Assemblée annuelle
Annual Meeting

6 juin 2023
June 6, 2023

McGill University

L’Edifice Lorne M. Trottier
3630 University
Montréal, Québec
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<td>9:00 – 9:20</td>
<td>Remarques bienvenue: David Plant, Benoit Boulet, Viviane Yargeau, Jim Nicell</td>
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<td>9:20 – 9:50</td>
<td>Dominic Goodwill (Xanadu Quantum Technologies) <em>Informatique quantique photonique tolérante aux fautes</em></td>
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<td>9:50 – 10:20</td>
<td>Lawrence Chen (McGill University) <em>Vers la photonique intégrée pour la photonique micro-onde</em></td>
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<td>10:20 – 10:50</td>
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<td>10:50 – 11:15</td>
<td>Melissa Chee (ventureLAB) <em>Pourquoi l’innovation et l’inclusion alimenteront l’avenir du leadership du Canada dans l’industrie mondiale des semi-conducteurs</em></td>
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<td>11:15 – 11:40</td>
<td>Pablo Piantanida (CNRS) <em>Méthodes théoriques de l’information pour un apprentissage automatique fiable</em></td>
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<td>11:40 – 12:05</td>
<td>Christine Tremblay (ETS) <em>Réseaux optiques intelligents activés par l’apprentissage automatique</em></td>
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<td>12:05 – 12:30</td>
<td>Günes Karabulut-Kurt (Polytechnique) <em>Nouvelles frontières dans les communications spatiales</em></td>
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<td>12:30 – 13:30</td>
<td>Diner</td>
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<td>13:30 – 16:00</td>
<td>Séance d’affiches et de démonstrations des étudiants et remise des prix, généreusement offerts par : Keysight, Ciena, MDA et Marvell</td>
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## PROGRAM

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<tr>
<td>8:30 – 9:00</td>
<td>Registration – Meet &amp; Greet over Coffee</td>
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<tr>
<td>9:00 – 9:20</td>
<td>Opening remarks: David Plant, Benoit Boulet, Viviane Yargeau, Jim Nicell</td>
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<td>Dominic Goodwill (Xanadu Quantum Technologies)</td>
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<td><em>Fault-tolerant photonic quantum computing</em></td>
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<td>9:50 – 10:20</td>
<td>Lawrence Chen (McGill University)</td>
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<td><em>The path towards integrated microwave photonics</em></td>
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<td>10:20 – 10:50</td>
<td>Networking Coffee Break</td>
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<td>10:50 – 11:15</td>
<td>Melissa Chee (ventureLAB)</td>
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<td><em>Why innovation and inclusion will fuel the future of Canada’s leadership in the global semiconductor industry</em></td>
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<td>11:15 – 11:40</td>
<td>Pablo Piantanida (CNRS)</td>
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<td><em>Information-theoretic methods for trustworthy machine learning</em></td>
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<td>11:40 – 12:05</td>
<td>Christine Tremblay (ETS)</td>
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<td><em>Smart optical networks enabled by machine learning</em></td>
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<td>12:05 – 12:30</td>
<td>Günes Karabulut-Kurt (Polytechnique)</td>
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<td><em>New frontiers in space communications</em></td>
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<td>12:30 – 13:30</td>
<td>Lunch</td>
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<td>13:30 – 16:00</td>
<td>Student Poster/Demo Session and Presentation of prizes, generously provided by: Keysight, Ciena, MDA and Marvell</td>
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Dominic Goodwill  
Principal Photonics Engineer  
Xanadu Quantum Technologies  

Topic: Fault-tolerant photonic quantum computing  

BIOGRAPHY: Dominic Goodwill is a Principal Photonics Engineer at Xanadu, focused on manufacturing scale-up of photonic quantum computers. Prior to joining Xanadu, he has 30 years experience in classical datacom and telecom. He previously worked at Huawei, Genband and Nortel, on silicon photonics, optical interconnects, lidar, photonic switching and video applications. Dominic has served as a sub-committee chair of OFC and chaired the IEEE Optical Interconnects conference. He has contributed to OIF and Infiniband standards, and is an inventor on 59 issued patents. He holds a Ph.D. from Heriot-Watt University.

