6]. However, Adobe Aero has not yet released sun estimation function when we used them to develop this design. Form of the red head junk is based on the replica (Figure 1) docking on Chao Phraya River, Bangkok, Thailand. Key elements of red head junk are kept during 3D modeling process. Three masts (mizzenmast, mainmast, and foremasts) together with booms

and sail cloth panels are being kept. One key difference between physical replica and 3D AR is the shape of the sail clothes. Replica clothes always present in beautifully rectangular shape. We decided to present AR junk with triangular clothes since they represent junk sailing in real ocean with variety of wind directions. Moreover, triangular shape of clothes create zig zag outline that makes AR junk looked more outstanding. Colors of the AR junk are slightly darker than the replica since AR junk has to be presented at old historical building in Talad Noi. Too bright color might make it looks too different from the background which can reduce quality of immersive experience from visitors' perspectives.

The process of modeling in Blender to AR prototyping in Adobe Aero has to be iterate many times to clean up the model. Our workflow is based on MacOS. Although Adobe Aero can be run on both iPAD and MacbookPro, we found that Adobe Aero on iPAD generation 6 cannot handle OBJ file with the size over 120 MB quite well. Therefore, we decided to run them on MacbookPro. We also tried to apply high-resolution textures of wood and junk sail cloth in Blender. File size was increased to 200 MB which also increase time when load them into Adobe Aero environment. 200 MB can cause almost 1 hour for loading. Final stage of design, all texture maps are omitted to increase work speed. We use dark brown colour to represent the wood and yellowish white to represent sail cloth. Red head with white and black circle are also made of polygon with diffuse colours.

## 4 Results

Since this paper was conducted during COVID-19 pandemic, we cannot do any field research. We decided to conduct an interview with online questionaire. There is 58 participants who are all bachelor degree students with background in art and design. Questionaire is split into 2 sections: 1. general information and 2. immersive conceptual experience. Questions in first section are level of familiarity with AR technology and preferences between between 2D AR and 3D AR (Figure 2). Background for AR mockup is So Heng Tai Mansion (Figure 1), which praised as Talad Noi's most famous heritage architecture by tourism authorities and many tour guides. Second sections is designed to measure Immersive Conceptual Experience: ease of use when each person has to walk around the AR to see the object from different point of views, instagrammable level and selfie, expected time to spend with 1 AR content, and opportunity to use red head junk as a digital landmark for So Heng Tai Mansion. Participants are also invited to share their opinion freely in a comment section at the last part of the interview.

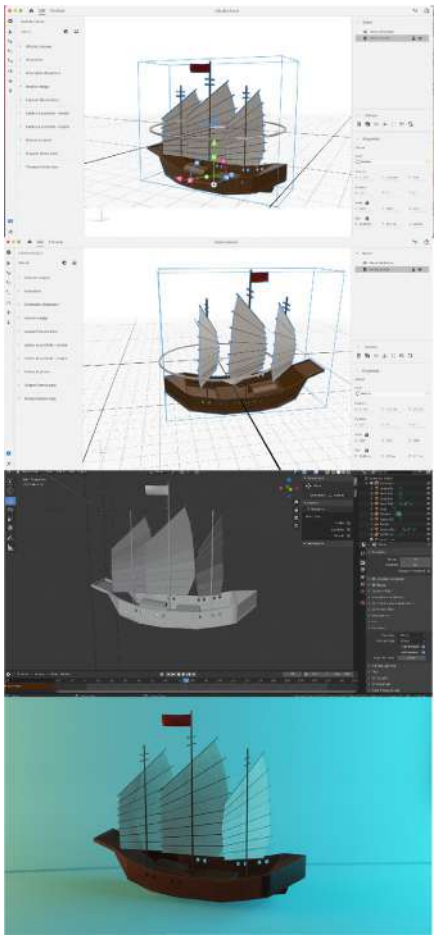


Figure 2: 3D prototyping in Adobe Aero (2 images above) and 3D modeling in Blender (2 images below)

Results from participants (N=58)—younger generation with age between 18-22 years old—show that, surprisingly, 14 participants (25 percent) has no idea about augmented reality technology. Among 59 of the rest, who has already known AR technology, only 15 persons confident that they are very familiar with AR. Eighty five percent of students prefer the design of 3D AR over 2D AR and ninety three of them show possibility to take a selfie with 3D AR over 2D AR. Some comments said that red head junk should not be displayed alone, ocean wave or other object shall be applied to make it more interesting. Quality of 3D model are also criticized. Junk boat model in this prototype seems too simple for some people. However, information from this interview shows that 3D AR still has great opportunity to enhance immersive experience among young toursits. They strategy to use 3D model of historical object is acceptable but the quality of 3D modeling has to be improved.

Although questionaire show pretty positive feedback on immersive experience, we found that engagement scores are slightly dropped. Only 32 persons (57%) are ready to "like" So Heng Tai Facebook and Instagram page after visit. 6 persons said that they don't want to visit real So Heng Tai Mansion in Talad Noi. 38 persons said they may visit Talad Noi in the future. Most of them (38 persons) don't want to spend time more than 3 minutes per 1 AR content.

Place satisfaction questions has some interesting results. We asked them about using red head junk as a digital landmark for So Heng Tai Mansion. Results show only 16 persons are totally agree with this idea (rating scale 5 of 5). 19 persons show quite agree (rating scale 4 of 5) and 19 persons show moderately agree (rating scale 3 of 5). There are 3 persons who are not quite agree (rating scale 2 of 5) whilst totally disagree person (rating scale 1 of 5) is none. We cannot find any comment related to placemaking or meaning of place. Most of the comments are revolving around art style and planning for the next trip.

Although only 6 persons gave their feedbacks on comment section, researchers can found some interesting results after conducting qualitative analysis based on thematic analysis method. Comments can be grouped into 3 topics —realistic quality of AR object such as historical accuracy of the form of the junk, texture, and colour; travelling deterred by Covid pandemic; complaining about lacking of animation or movement. Information from comment section might be an answer to the results that AR has high score in immersive experience but moderate score in place satisfaction. From the comments, none of participants can find any correlative story between Red head junk and So Heng Tai mansion or Talad Noi district. From participants' perspectives, correlation between AR and real space is limited to visual harmonization aspect. Relation in historical meaning aspect has been missed out.

## 5 Conclusion and Discussion

Research shows that 3D AR has a great potential to deliver root culture of Chinese disaporas in Bangkok to younger generation. Although 3D AR received a very good feedback for immersive experience, scores on level of place satisfaction and user engagment are still moderate. Half of participants prefer neither share the content of So Heng Tai Mansion on their social media nor eager to repeat their visit to Talad Noi. Lacking of elaborated details in 3D AR also lead to comments that ask us to redesign the junk to make it looks more realistic. The word "realistic" entails discussion of storytelling through 3D AR. We found that high resolution textures and high fidelity model make 3D file size too large so AR software cannot handle it well. Synchronization with sun direction might be another feature to increase more realistic look to the model. Unfortunately, our chosen software has not yet provide this feature.

From researchers perspective, participants tend to perceive 3D AR object—the Red head junk—as another prop for heritage site likes So Heng Tai mansion. However, this could be considered as a virtual prop, not physical prop. Therefore, realistic quality of the 3D AR object is very important because visitors expect that this virtual prop should look harmonize with physical surrounding. Visitors did not treat this 3D AR object as a new storytelling media so they did not try to find any correlation between the story of 3D AR object and the physical surrounding. Nevertheless, result shows that participants tried to spend time with the detail of AR. Participants show that they are eager to investigate the historical accuracy of 3D model which might lead to an opportunity to improve this 3D AR project. If researchers add more time-based effects (such as voice over narration, music background, animation) to the object, it might be more effective to tell the story about origin of Chinese diaspora to those participants. AR object should be more 'active' to tell the story of the surrounding space. People might find difficulty to connect the story between virual and real world by themselves. If 3D AR object is in static or passive format, likes the one used in this project, it might need a hand from home owner, volunteer tour guide, or, at least, signage to explain the historical meaning between AR and real space.

