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Virtual Influencers in Online Social Media

Mauro Conti, Jenil Gathani, and Pier Paolo Tricomi

***Abstract*—Influencers are people on social media that distinguish themselves by the high number of followers and the ability to influence other users. While Influencers are a long-standing phenomenon in social media, Virtual Influencers have made their appearance on such platforms only recently: they are Computer-Generated Imagery (CGI) characters that act and resembles humans, even if they do not physically exist in the real world. This recent phenomenon has sparked interest in society, and several questions arise regarding their evolution, opinions, ethics, purpose in marketing, and future perspective.**

In this article, we conduct an exhaustive review of the virtual influencer phenomenon. Through an extensive study of the literature, press articles, social platforms data, blogs, and interviews, we give a comprehensive reflection on Virtual Influencers. Starting from their evolution, we analyze their opportunities and threats. We provide detailed information about the most popular ones and their marketing collaborations, with a comparative analysis of virtual and real (human) influencers. Moreover, we conducted an online survey to grasp people's perspectives. From the 360 participants' answers, we draw conclusions about Virtual Influencers' ethics, importance, overall feelings, and future. Results show controversial opinions on this recent phenomenon.

***Index Terms*—Influencers, Virtual Influencers, Social Media, Social Network, Influencers Marketing, Virtual Characters.**

Introduction

As Social Media spread among people, companies began to embrace them as advertising tools. Marketing agencies rely on people with a high number of followers and ability to influence the mass (known as Influencers) for advertisements. The usage of visual content on these platforms has increased in the last decade, especially on Instagram, which became an effective way for brands to literally show their products and values. Constant innovation in the influencer marketing industry has led to a new phenomenon called Virtual Influencers (VI). We can describe a virtual influencer as a person or thing created by software that can influence others, primarily through marketing collaborations or participation in social campaigns, and is solely created and consumed via digital mediums [1]. They resemble human characteristics, behavior, and actions but do not correspond to any human in the real world. Companies are not releasing information about the software or technology they use to create VI. However, we expect they are created by 3D artists using CGI (Computer-Generated Imagery) and motion capture technologies to depict them as real people in real situations. Sometimes, VI are digitally-altered versions of real people or a digital combination of a CGI-made head and real person's body. We presume that even content related to VI (e.g., posts), which nowadays is mainly created by humans, will always be more generated by Artificial Intelligence (AI). In the following sections, we will refer to the above definition of virtual influencer.

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One recent study stated that people like or comment on virtual influencers' posts three times more than Real (human) Influencers (RI) ones. This trend has followed from 2019 and was consistent in 2020 as well [2]. In the past three to four years, brands from every industry have exploded Instagram with digital avatars, demonstrating their commitment towards innovation and creativity. Examples are Renault, IKEA, Prada, or Samsung. During the difficult time of the COVID-19 pandemic, VI contributed to raise awareness about social distancing and other ways to help prevent COVID-19 from spreading [3]. Although the COVID-19 pandemic decelerated the growth of human influencers worldwide, virtual influencers were not affected. In reality, the COVID-19 crisis probably fueled the expansion of virtual influencer marketing strategy. People are clearly attracted to VI, given the growing trend of companies partnering with them. Viewers probably like the human emotions VI express in daily-life situations, although they are not real. Furthermore, VI can digitally be anywhere at any time, delivering their followers highly-catchy content.

Contribution. We provide a wide overview of the emerging phenomenon of Virtual Influencers under several aspects: evolution, popularity, marketing, ethics, opportunities, and threats. For this purpose, we collected and analyzed several literature articles, online resources, and reports provided by websites specialized in influencers' analysis. Moreover, we carried out a comparative analysis between Real and Virtual Influencers. Finally, we conducted a survey with 360 participants to understand people's views on VI.

Structure. We first introduce the history and evolution of Virtual Influencers. Then, we present some of the most popular Virtual Influencers, followed by a discussion on their marketing. Next, we analyze the differences between Real and Virtual Influencers. Last, we consider opinions about Virtual Influencers, concluding the article by presenting some future directions.