Researchers suggest that time-based 3D AR or animated 3D AR for cultural heritage area shall be further studied since it has a potential to bridge the gap between historical story of an AR object and physical space.

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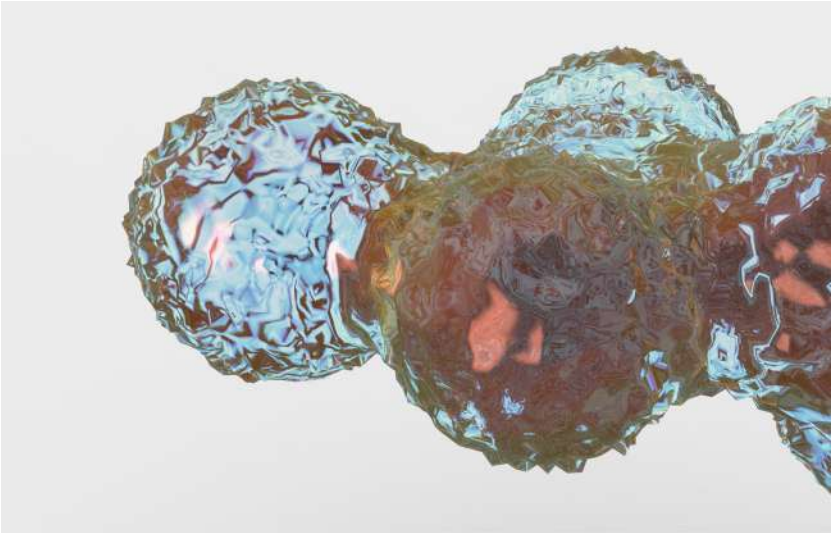
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# Sound as a Form Generator: Experimental Design Project Using Sound Data as a Source to Generate Forms.



**Abstract**
Sound is in everything in our lives and with its characteristics, can shape our individual and collective behaviour.

But what would be the results of using sound to create new forms and inspirations in the design field?

This research's objective is to demonstrate that sound data can be used as a response tool for the formation of new solutions in the field of Design. This project demonstrates the usage of a construction system based on the generative model for creating 3D shapes using sound information production tools. The research/creation process and the retroactive simulation generated by the parametric modelling software (grasshopper) and sound data production controllers, allowed the development of a set of projects for specific contexts, where the structural aspect and the manufacturing are part inherent to the integrated design process. Finally, the generated shape files were produced using 3D printing machines.

**Keywords:** Generative Design, Sound Design, Industrial Design

## 1 Introduction

In my research body of work, I explored the possibilities of generating new 3D forms using new sources of sound data. Through the study of previous projects connected with this idea, and the development of a work process oriented by a grasshopper algorithm, specific for this context, it was possible to achieve differentiated forms applicable both to industrial design and graphic design.

Besides focusing on the manipulation of just the tone and pitch but also the volume, the results created reflect the different aspects and characteristics of the nature of sound. With such results, I can demonstrate that sound can be another material source to develop different solutions in the field of design, as well as, to achieve new generative forms.

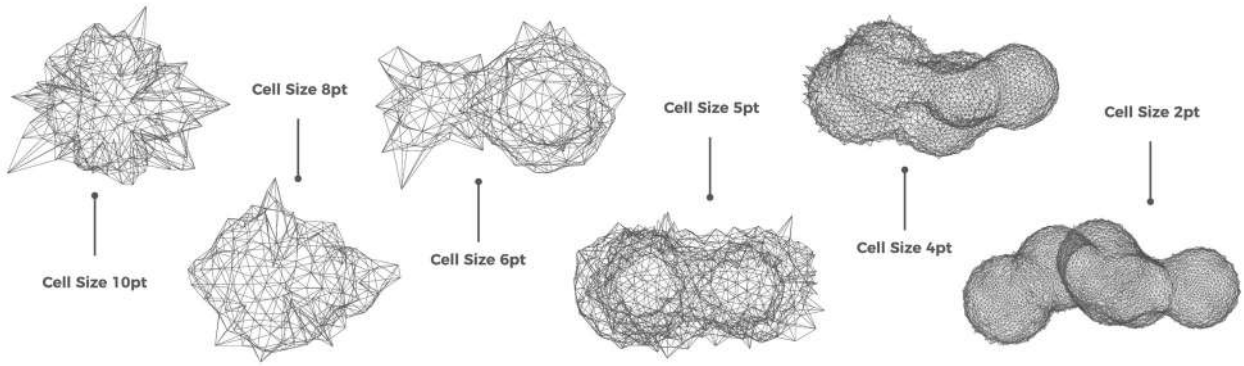



**Figure 1** The 6 forms generated from sound data, from a self-produced song.

## 2 Research

In the book called “The Sound and the Sense”, the author Winisk refers to sound as something impalpable and invisible that, with its characteristics, shapes our individual and collective behaviour [1]. After reading this sentence and being passionate about design, some questions came to my mind.

If sound shapes us, what about forms? What are the possibilities of connecting sound and manipulating it to create new forms? new inspirations in the field of design? With these questions in mind, I decided to research more and start framing my possible new project.

The usage of sound as a source to generate 3D forms is not a new concept, and Timchenko's work "Audio to Architecture" [2] is an example of that. In his work process he identifies and measures the sound waves in order to create forms. Another example is Trombini's work "What is the form of sound" [3], where he uses a similar construction idea as the previous work in order to create and change both forms and remixes. By understanding previous projects and experiences regarding this topic, I noticed that most of them don’t combine sound effects with the manipulation of the volume during their experiences. Seeing this phenomenon and being interested in this topic, I decided to length the results gathered from previous experiences by experimenting using both pitch and volume manipulation, and generating 3D forms applicable to the design field.

As we know, the sound is heard, that is how it is most often experienced, and when a sound is produced, the result of it is a sound wave travelling to our ears. Consequently our brain processes the frequencies and pieces them together, like a puzzle, in such a way that they make sense. Due to the natural characteristic of sound being invisible, the way to measure it is by the pitch; the actual simple harmonics of the sound, and by its volume.

Starting my research to find solutions for what I desired to develop, another question came to my mind. How can I manipulate and generate a 3D form simultaneously with sound?. I was aware of the process that I wanted to, therefore, to create my own sound data and manipulate it in my experiences, I decided to start step by step and focus primarily on understanding how I could create music, and the method of manipulating it as I wish.

Watching some Youtube tutorials and gathering information from other resources on how to do it, such as the conceptual project from Juanjose Rivas, “Form / sound sculptures,” that uses recorded sound action to create sculpture sound art [4], I discovered that a midi controller can manipulate the music in real or in no real-time. For those who don’t know what a midi controller is, is an external device unit that allows two or more devices to "speak" using digital communication language, MIDI, simulating sounds and effects through various forms of controls. So by connecting this controller to my computer and to the music production software, I am able to do the same thing as a DJ does in a live concert, which is constantly modelling a soundtrack.

Knowing now that I needed a controller to manipulate as I wanted the pitch and volume of a sound, with previous research, for the next step, I decided to use the controller LaunchKey as my input, and the program Ableton Live as my music production software to create the Output B, the music that will connect with the generative programs. In terms of tools to read the sound data and generate the Output A, the form, I used the program Rhinoceros 3D and Grasshoppers to create a specific algorithm system for that matter. (Fig.2)

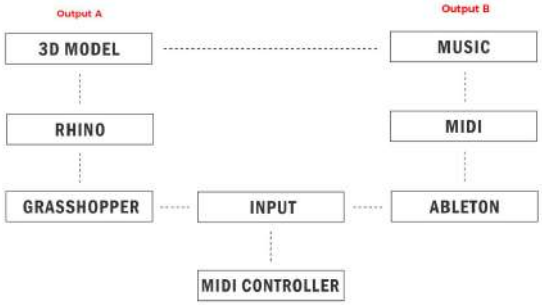


**Figure 2** Work process proposal to develop a group of generated forms using sound data

In this work process, where I propose to transform sound into a 3D form, first I connected the midi controller to the computer and connected it to the program Ableton Live. Consequently, I changed the stereo mix option of the computer to capture not the sound from the microphone but to capture the sound produced on the inside of the computer. This is a very important step in this work process, because that way the algorithm created on the grasshopper program is capable to read the music data created on the music production software using the midi controller, and transform that music data into information to change and deform the form already created on the 3D program Rhino. Having the computer stereo mix changed, the controller connected to the music production software is now capable of sending sound data to the 3D programs, and consequentially transform the characteristics of the sound produced into new forms.

I started my first experiences with a simple flat mesh. Taking in account the results that I wanted to achieve, I developed a grasshopper algorithm that ables the mesh to move and deform, with the sound data implemented in the experiment. However, the results didn't fulfil my expectations, (Fig.3) due to the fact that the deformation was too mild and the forms generated by the sound were not interacting enough. Taking into account the results obtained, I restructured the algorithm body to support a more complex type of mesh shape, and applied a simple geometry form, in this case, a circular ball. Containing the same work process as the previous work, the results were much more satisfactory.

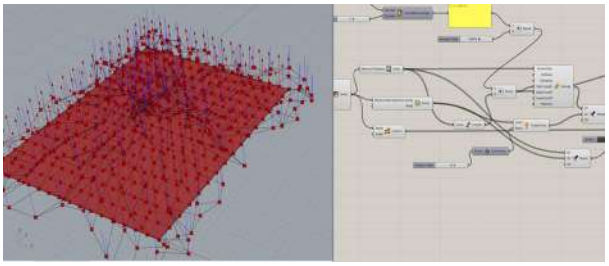


**Figure 3** First experience with a simple mesh and sound data.

After understanding the flow of the work process previously presented, and having now an algorithm to work with, I achieved the first 3D dimensional form that inspired the next steps in my creative process (Fig.4).

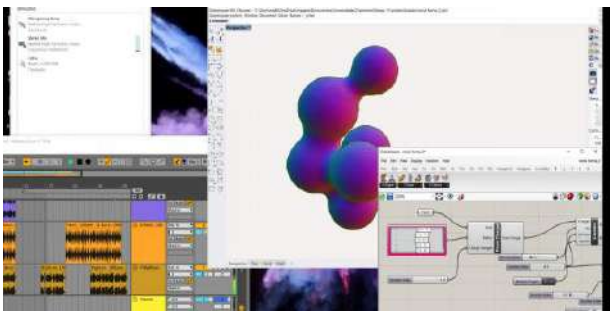


**Figure 4** First successful experience with using both parametric software and music production software.

As I moved away from the simple geometric forms where I had started, I explored more organic and futuristic shapes that could be even more exciting to implement in the design field. However in this case the circular shape was the one that worked the best with the developed algorithm, therefore the forms forwarder generated they are very oriented by the circular aspect.

From the various forms achieved with the manipulations of the volume, pitch, and experiments with different styles of sounds, I gathered the best 6 generated forms and applied some of them in the field of industrial design and graphic design. (Fig.1). Such applications in the field of industrial design can be seen in decorative solutions for interiors and solutions for outdoor spaces such as exuberant structures for parks. (Fig.5)

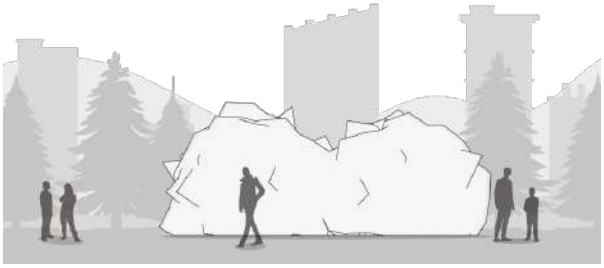


**Figure 5** Illustrated proposal of a structure for outdoor environments, made by sound data.

Regarding the graphic design field, I applied the sound data to the best 6 generated forms in the development stage and created some short clips based on the real-time movement of their shapes. (Fig.6)

For the physical reproduction of the results, I used a 3D printer and for the digital production of the results, I used free editing programs.

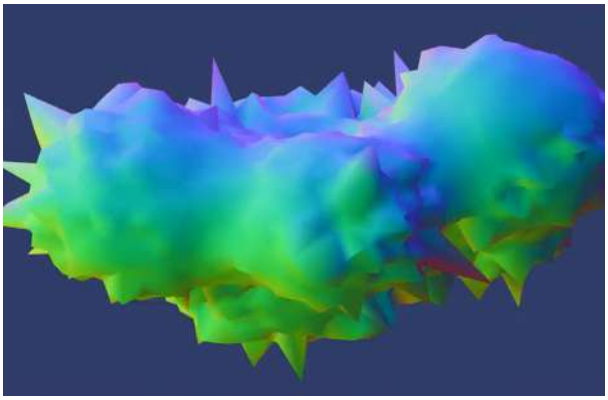


**Figure 6** Short Clips based on the real-time manipulation of the movement of the 6 generated forms.

## 3 Conclusion

I began my research work with the idea of exploring new possibilities of connecting and manipulating sound to create new solutions able to be implemented around the design field. However, at first, I wasn't sure what the exact path this research work would take, and how it would develop, as well as the sounds that would eventually be developed and used. But even so in the end, I was able to keep my initial goal and demonstrate the concept I had thought of.

Through researching, developing ideas, and performing experiments using sub-controllers to manipulate the sound and shape of the 3D mesh, I was able to understand that this type of method was not easy to elaborate because it asks for a variety of materials and knowledge. However the final results from this study turned out very interesting and worth the investment.

With this research project, I created differentiated forms that show the nature of sound, applicable to both industrial design and graphic design, such as decorative solutions for interiors, solutions for outdoor spaces, and digital short clips based on the real-time movement of geometric shapes.

I concluded, by executing this research project that the sound integrated with other resources, such as new technologies, sound controllers, and others, have the ability to become more than just sound. In this case, the sound became an inspirational material of form creation, that provided even more meaning to the solutions created for the design field.

I can conclude that the manipulation of pitch and volume of sound, to generate new 3D forms, can be an interesting resource for designers to develop innovative, and differentiated solutions in the design field.

As for future plans concerning this project, in order to get the project to another level whilst having generated forms that are more circular, I am planning to work on expanding the number of possible forms in with the aim of generating more interesting interactions that can be implemented as viable design solutions. In order to achieve that, I will extend the experiments using the same work process but adding a new algorithm structure that allows the support of other form types that are less circular compared to the results obtained previously in the experiences.

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# The "Blinding Light" – A Reflection on the Essence of Technology-Mediated Illusion through Techno-Art Experience



**Abstract**
With the advancement of technology and the rapid internet development, people can now easily obtain information through diverse media. However, are we aware of the biased or even manipulated information? The presented techno-art work is built to provide a situated experience for the audience to reflect on technological mediation. In a dynamic process, illusions are created, experienced, explained (but failed), and, finally, transcended.