Virtual Influencers Timeline

To show the birth and evolution of virtual influencers, we reconstructed a timeline (Fig. 1) of significant events related to virtual characters. Figure 2 shows examples of them, which we now describe. Although the connection between virtual characters and virtual influencers has not been demonstrated in the literature, their similarity allow us to consider virtual characters as predecessors of Virtual Influencers.

The phenomena of virtual characters existed way back in the early 90s, with cartoon characters being the pioneers. Animation has been used as advertising tool since 1940s, given the high viewer engagement it creates. However, the

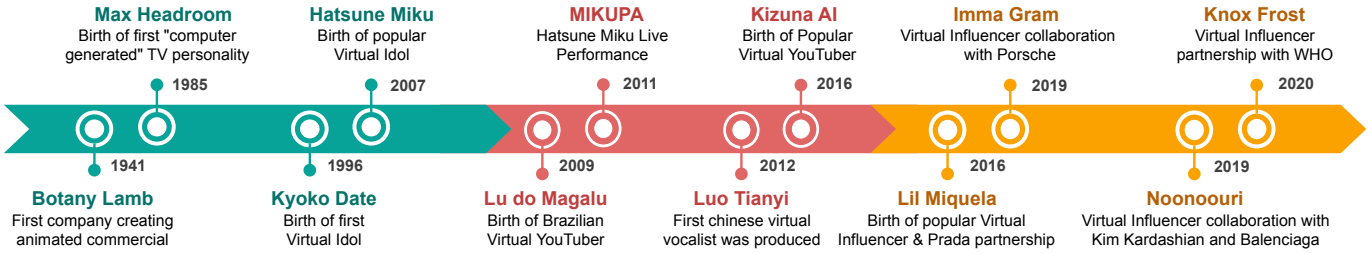


Fig. 1: Timeline of significant events related to virtual characters.

first virtual celebrities were launched in Japan alongside virtual idols, which are media performances that occur independently of any living performer's referent [4]. The Japanese talent agency HoriPro teamed up with Visual Science Laboratory, a computer graphics company, to create Kyoko Date, the world's first 3D computer-generated female model [5]. Kyoko had released her first CD single, "Love Communication", which was well-received on Japanese radios. Another popular virtual idol is Hatsune Miku (Fig. 2). She was considered very well-known in the world of character entertainment [6]. Hatsune Miku, or Miku Hatsune, which translates to "first sound from the future", is a virtual singer brought to life in 2007, developed by Crypton Future Media using Vocaloid, a Yamaha voice synthesizer program. Her popularity skyrocketed, prompting her to record her own music in live concerts like any other pop star.

Virtual idols grew rapidly, resulting in the birth of virtual YouTubers in early 2016. A virtual YouTuber, or "Vtuber", is a fictional character in YouTube videos and live streams. These are 3D models that most commonly exist in the digital form and are typically associated with some voice to provide vocal performances [7]. With 3 million subscribers on YouTube, Kizuna AI (Fig. 2) is one of the most famous Vtubers. She has served as a spokeswoman for SoftBank and the Japan National Tourism Organization, hosted offline fan events, performed at music festivals, and was engaged in a talk with Japanese Nobel Prize winners.

In 2016, a relatively new phenomenon known as Virtual influencers emerged, which can be thought of as an evolution of virtual idols and virtual YouTubers. Since most of the virtual characters were used as influencers, this phenomena quickly gained traction on Instagram, which is one of the most effective platforms for influencer marketing [8]. These characters were more appealing than virtual idols because of their realistic human-like appearance. Moreover, they were actively involved in marketing and social campaigns, and thus identified as "influencers". Lil Miquela (Fig. 2), launched in mid-2016, amassed more than 3 million followers on Instagram [9]. Following her success, many other VI were created. In this article, we will mainly focus on Virtual Influencers.