**Keywords:** techno-art, technological media, illusion, light

## 1 Introduction

We receive various information via technological media just as we see the world because of light. Using light as a metaphor for technological media implies the fact that technological media is everywhere, allowing things to "appear" – in the form of "information." For example, social media significantly shapes humans' social behavior [1]. In such a digital age, the authors put forward a speculation [2], namely, what is, if the essence of light is altering. Will this cause reflection on the belief of what we "see"? Such speculation is actually a metaphor of media manipulations, illusions, misunderstandings that bias our perception and interpretation mediated information [3].

In technology and art, technology is essentially a physical and interactive medium [4]. In its interactive experience, the technological media has the ability to break the audience's boundary between perceived "realness" and "unrealness." For example, He-Lin Luo's [5] work, *A Twister to Twist*, has a twisted Buddha sculpture and a monitor displaying the sculpture and its environment. The image is transforming over time, and the audiences have a moment to see the sculpture as a normal Buddha when the environment is transformed by the image processing program. The created impactful experience accelerates audiences' belief to accept the virtual image as real but physical things as unreal.

Another example is Ya-Lun Tao's [6] *Step In and Out of the Dream* using VR to deconstruct audiences' concept of self's body. The resulted experience is dreamlike. Most of these works are based on the psychological mechanism of illusion to produce unrealistic experiences. In the presented work, we further deal with the essence of techno-art as a medium of representing illusion and bias.

The application of illusion is a welcome subject in art and design research to explore an alternative understanding of the real and virtual world. Studies on illusion experiences are widely ranged, from the understanding of physical [19] or virtual things [24] to the perception of virtual body [14][21], from visual [22] to acoustic illusions [20].

## 2 Psychological and Philosophical Inspiration

2.1 Illusion

Illusion is the core concept of this project. Müller-Lyer illusion (Figure 1) [7] is a classic case often cited when discussing illusions. Since the publication of this illusion, there have been various "explanations," such as size constancy, depth cue, and conflicting cues [8]. However, explanations do not relieve the perceived illusions. In fact, the purpose of explaining illusions is more to understand the essential issues of human beings. For example, Müller-Lyer illusion is used to understand the operation of "perception" (e.g. [9][10]), to experiment with humans' social distance [11], or even to analyze animals' behavior [12].

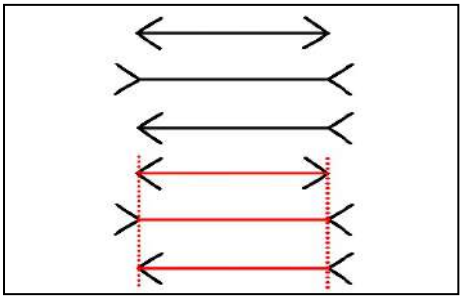


Figure 1: Müller-Lyer illusion

In other words, the purpose of psychological research on illusion is not to deconstruct illusion but to understand humans' (or animals') subjectivity. To this purpose, the research about body transfer illusion has also become a thought-provoking subject. As the closest existence in humans' perception, our bodies are supposedly difficult to be misunderstood, but there is still the illusion like the rubber hands illusion [13] [14]. The rubber hand illusion is based on a series of manipulation processes in a well-designed body perception process, and participants would finally mistakenly identify their own bodies.

Following this brief discussion about illusions, what we want to explain is the fragility of human perception. Furthermore, we believe that techno-art plays its role in the contemporary era because it reveals the truth of technology media – not only on the individual but also on the social level.

2.2 Media bias

The first and foremost issue of the socialization of technology is media bias. Media bias refers to the situation when a message delivered by media cannot uphold a neutral and truth-seeking position to broadcast content [15]. The cause of media bias is not only from the media itself due to improper profit. Also, the audiences' stereotypes and preferences in selecting the medium are also barriers to a global and fair view of the truth.

In addition to the biased media selection, what people believe as "evidence" can also be manipulated – what we say "Seeing is believing." However, history shows us the problems of this credo. Lenin's command to take fake photos for the October Revolution and Nayirah's testimony incident in Kuwait were all once "evidence" to manipulate the truth (see [16] [17]).

2.3 A Reflective Journey into the Metaphor of Light

The idea of this work is to reflect on the essence of technological media. In the process of our work, we realized that the discussion's subject is actually the same as the entire philosophical discussion about light. Before explaining the presentation and execution of this artwork, we briefly use Plato, Descartes, and Heidegger's metaphors of light in their philosophical work to summarize the contemporary meaning of technological media. It should be noted that the following philosophical reflection is not a "preset" of our work but more like an exploration and understandings (findings) in our continuous discussion.

In Plato's *Allegory of the Cave* metaphors, light represents the origin (the *T*ruth). What we see as everything is only the shadow of its essence, and it is the light that creates the shadow. With this metaphor, Plato tried to persuade people to go beyond things' appearances and strive for the knowledge of understanding them. In other words, representation is always an illusion. However, to this, Descartes saw the meaning of illusions. His *Traité du monde et de la lumière* (*The World*) is one of the earliest works studying optical refraction. It mentions that the speed of light changes in the medium, thereby causing the phenomena of refraction. For Descartes, if the light is no longer constant, how can one determine that something is true? Here, his answer is "cogito, ergo sum (I doubt; therefore I am)." The fact that we are suspecting about the truth proved the existence of a questioning subject. Our existence is the only truth. Following this, the ultimate goal of using illusion for artistic work is to allow reflection on subjectivity in the interaction with the artwork. In other words, it is not the work itself being created but the viewers' subjective speculation. Despite this, skeptical eyes are not always a human habit. Heidegger used the metaphor of *Lichtung* (clearing; lighting) in his work, *Sein und Zeit* (*Being and Time*), to illustrate how people and things are "being-in." In his concept, humans (or, more precisely, the spirits) are the existence of light. However, it cannot illuminate objects by its free will. We need speculation and suspecting to bring things and us into the condition of *Lichtung* (clearing). "Being-in" is, therefore, the condition of meaning. In other words, reflection or speculation is not an abstract concept but a situated experience.

The condition of "being-in" inspired us to use audiences' bodies to experience the illusion and, at the same time, the object to be experienced as an illusion. If the object is a common object, the reflective experience is always limited in the field of our artwork. The only way to make the experience more sustainable (to make the audience aware of their suspicious subjectivity) is to challenge their general

experience of the self.

## 3 Presentation and Execution of Work

From our reflections and discussions on illusion and media bias, we conceptualized the work of *Blinding Light*. This work is a physical and interactive installation. It is a box with a screen mounted on the front wall and a round hole about 15 cm in diameter beneath the screen (Figure 2). The audience puts a hand into the box through the round hole, and two opposite hands will be displayed on the screen. A hidden camera captures the actual hand, and the two hands on the monitor are virtual representations. However, with a series of processing strategies programmed by *TouchDesigner*, the perception of the hands changes over time. First, audiences believe the hand from her/his side is hers/his, and there is another hand from someone else. They then experience their hands being destroyed by the opposite ones. However, they will soon experience "solving" the illusion and perceive the opposite hand as theirs. Finally, the audience will realize that even the solving experience is also an illusion. This series of experiences is created via different image processing stages, which are (a) opposite, (b) contour, (c) delay, (d) distortion, (e) chaos, and (f) reversed delay – explained as follows.



Figure 2: the installation of Blinding Light

(a) opposite

The audience sees a hand appearing on her/his side and believes that the hand is hers-his. Another hand is presented on the opposite and is perceived as a hand from someone else.



Figure 3: stage 1 – opposite

(b) contour

The hand displayed on the opposite has two features. The first one is that it has only outlines. Compared to the hand on the near side with full color, the audience would interpret the opposite hand as something different (see Figure 4).

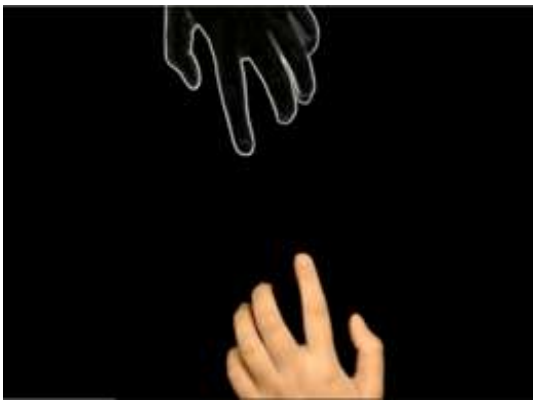


Figure 4: Stage 2 – contour

(c) Delay

Another character of the opposite hand is that it moves asynchronously to the normal hand. Its motion is always delayed. However, the audience would discover the difference rather than the similarity, which means the opposite hand tends to be perceived as a hand of the other but not her/his own hand with delayed appearance.



Figure 5: Stage 3 – Delay

(d) Distortion

When the audience moves her/his hand further forwards and the two images contact each other, the audience will see "her/his own hand" being transformed by the opposite hand. The seemingly abstract and fragile outline is now contrarily performing a more powerful impact on the solid image.

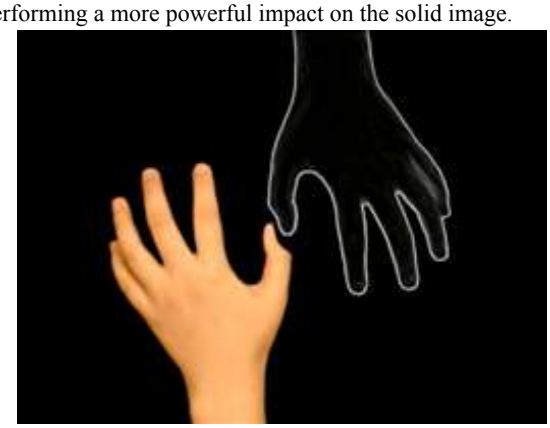


Figure 6: Stage 4 – Distortion

(e) Chaos

The transformation of the hand on the close side will then get even severer. The hand contour overlaps on the solid hand. The audience experiences her/his own hands being attacked and destroyed. Some wired colors even appear on the skin.



Figure 7: Stage 5 – Chaos

(f) Reversed delay

After the distortion and chaos, a tiny switch occurs. Now, the time delay is changed. The opposite hand becomes synchronous to the audiences' real hand, and the hand on the near side moves delayed. The audiences have to reconstruct her/his body perception. It is now the hand contour, a representation of the real hand. However, how can it be possible? After these series of image transformations, the audiences can no longer accept only one of the two hands to be hers/his, since an "explanation" of the illusion shall not work. Both hand images are from the same subject and are, in fact, the same one. The audience is, in fact, interacting with their own hands.



Figure 8: Final Stage – Reversed Delay

## 4 Epilogue

Our artwork aims to disclose subjectivity in truth-finding process. By interacting with and against a series of illusions, audiences perceive, explain, fail to explain, and, finally, transcend the phenomena of illusions. With this artistic goal, we expect a subject that is aware of its presence in front of the artwork and reflect on the issues of technological media. Technological media (such as social media) are biasing due to their nature, but human beings have also reshaped humanity in the age of technological development. Borrowing Allenby & Sarewitz's [23] term, we are becoming the **techno-human**, a being that can understand the essence of technology and overcome technological manipulations.

And this is exactly the goal of our work.

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# RI #1 - Nike

Resonant Irregularities of Winged Victory of Samothrace



Abstract
This paper is about the work "RI#1-Nike", which was created in the Resonant Irregularities project, a project that aims to create a three-dimensional form or sculpture that exceeds human intentions. The question is whether a machine can create a work of art and whether there is beauty in it. In order to do this, we focused on the glitch art method, using sculptures as a base and focusing on the new expressions that emerge from the gradual changes that occur through repeated 3D scanning and 3D printing. By repeating trials based on several sculptures, and by repeating prototypes with different 3D scanners, we recognized their characteristics. Based on these findings, I created "RI#1-Nike" by using four 3D scanners based on "Winged Victory of Samothrace".

Keywords: Media Art, Glitch Art, 3D Print, 3D Scan

## 1 Introduction

In recent years, 3D printer technology has evolved to the point where it can produce an almost unlimited number of different shapes and materials. 3D scanners for scanning three-dimensional objects have also developed in the same way. In recent years, smartphones have been equipped with LiDAR sensors, making it easy to achieve relatively high resolution scans. Applications for smartphones based on photogrammetric technology have also appeared, allowing for easy 3D scanning, but the accuracy is low, and data is often added to parts that do not exist originally, or conversely, data is often missing. However, in the realization of art and information media, there are many examples where so-called noise, such as non-existent parts or missing data, works effectively. The value of such works and expressions as artworks is often created by considering the reasons why noise is generated and its meaning.

The output shape of printed 3D objects is greatly affected by the errors and noise of 3D data caused by the accuracy and errors of the scanner, not to mention the output errors caused by the performance of the printer. We believe that this is where the individuality of the scanner is born, and through repetition, there is a possibility that a new value beyond human intentions can be imagined from the same 3D object. We named them Resonant Irregularities. We have demonstrated this with multiple objects and a 3D scanner[1]. This work, "RI#1-Nike", is the first art work

to come out of this project.

## 2 Related works

Similar cases that have been produced or experimented with in the past will be introduced in several categories.

### 2.1 Loop and Feedback

"I Am Sitting In A Room" by Alvin Lucier uses a microphone to read aloud sentences starting with "I Am Sitting In A Room ..." in a room with reverberant. The sound is recorded and played back from the speaker in the room. And, the sound from the speaker is recorded again. Recorded sounds include the reverberation of space. By this repeating recording, the reverberation characteristics of the room are emphasized, and the original sound going to inaudible[2].

"I Am Sitting In A Video Room"[3] by Patrick Liddell (ontologist) is an homage to Lucier's "I Am Sitting In A Room". This artwork repeats the process of downloading a video that was uploaded to YouTube and uploading the video file again. The repetition process accentuates the characteristics of the video alteration by data compression, and the final result is very different from the original video including the audio.

These works expose the characteristics of the media itself that we are not usually aware of through repeated copying. This is considered to be an important indicator for observing the changes while repeating the copying in the authors' experiment.

### 2.2 Related about 3D printer

There have also been attempts to create works using loops and feedback from 3D printers and 3D scanners; Miyako Atsuro's "Object Resolution"[4] is an ongoing project. Inspired by the degradation caused by image compression when a digital image is copied multiple times, Miyako scans a banana in 3D and outputs the 3D data as a 3D print to replicate the banana. This work examines how the shape of the banana changes when the copy is scanned and printed again.

David Bowen's "growth modeling device"[5] scans the growth of an onion bud with a laser scanner and 3D prints the growth process of the bud. It is scanned and printed every 24 hours and left as a plastic model.

Debra Thimmesch's article on the web, "3D Printing Glitch Adds Meaning to Art Student's Sculpture"[6], argues that glitches are problems that occur with 3D printers and that they are a form of artistic expression. This is one of the ways to express art. A glitch is an electronic mistake or error in an industrial product, a momentary malfunction that does not stop it from working.