Popular Virtual Influencers

Nearly 70 percent of brands uses influencers on Instagram for their marketing campaigns, compared to around 45 percent on TikTok and Facebook [8]. This could be one reason for Virtual Influencers to be highly active on Instagram compared

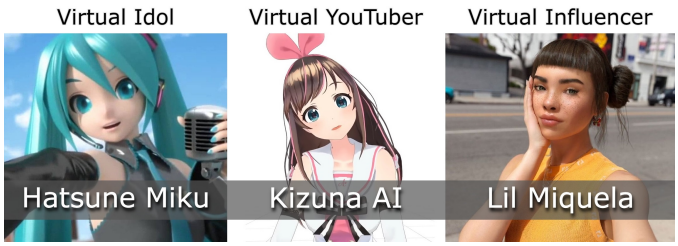


Fig. 2: Examples of virtual characters.

to other social media. Hence, we focus more on Instagram in this study. Table I provides information of top 7 most popular VI present on Instagram, based on the number of followers and collaborations with famous brands. Figure 3 shows all of them. The table is reconstructed using multiple sources on the Internet. The number of followers and the engagement rate are referred from HyperAuditor, a website that offers a comprehensive Instagram account analysis report. Here, engagement rate refers to the percentage of the audience who likes or comments on the posts. Birth date, origin, creator, and brand collaborations are sourced from VirtualHumans, a website which provides detailed information about VI. Estimated per post earnings of each VI is calculated based on the engagement rate and the number of followers, using an online tool (Instagram Influencer Earnings Calculator). We now analyze the VI reported in Table I.

Lu do Magalu. Lu made her YouTube debut in 2009, promoting iBlogTV on behalf of Magazine Luiza ("Magalu"), one of the largest Brazilian retail firms. Lu has been featuring unboxing videos, product reviews, and technological tips on behalf of the company. Although Lu has a low engagement rate of 0.08 percent, possibly because she is only famous in Brazil, she has a massive audience of 5 million followers on Instagram. She is also famous on Twitter and TikTok. Lu has worked with several fashion companies and supports social causes such as cancer, diversity, and violence against women.

Lil Miquela. Miquela Sousa is a 19-year-old Brazilian-American influencer who debuted on Instagram in 2016, with more than 3 million followers [9]. She is a Computer-Generated Imagery (CGI) character developed by Brud, a Los Angeles-based company. She describes herself as a "musician, change-seeker, and drip robot". Lil Miquela has collaborated with American music producer Baauer on the "Hate Me" album, and her Spotify page have gained a huge amount of monthly listeners. She supports social issues such as Black

TABLE I: The Top 7 Virtual Influencers.

Name	*IG profile (URL link)*	*Followers*	*Engagement rate*	*Origin country*	*Birth date*	*Creator*	*Estimated Earnings per Post (EEP)*	*Brand collaboration*
Lu do Magalu	@magazineluiza	5M	0.08%	Brazil	2009	Magazine Luiza	$10,128–$16,880	Magazine Luiza
Lil Miquela	@lilmiquela	3M	1.85%	USA	2016	Brud	$6,056–$10,093	Calvin Klein, Prada
Knox Frost	@knoxfrost	800K	1.02%	USA	2019	–	$2,386–$3,977	WHO
Thalasya Pov	@thalasya_	495K	0.95%	Indonesia	2018	Magnavem Studio	$1,474–$2,457	Chocolatos ID
Imma	@imma.gram	331K	1.61%	Japan	2018	Aww Inc.	$987–$1,646	Porsche, IKEA
Bermuda	@bermudaisbae	293K	7.29%	USA	2016	Brud	$881–$1,468	Chanel
Shudu	@shudu.gram	215K	3.12%	England	2017	The Diigitals Agency	$645–$1,075	Balmain



Fig. 3: Visual aspect of the Top 7 Virtual Influencers.

Lives Matter and transgender rights. *The Time* magazine named her one of the Internet's 25 most influential people in 2018, alongside Donald Trump and Kanye West.