These works and projects, as well as the editorial, may provide a benchmark for considering the errors and noise of 3D printers and scanners in the authors' experiments.

### 2.3 Related about 3D glitches

"Glitch: Designing Imperfection"[7] by Iman Moradi et al. is a book that mainly considers glitching in images as an artistic expression and was compiled after an open call for submissions. In this book, Moradi refers to unintentional, spontaneous glitches as pure glitches, and intentionally created glitches as glitch-alike. On the other hand, Japanese artist ucnv argues that intentional glitching is a form of artistic expression by taking the perspective of a developer of various technologies in his book[8] "Glitch Art Theory". Rosa Menkman, in her article "The Glitch Moment(um)"[9], argues that the relationship between the technical and cultural aspects of glitching needs to be clarified, and examines the cultural value of glitching. These literatures provide detailed explanations of glitching, so please refer to them for more information on glitching.

Thomas Ruff's "jpegs"[10] is a collection of a series of works that deal with the image data format Jpeg, which can be found on the Internet. The image data is compressed at the highest compression ratio. Jpegs are photographic works in which the image is enlarged and displayed again, and the photographs on the jpegs display the block noise characteristic of the Jpeg format, resulting in glitchy expressions. It focuses on the beauty of the photograph itself and the beauty of its structure by revealing the format structure of the Jpeg image. These works and articles can be used as a benchmark for considering the handling of data containing scanned errors and noise in the authors' experiments.

These reference cases suggest that the authors' experiment of repeatedly copying objects in 3D and observing and discussing the changes in the objects may create novel value, and the experiment should be carried out.

## 3 RI #1 - Nike

After applying the process of "Resonant Irregularities" to several objects from our previous research, we selected the "Winged Victory of Samothrace" as the original model because of its interesting changes. This is a shape that is highly artistic in nature and already lacks arms and head, making it suitable for our concept of shape loss or creation due to irregular noise. It was also interesting to scan the figure with multiple scanners, as they produced distinctly different results. We used four methods for 3D scanning: two stationary scanners, Sol 3D and Matter & and Form, a handheld scanner, Sense3D, and a smartphone app, Trnio. The original data was used from the data available on the web (https://www.thingiverse.com/thing:196038). The original data had 2836081 vertices and 3672162 triangles, which are very high resolution, but since the amount

of data was too large to upload to a 3D printing service, the number of vertices was reduced to 213170 and the number of triangles to 426344. As a result, the number of vertices was reduced to 213170 and the number of triangles was reduced to 426344. As a result, the detail was lost, but we set this as the first generation.

Since the changes were mainly made by a 3D scanner rather than 3D printing, high precision and complex shapes could be formed by Selective Laser Sintering 3D printing.

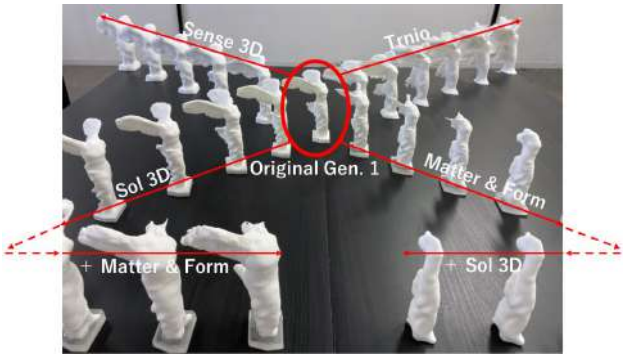



Figure 1 Overall view and placement of the sculptures.

Figure 1 shows the overall image of the work and the arrangement of each sculpture. The original first generation is placed in the center, and the second and subsequent generations radiate out from it in four directions. Each of them was scanned by a different 3D scanner and has different characteristics. There are also two sub lines, one scanned by Matter & Form against the last generation of Sol3D, and the other scanned by Sol3D against the last generation of Matter & Form.




Figure 2 3D sculptures scanned by Sol3D.

Figure 2 shows the 3D sculptures scanned by Sol3D in order. The surface is smooth and has few bumps, and as it becomes rounder and rounder through repetition, the details of the feathers and wrinkles of the clothes gradually disappear. In particular, the right wing is gradually becoming thicker, and the base of the lower part is gradually being shaved off due to the characteristics of the scanner. The scanner is the most accurate of all the scanners used, so the shape does not collapse abruptly, and the gradual




Figure 3 3D sculptures scanned by Matter & Form.

changes can be enjoyed, but they do not exceed predictions and are not very interesting.

Figure 3 shows the scans made by Matter & Form, ordered by generation. The surface is fine and uneven, and there are areas that could not be scanned that are missing. Also, the accuracy of scanning thin areas is low, so thin parts of feathers and clothes will be missing. As a result, the change is relatively sudden: the feathers almost disappear, leaving the base, and the entire body becomes thin and thin. Since the base is almost horizontal, the first scan loses the almost horizontal surface, leaving only the almost vertical sides, and the second scan loses the thin sides and almost disappears. Even though it has become thin and stick-like, you can still feel the characteristics of the original sculpture, and observing the details of the wings that disappear as if they were weathering, it is a shape that is difficult for humans to create and has a very interesting shape. These most represent the concept of this project.




Figure 4 3D sculptures scanned by Sense 3D

Figure 4 shows a scan with Sense3D, which is a handheld 3D scanner that requires a person to move the scanner so it makes the results less stable than the two scanners mentioned above. Sense3D is less accurate and tends to fill in areas that could not be scanned smoothly, so it tends to be more rounded. As a result, a sudden rounding and fattening of the whole image can be observed. The surface is not uniformly smooth, and there are areas that are wavy and uneven, which makes it more interesting than Sol 3D, which is rounded as well.

Figure 5 shows a scan with Trnio, which unlike the other three is a 3D scanner with an iPhone app. It is like Sense3D mentioned above, it requires a person to move the camera, so the results are not stable, so multiple attempts were made as well. It is prone to noise, and shapes that do not originally exist in the object tend to be generated at the edges. Accuracy is low and detail is lost, but




Figure 5 3D sculptures scanned by Trnio

the surface is uneven and changes to a simpler shape rather than becoming more rounded. As a result of all this, the surface area gradually becomes wider around the feathers, and the complex and simple shapes are mixed together. The features are still difficult to create by humans, and the shapes are solemn and beautiful.



Figure 6 Above is 3D sculptures scanned by Sol 3D for the last generation of Matter & Form. The bottom is 3D sculptures scanned by Matter & Form for the last generation of Sol 3D.

Figure 6 show two stationary scanners, the last generation of Sol3D scans followed by repeated Matter & Form scans and vice versa, with the two scanners having opposite characteristics: one becoming thinner and the other fatter. The initial Sol3D scans began to show the characteristics of the Matter & Form scans, with the surface becoming uneven and chipped with holes, as if the wings had been eaten by insects. The other side becomes rounder, but the already lost features do not return, and the surface becomes smoother, but there is little change even after repeating the process. Once the information is lost, it cannot be regained, nor can each of them end up in a similar shape. These two lines never intersect.

## 4 Conclusion

In this work, a shape that could never have been created by human hands was created in the process of shape change. This is similar to the act of bringing to light the physical characteristics of spatial reverberation through sound, as presented in Lucier's "I Am Sitting In A Room". Since this work exists physically as a three-dimensional object, all of its generations can be viewed simultaneously. By showing all of them side-by-side, we can see their transitions in detail from various angles, and feel the distinct characteristics of each line. The form of the work, which is difficult for people to create, and the differences between the generations are the highlights of the work, and constitute the work not as a single sculpture but as a collection of them.