Knox Frost. Knox Frost, a 20-year-old "guy" from Atlanta with over 800k Instagram followers, is a top male VI. His content over Instagram sparks vibrant discussions in the comments sections of his posts. He has often provided his advice in supporting some social matters like self-empowerment and mental health. He also collaborated with the World Health Organization (WHO) on the COVID-19 public awareness and fundraising campaign.

Thalasya Pov. Thalasya Pov was brought to life in Indonesia in 2018. Since then, she has nearly hit around 500k followers. Magnavem Studio developed her, and she now owns a clothing store (Yipiiii). She is dressed as a typical Indonesian influencer, often sharing photos of herself in cafes and tourist attractions. She has also partnered with real influencers such as Gilang Dirga and Raditya Dika, and has been a Chocolatos brand ambassador, sporadically sharing pictures of herself enjoying the snack.

Imma. Imma was developed by Aww Inc., a Japanese startup that produces virtual influencers. She was featured on the cover of CGWorld magazine and has gained more than 300k followers. Imma has partnered with several famous companies to promote their products and services. She is well-known for her edgy street-style images with very catchy expressions and poses. She looked so real in a photograph alongside two other actual human models in a makeup spread for Kate cosmetics, that it was impossible to tell she was a virtual character. She also supports Black Lives Matter.

Bermuda. Bermuda was brought to life in 2016 in Los Angeles. She is another creation of Brud. She has the highest engagement rate of 7.29 percent among all VI and aims to inspire more women to pursue careers in robotics. She is also a rapper with tracks available on Spotify, and is also known as "The Most Controversial" VI. Bermuda once hacked Miquela's account, gaining both of them more followers and driving Miquela's account past the million-follower mark. This attack was assumed to be a marketing strategy by Brud to gain attention.

Shudu. Shudu is the world's first digital supermodel created by British photographer Cameron-James Wilson, the founder of The Diigitals Agency. She has over 200,000 followers on Instagram with a significantly higher engagement rate of 3.12 percent as compared to some of the most popular virtual influencers. Shudu has also landed some major brand collaborations.

The Influencer Marketing

Influencer marketing is a phenomenon where companies approach famous or high-influence people on social media for a brand or product endorsements, extending the "word of mouth" marketing strategy. Influencers are content creators who have built their own personal brand image both online and offline, and are able to drive people's purchasing decisions. The influencer marketing industry is expected to rise in value to $13.8 billion by 2021, which is almost ten times to what it was in 2016 [8].

Big companies and major brands are moving towards digitalization by creating or partnering with virtual influencers. Lil Miquela, one of the most famous virtual influencers, has collaborated with companies such as Prada and Calvin Klein, alone or alongside human influencers. Her estimated earnings per post (EEP) range from $6,056 to $10,093, indicating her enormous success and popularity. Lu, who is the spokesperson of Magazine Luiza, has also collaborated with the fashion store Zattini for their winter collection clothes. Her EEP of $10,000 is probably higher than those of many human influencers. Shudu, the world's first digital model, has worked for famous brands like Ellesse and the high-end luxury fashion house Balmain, with an average EEP of about $700 – $1000. Even during the COVID-19 pandemic, where the whole world (and most human influencers) was at a stand-still, some big brands collaborated with virtual influencers. The WHO had partnered

with Knox Frost to disseminate best practices against COVID-19. He supported the COVID-19 fundraising campaign in his Instagram feed, by also including a link to the WHO's donation page [3]. Another big "virtual" collaboration during the COVID-19 pandemic involved IKEA. They inaugurated a new store in Tokyo, with the help of Imma. Imma has also collaborated with various well-known firms, including Magnum, Porsche, Amazon Fashion.

The above collaborations are just examples of how companies are moving toward "virtual" partnerships. Due to VI flexibility and increasing popularity, we expect to see more collaborations in the future.

Virtual vs. Real Influencers

In this section, we present some opportunities and threats of using VI, a comparative analysis between Virtual Influencers and Real (human) Influencers (RI), and VI ontology and ethics.

Opportunities of Virtual Influencers

More Flexibility. Virtual influencers are completely flexible and adaptable. Creators can use virtual influencers in whatever promotional capacity they wish, placing them at any place and at any given time. On the contrary, human influencers are constrained by factors such as photographic expertise and modeling abilities. During the COVID-19 pandemic, VI flexibility helped them to remain active in posting innovative content, while RI were confined to their homes.

Exclusivity. Virtual influencers can be produced specifically for one particular brand and remain connected to it forever. On the other hand, human influencers often work with several brands simultaneously and are not solely known or affiliated with them.

Brand Safety. Since VI are digitally created, brands can customize VI personas to suit their image and comply with their brand values. This reduces the company's risk of exposure due to inappropriate behavior or tainted past of RI. This also avoids VI from publishing any material that is against the brand or its messages.

Brand Innovation. Among younger audiences, companies that partner with virtual influencers are perceived as being more innovative and tech-savvy than those that work with real influencers.

Threats of Virtual Influencers

Unrealistic Expectations. VI are prone to inflating people's perceptions. By redrawing expectations for appearance, style, and culture, adolescents could feel forced to imitate and follow those standards. This could negatively affect the audience's mental and physical health without considering that these digital creations do not physically exist in the real world.

Unrealatable. The relationship that consumers may develop with VI could be limited. Fans would never meet their favorite VI, and could also perceive a lack of human touch since it is not real, which can harm brand loyalty [1].

Authenticity. Authenticity, trust, and transparency are important values for any influencer. In case of VI, is it possible for a virtual influencer to suggest a product that they have not physically tested? VI will never try on an outfit, a makeup set, or a weight-loss product since they are just digital creations. This raises suspicions about virtual influencers' trustworthiness and authenticity.

Costs. Considering the costs besides the partnership itself, content generation is very expensive for VI. Experts of computer graphics are always required behind their actions, which obviously need to be paid. On the contrary, RI can produce a lot of content with minimal effort, and therefore, be more active.

Top Real vs. Virtual Influencers

We now compare real and virtual influencers by analyzing the best representative of both categories. In particular, we focus on top-three virtual/real influencers (i.e., with the highest number of Instagram followers and collaborations with famous brands). We considered Lu do Magalu, Lil Miquela, and Knox Frost for the VI, and Kylie Jenner, Cristiano Ronaldo, and Ariana Grande as the top RI. The comparison is based on reports released by HypeAuditor, summarized in Table II.

The difference in the number of followers of real and virtual influencers is evident. Lu do Magalu, the most popular VI, has 5M followers, while Kylie Jenner, the less popular RI we considered, has ~228M followers. This huge discrepancy probably reflects that many popular RI are celebrities outside Instagram, while VI only exist in social platforms' scope. Furthermore, VI joined these platforms late compared to RI, and many people still ignore their existence. Even the followers' growth is substantially different. RI growth was stable around 30 percent in the last year, while for VI, it fluctuates from very high increases (e.g., 65 percent Lu do Magalu) to a substantial decrement (e.g., -39.7 percent Knox Frost). People might have unfollowed the influencer because of its content or the account lost bots. In fact, it is estimated that only around 60 percent of the followers of VI are real people, while the value increases for RI.

The estimated reach expresses the number of people who usually see an influencer post. RI present higher values because of their higher number of followers, but the percentage over the total number of followers is similar to VI one (from 5 to 30 percent). The same applies to the engagement rate. What differs is the diversity of the population they reach. RI are followed in many different countries, while the majority of VI audience usually comes from their origin country (e.g., Lu do Magalu audience is mostly Brazilian). Finally, the EEP is substantially higher for RI, which is expected due to their huge number of followers.

Ontology and Ethics

Defining the ontological status of Virtual Influencers is challenging. A recent study claimed no meaningful difference between RI and VI [10]. Although VI do not physically exist, they have a unique identity well-defined on social media, and their followers interact with them as with any other real influencer. However, VI are still considered just company tools since their content is designed and created by the humans

TABLE II: Top 3 Real vs. Virtual Influencers.