This allows us to glimpse the discrete and mathematical order that is characteristic of the use of digital technology in the constantly changing sculptures, even though they contain parts that are beyond human intention. We believe that this work presents a new way of media art, a fusion of science and art.

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# Circle of Apollonius and Afterwards: Fractal Image Sources of Smoke and Asian Ink Animation



**Abstract**

How can we grasp the essence of the nature? How can we expand it to the artworks? This artwork began with a concept of image expressions called Image Phenomenon that a visual attempt to combine and create artworks with natural phenomena. In this artwork, some fractal structures of smoke and Asian ink with *Hanji*, Korean paper, were inspired and adopted for creating a media art. Smoke was likened as a path, and a character runs on the path and shows various storytelling of human life. Image sources were arranged with Adobe After Effects, all the layers of fractal image of smoke, ink, and the motions of the character had been fed into the computer and composed to an animation titled as 'Circle of Apollonius' in 2008. After that, a Korean media company finding this animation by chance asked to create a new media art. That experience brought a new phase to Asian ink animation such as giving colors or perspective. However the basement of the new phase was 'Circle of Apollonius', and the basement of 'Circle of Apollonius' was the concept of Image Phenomenon. This presentation will show such historical development from Image Phenomenon to 'Circle of Apollonius', and the next artworks.

**Keywords:** Image Phenomenon, Asian Ink Animation, Fractal structure

## 1 Concept and Motivation

This artwork began with a concept of image expressions called *Image Phenomenon* that two Japanese art professors, Noriyuki Shinohara and Ryoku Itaya, educating at Musashino Art University have advocated. Image Phenomenon is an attempt to combine and create artworks with phenomena aroused by likening image sources of the real material world to the landscapes, by breaking them into pieces, by changing their nature, by transforming their scales, by changing their dimensions, by adding or removing the time from them, and so on [1].

On the viewpoint of this concept, many kinds of natural materials being considered as image sources were observed. How can we grasp the essence of the nature? How can we expand it to the artworks? When we observe the tree growing, for instance, how can we express the nature in words? In the regular form of the branch growing to catch the sunlight for photosynthesis, self-similarity, self-replication, or randomness will be found there. We may call such natural essences as the fractal structure that French mathematician Benoit Mandelbrot referred in 1975. [2] Even a tiny phenomenon, if you repeat it again and again, you can derive more complicated image here. Finally, with such motivation, smoke was observed at an old temple where fluttering white smoke of incense reached onto the dark ceiling. That aroused an inspiration for this artwork.

## 2 Image Sources

Three conditions were set up to find and arrange materials

as image sources for this artwork: (i) The material must have fractal structure. (ii) The material shouldn't be conceptual but visible and tangible. (iii) The material must be controlled for video taking. Actually, only a few materials would meet these conditions. In this artwork, we utilized Asian ink with *Hanji*, Korean traditional paper. *Hanji* is made from paper mulberry that has different character from Western paper, the fiber is much longer and tougher like a textile. Asian ink is made of glue and soot gathered after burning rosin, soluble in water, adjustable the thickness while adding it water. It depends on the thickness of the ink and weaving *Hanji* that a painting in Asian ink may change the style and technique. And smoke flows among the air toward where air density is low, it also has a fractal structure. Hence, this artwork adopted Asian ink with *Hanji* and smoke for creating a media art.

## 3 Digital Technologies

The data of image sources recorded in DV (720*480) had been fed into the computer and arranged with a composition software, Adobe After Effects, and adjusted the value of the level. Then smoke source was separated from the background, this keying was the most difficult task because smoke is vague and doesn't have clear borderlines. Therefore, not the blue screen but the black board was prepared against white smoke of incense, and tried lots of times to take videos. Also smoke source was controlled the speed of fluttering to match the ink animation, using the Time Warp filter of After Effects. While preparing the fractal image sources of smoke, ink characters drawn in Asian ink were also scanned and imported to the computer and arranged for the animation. Finally, all the layers of the ink character, motions, and fractal sources had been imported to the computer and composed them into an animation that titled as 'Circle of Apollonius' with the length of 7'08 minutes. [3]

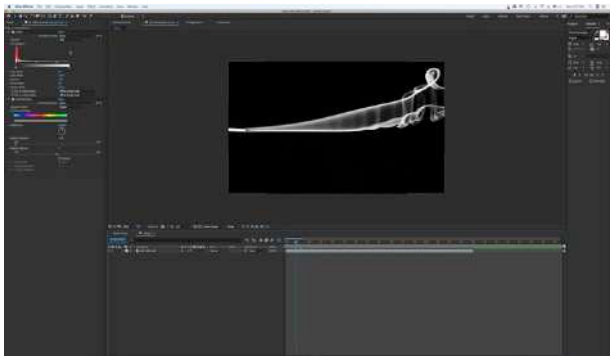


Figure 1: The workflow of extracting smoke footage through After Effects as a source for video work

In this media art, we may find some ways to recognize the meanings. Smoke, for instance, represents reality and the ink character does illusion that doesn't exist in the real world. Or smoke may disappear soon in the air but the character never: finite and/or infinite sequence. The character runs the ways from teenage to the forties that reminds us of the circle of life (actually that was the original title). This artwork may show that such storytelling or narrative should be an indispensable element to create an art from the phenomenon.

## 4 Afterwards

'Circle of Apollonius' was the first attempt to collaborate a phenomenon and a media art for the author around 2008, and it seemed to be successful. At that time, there was only an idea to create a media art for expressing storytelling. However, after that, Korean broadcasting company, Seoul Broadcasting System (SBS), asked to create a new media art for expressed storytelling of their TV drama series 'Faith', or '*Shin-i*' in Korean, also known as 'The Great Doctor' in 2012. That new experience brought fresh ideas to create Asian ink animations, using colors, the space having depth (Figure 2), looked like 3D in spite of 2D on the *Hanji* paper.



Figure 2: The next artwork at Korean TV drama 'Faith'

The request of SBS unexpectedly developed a new phase such as giving colors or perspective drawing to Asian ink animation. However, the basement of this phase originally was the experiment of 'Circle of Apollonius' using smoke and Asian ink with *Hanji* paper, and the basement of 'Circle of Apollonius' was born from the concept of Image Phenomenon to grasp the essence of nature and express the image of fractal structures. In this presentation, such historical stories and perspective will be shown for the next artworks of Asian ink animation. [4]

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# Spreading Awareness of Marine Pollution by Developing an Educational Mobile Game




**Abstract**
Every year, marine pollution due to land debris gets worse and causes damage to the habitat and ecosystem of marine creatures. It is important for the younger generation to be aware of the problem and the efforts to reverse it. Efforts to spread awareness about marine conservation can be done in different ways. One of which is by utilizing digital interactive media such as games which are currently popular among children and teenagers. Mobile games are one of the most consumed by the younger generation, that is why we decided to develop an educational mobile game with the theme of fishing to spread the message about the condition of our oceans. Using the MDA framework, we were able to translate marine conservation into game design with fun mechanics. Our game revolves around fishing wastes that are shaped like marine wildlife. It is designed so that players would be encouraged to catch as many species of waste wildlife and become aware of many different wastes polluting the sea. We hope that children and teens can be more aware of the state of the sea and understand that every component shown in this game can generate empathy for the problems faced by the sea.