	Influencer	*Followers*	*Yearly growth (%)*	*Most following country*	*Real followers (%)*	*Estimated reach*	*Engagement rate (%)*	*Estimated per Post Earnings (EEP*
Real	Cristiano Ronaldo	280M	29.1	India (15%)	80.5	15M–80M	1.98	$889K
	Ariana Grande	232M	26.1	USA (19%)	67.3	15M–60M	1.8	$996K
	Kylie Jenner	228M	32.5	USA (19%)	61.0	10M–55M	2.5	$1.2M
Virtual	Lu do Magalu	5M	65	Brazil (79%)	62.2	300k-1500k	0.05	$13K
	Lil Miquela	3M	49.7	Brazil (14%)	64.2	150k–800k	2.1	$8K
	Knox Frost	800k	-39.7	USA (33%)	60.6	50k–250k	1.10	$3K

managing them. This status might change once VI start using AI to generate their content.

Virtual Influencers' ontological status raises challenging ethical questions. Regarding their motivation, if creating "fake" identities for business might be questionable, this is not meaningfully different from real influencers exaggerating and proposing the best version of themselves [10]. Further, even if VI business model is transparent (i.e., more followers means higher prices for their usage), the secrecy behind their management threatens both real influencers and audiences. The former would see VI as unfair competitors; the latter might find VI communication deceiving. Finally, at present, the moral and legal responsibilities of human-controlled VI are difficult to define, and this will be even more challenging for AI-driven VI.

Opinions about Virtual Influencers

This section reflects upon some people, creators, and virtual influencers' opinions for or against Virtual Influencers (VI). We analyzed people's opinions by conducting a survey.

People's Opinion on Virtual Influencers

In [11], the authors interviewed several people to understand their thoughts about VI, who both supported and opposed them. Many respondents agreed that it was hard to trust a virtual influencer since it pretends to be real while it is not. The novelty and higher engagement of VI was appreciated, but the lack of authentic content and the impossibility to meet virtual influencers resulted to be prominent.

To have a wider understanding of people's thoughts about VI, we conducted a survey targeting social media users. We used an online platform to recruit participants, receiving 360 valid answers from 37 countries. Participants' age ranged from 16 to 61 (avg 26.3, std 7.7), divided into 169 females, 186 males, and 5 others. We validated answers through several attention checks. The survey had four sections: general, marketing, ethical, and evaluation of VI posts.

General Questions. We started the section by asking: "Have you ever heard about Virtual Influencers? (e.g., Lil Miquela, Lu do Magalu)". 38.6 percent of the participants responded positively, highlighting how the phenomenon is still new and unripe. Moreover, only 16 percent follow at least one VI on socials, and less than 7 percent three or more. A big portion of positive answers came from countries in North America, such as the United States and Mexico, in which VI have been first developed. This section highlighted that people would follow Virtual Influencer mainly for curiosity and fun, rather than to learn something or feel closer to them. Moreover, participants would find it important to see relatable and authentic content from VI (aspects taken for granted for RI). RI are expected more to deliver frequent updates and ways of communicating with their followers. Finally, viewers slightly prefer VI to look like a more real person than a cartoon character and think they should primarily publish content on technology, fashion, daily life, and social matters.

Marketing Questions. While 70 percent of the participants believe a company must have a RI sponsoring them, only 20 percent think the same for VI. People think VI could give more flexibility to the company and boost its exclusivity, innovation reputation, and brand safety. Still, only 12 percent of people would trust a Virtual Influencer equally or more than a RI. Rather, 45 percent stated they would trust VI depending on the context, 27 percent always less than a RI, and 15 percent would never trust them.

Ethical Questions. In case the behavior of VI appears unethical, only 26 people would condemn the VI itself, while most participants would accuse both the VI creator and the company using it. In general, people like to see Virtual Influencers supporting Social Issues (e.g., Civil Rights, Gender Inequality) but are reluctant if the supported cause is personal or closer to them. This reflects the 60 percent of participants thinking it is impossible to build a relationship with a VI (33 percent answered "Maybe"). Finally, only 15 percent would chat with a VI, 30 percent maybe, and 55 percent not.

Virtual Influencers' posts evaluations. In this section, we presented three posts created by three virtual influencers (Fig. 4), asking for a value from 1 (low) to 5 (high) for the following aspects: authenticity, relatability, innovative content, attractive content, comparable to a real influencer, and overall evaluation. Knox Frost's post, which depicts him while composing music, on average was considered the most authentic, relatable, and innovative. This might be related to the theme of the picture (i.e., composing music, which might be accepted for a virtual character), and the influencer wearing a mask during the COVID-19 Pandemic. Lil Miquela's post received the highest votes for attractive content, while Bermuda's one was voted the most similar to real influencers' posts. Overall, Knox Frost's post was better accepted by the participants, but many others stated that VI and their similarity with real influencers scare them, revealing a general negative feeling.

Creator's Opinion

Cameron-James Wilson claims he never intended to mislead anyone by creating Shudu. He described her as a "art piece" and a "virtual" celebration of attractive, dark-skinned women [12]. Wilson tried to recreate the elegance embodied



Fig. 4: Virtual Influencers' Instagram posts.

by black supermodels as a fashion photographer. He further added that he created Shudu with 3D modeling software and would like to think of her as a mannequin. "You can pose her and give her an expression once you've finished creating her", he said.

Hirokuni Miyaji, the creator of the virtual influencer Liam Nikuro, explained that he wanted to demonstrate what "we can do" for businesses [13]. Their motive is to raise awareness and get brands excited to collaborate with them on their own virtual humans rather than make Liam famous. He also shared his long-term plan for Liam, which is to introduce AI and allow him to interact with real people. Eventually, he stated that the distinction between fictional and real influencers will become increasingly blurred in the future. Only the content will be important.

Virtual Influencer's Opinion

Besides the creators, even virtual influencers are opening up for interviews to talk about themselves and what they stand for. With the help of interviews conducted with the VI, Lil Miquela and Lu do Magalu, we would like to highlight some of the opinions that these virtual influencers have about themselves. In an interview, Lu was asked "Who are you?"; she replied saying "I'm a strong, virtual woman who creates content to share her knowledge and her causes with everybody". She further added that she loves assisting people and is fascinated by technology, and innovation and is honored to serve Magalu [14]. A similar question was asked to Miquela, and she answered saying "I'm an artist and have expressed opinions that are unpopular and as a result, have cost me fans". Furthermore, she would love to do everything that her fans want, but ultimately, she would have to make choices that she believes in [15]. We may conclude that there is almost no difference between interviews conducted with a human being and those conducted with a virtual character. They are questioned in the same way as a real person would be, and these VI have responded close to how a real person would.

The Future of Virtual Influencers

Our research showed the rising trend of virtual influencers. With the ever-increasing coexistence of human and virtual beings, like in virtual reality applications or the metaverse, we expect the VI phenomenon to continue growing. We believe techniques used on social media by real influencers, in general, can be applied to VI as well to increase their impact. However, several concerns still exist in people's minds regarding the transparency and authenticity of virtual influencers, facts that were confirmed by our survey.

The majority of virtual influencers are currently CGI-made, limiting audience interaction to static social media posts or videos. Nevertheless, with advancements in AI and virtual reality, some VI are already participating in live interviews and activities, becoming more "human". AI-driven virtual influencers will raise ethical concerns worth discussing in the future.

Further VI analysis might focus on their content, such as determining whether it is AI-generated or made by humans, and whether consumers will notice and embrace AI-generated content. Finally, VI impact on existing communication technologies, systems, or services should be evaluated. For example, how their behavior changes on different communication platforms, or whether companies will develop new systems to increase their functionalities.

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