**Keywords:** marine pollution, mobile games, younger generation

## Introduction

The state of marine pollution is getting worse each year. Land-based waste takes about 80% of marine pollution [1]. Things like plastics and manufactured chemicals are considered hazards to the marine habitat. Not only that, ocean pollution has multiple negative effects on human health, one of which is the consumption of contaminated seafood being the main route of human exposure to chemical pollutants [2]. This problem should be looked upon more, especially by younger generations like children and teens. The involvement of youth in the act of marine conservation is as essential as their awareness to the problem.

Children and teens have shown interest in interactive media, one of which is mobile gaming. In the United States, 46% of children aged 13-18 play mobile games on a daily basis [3]. In Indonesia, 58% of children aged 8-11 often play mobile games [4]. With that in mind, there is a possibility to spread awareness of marine pollution with the help of mobile interactive media.

## Methodology

For our game design we will be using the MDA framework, also known as Mechanics – Dynamics – Aesthetics.

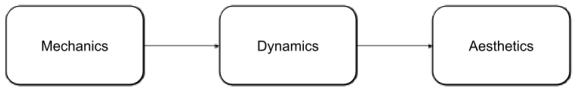



Figure 1: The MDA Framework

Mechanics describes the particular components of the game, at the level of data representation and algorithms [5]. Mechanics contain various rules and interactions that are in the 'hidden' part of the game. Together with the game's content like levels, assets and so on, the mechanics support overall gameplay dynamics.

Dynamics describes the run-time behaviour of the mechanics acting on player inputs and each other's output over time [5]. It's the part of mechanics that the player can see. Dynamics work to create the aesthetic outcome.

Aesthetics describe the desirable emotional response evoked in the player, when the player interacts with the game system. [5]. Vocabulary to describe the aesthetics of a game includes but is not limited to:

1. Sensation: game as sense-pleasure
2. Fantasy: game as make-believe
3. Narrative: game as drama
4. Challenge: game as obstacle course
5. Fellowship: game as social framework
6. Discovery: game as uncharted territory
7. Expression: game as self-discovery
8. Submission: game as pastime

## Discussion

Our first step before developing our game design is to determine what topic we specifically would like to deliver through our game and how we could present it to create a unique and informative experience.

We based our game around the cleaning the ocean from waste and pollution. Cleaning up the ocean from waste is one of the efforts done to combat marine pollution. Another theme we based our game with is fishing. Fishing is a very common theme in games and most fishing games can be learned intuitively. Popular games such as Animal Crossing (Nintendo), Minecraft (Mojang), and Stardew Valley (ConcernedApe) also have fishing mechanics in their gameplay. Fishing is also often related to ocean activities. Combining the two themes together, we created a fishing game about cleaning the ocean from waste.

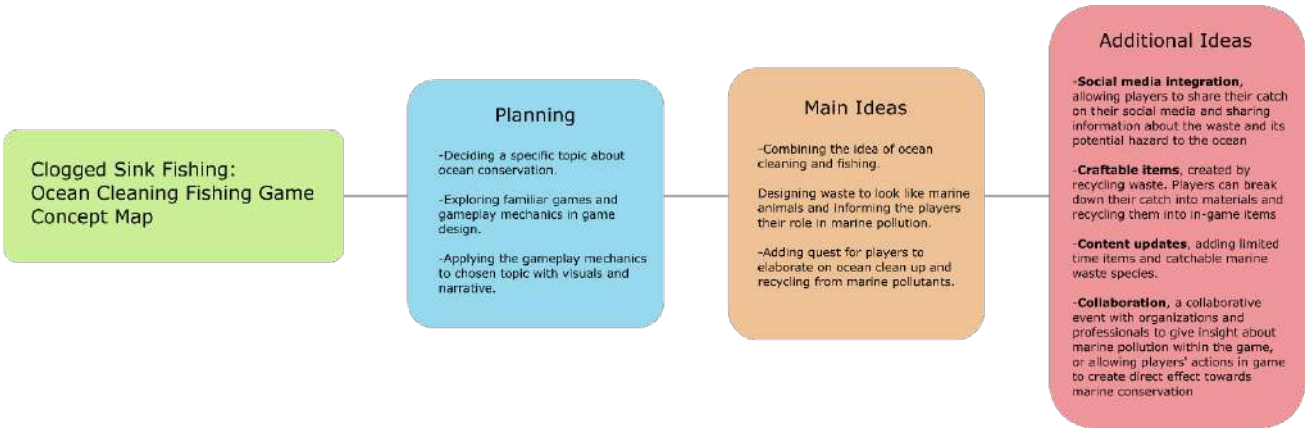



Figure 2: the game's concept map containing main and additional ideas for the game.

To visualize our direction for the game, we created a concept map. This map would help keep track of concept and ideas for the game as well as determine what would be applicable for the game and the message we plan on delivering.

Visually, we decided to design the fish the players would catch as waste with the form of marine wildlife. The types of waste we've chosen are wastes that would usually end up in the sea. Our goal with this is to reward the player with unique designs of marine wildlife that they catch while also informing them about the kinds of wastes polluting the ocean. When a player catches a waste, they would be presented an information about the waste, also its effects to the marine habitat.




Figure 3: game screenshots depicting the playable character and the waste they've caught as well as some information about the waste.

To elaborate more on the idea of ocean cleaning, we added a quest system for players to complete. They would be asked to handover specific waste for different in-game organizations to be recycled or processed, depending on their material. We aim for this to be able to educate the players and also promote the potential of recycling.




Figure 4: in-game quest related to recycling.

**Applying the MDA**

The aesthetic goal in this game is to create the emotional response of discovery, challenge, and submission.
To evoke discovery, we created a number of different marine waste for the players to catch. Rarity mechanics which the rarer the marine waste the harder they are to find are applied to the game, encouraging the players to try and catch all the marine waste.




Figure 5: waste wildlife and rarity levels present in the game.

Challenge can be created by creating varying difficulty catching marine waste of different rarity levels. We coded a power bar that would decide which level of rarity the players could possibly get. On top of that, we tuned the gameplay so that the common marine waste would be the easiest to catch with slower progress drain and less tapping speed, while rare waste would need significantly more effort to reel in with faster progress drain.

Allowing the players play the game conveniently is also one of our main points creating the game. Introducing easy-to-learn mechanics and gameplay lets the players get into the game quickly. Creating the game for mobile platform also let the players play the game anywhere at any time.
Our goal with this game is mainly to spread awareness to children and teens about different types of pollutants in the sea. This would help educate them more about the dangers of marine pollution to the habitat and human health.

**Future Ideas**

Due to our limits in development time and technical knowledge, we weren't able to optimize the potential of spreading awareness about marine pollution through our game. We have gathered a number of ideas that could possibly amplify our games effects while also making the game more fun to play:

1. **Social media integration.** This would allow players to share their catch to their friends in their social media, also sharing the information about the waste and its role in marine pollution.
2. **In-game items.** Players could break down their catch into materials that they could 'recycle' into in-game items. Players would be shown how the process of recycling in real life as well.
3. **Content updates.** Constant updates for the game could potentially create even more possibilities to spread awareness and creating engaging gameplay. Limited time items and waste wildlife species could attract players into playing the game more often, opening more windows to spread awareness about marine pollution in the game.
4. **Collaboration.** It is also possible to hold a collaborative event where every waste a player catches a sum amount of waste is removed from the ocean, and every item crafted a sum of those wastes are recycled. Another idea is to collaborate with real life organizations and professionals to create more quests and bring insights about marine pollution to the players.

## Summary

In summary, there are many alternative ways to spread awareness about marine pollution. Digital Interactive media and games prove to be one of the most popular media to be consumed by children and teens alike. Therefore, fun, educational, and sustainable game design is an interesting approach to spread awareness or even directly combat marine pollution.

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