Lawrence Chen  
Professor  
Dept. of Electrical & Computer Engineering  
McGill University)  

Topic: The path towards integrated microwave photonics  

BIOGRAPHY: Lawrence Chen has been with the Department of Electrical and Computer Engineering at McGill University since 2000. His research interests are in optical communications, microwave photonics and photonic integration, as well as engineering education, particularly learning systems and learning mechanisms.
Melissa M. Chee  
President and CEO  
VentureLAB  

**Topic:** Why Innovation and Inclusion will fuel the future of Canada’s leadership in the global semiconductor industry

**BIOGRAPHY:** Melissa is President and CEO of ventureLAB, a leading global founder community for hardware technology and enterprise software companies. She has over 20 years of tech expertise and a proven track record growing successful start-ups and global companies. Under her leadership, ventureLAB launched the Hardware Catalyst Initiative, Canada’s only lab and incubator for hardware and semiconductor-focused start-ups and scale-ups, and is a founding member and Vice-Chair of Canada’s Semiconductor Council.

Prior to joining ventureLAB, Melissa led New Initiatives at a major division of Constellation Software, one of Canada’s largest publicly traded software companies. Previously, as the Executive Officer responsible for Product, Operations and Marketing at a publicly-traded, Canadian-founded semiconductor company, Melissa headed global supply chain operations, product management and corporate marketing, where the company’s products were designed into major consumer brands including LG, Panasonic, Samsung and Facebook. Melissa began her career at Nortel, where she held roles in product management, marketing and systems engineering.

She has held numerous board positions through national and community impact organizations and is a passionate advocate for innovation in Canada to advance our global competitiveness, technology commercialization, and women in STEM. Melissa holds an MBA from the University of Toronto and a Bachelor of Engineering in Computer Engineering from McGill University.
Pablo Piantanida
Professor and Director, International Laboratory on Learning Systems
CNRS

Topic: Information theoretic methods for trustworthy machine learning

BIOGRAPHY: Pablo Piantanida received the B.Sc. and the M.Sc. in Electrical Engineering from the University of Buenos Aires (Argentina) in 2003, and the Ph.D. from Université Paris-Sud (Orsay, France) in 2007. He joined the Department of Telecommunications at Supélec in October 2007, and in 2015 the Laboratoire des Signaux et Systèmes (L2S) - CNRS at CentraleSupélec within Université Paris-Saclay. He is currently director of the International Laboratory on Learning Systems (ILLS), professor at CentraleSupélec (Université Paris-Saclay) with CNRS. From 2018 to 2019, he was a visiting researcher at the Montreal Institute for Learning Algorithms (Mila), Université de Montréal, and from 2019 to 2020 he was a visiting researcher at Laboratoire de Mathématiques d’Orsay (LMO). He is an IEEE Senior Member and has served as General Co-Chair of the 2019 IEEE International Symposium on Information Theory (ISIT), and as area chair for several conferences and he was Associate Editor for the IEEE Trans. on Information Forensics and Security. Previously, Pablo worked on information-theoretic principles beyond distributed compression, statistical decision, universal source coding, cooperation, feedback, index coding, key generation, security and privacy. His current research is in the areas of machine learning, computer vision and natural language processing.
Christine Tremblay  
Head of Network Technology Lab  
ETS  

Topic: Smart optical networks enabled by machine learning

BIOGRAPHY: Christine Tremblay is the Founding Researcher and Head of the Network Technology Lab at the École de technologie supérieure (ÉTS). Before joining academia, she held senior R&D and technology management positions in the private sector with the National Optics Institute (INO), EXFO, Nortel and Roctest. Her team pioneered the research on filterless optical networking, a disruptive network architecture alternative demonstrated and deployed on national and regional networks.

Her current research interests include machine learning for optical networking and network performance monitoring, as well as advanced network architectures. She has been the co-instructor for SC314 and SC210 hands-on courses on optical fiber and polarization measurements and served as Technical Program Committee Member at the Optical Fiber Communication (OFC) Conference for several years.
Gunes Karabulut Kurt
Associate Professor, Dept. of Engineering
Polytechnique Montréal

Topic: New frontiers in space communications

BIOGRAPHY: Gunes Karabulut Kurt received the B.S. degree with high honors in electronics and electrical engineering from Bogazici University, Istanbul, Turkey (2000) and the M.A.Sc. and the Ph.D. degrees in electrical engineering from the University of Ottawa (2002 and 2006, respectively). From 2000-2005, she was a Research Assistant with the CASP Group, University of Ottawa. Between 2005 and 2006, she was with TenXc Wireless, Canada. From 2006-2008, Dr. Karabulut Kurt was with Edgewater Computer Systems Inc., Canada. From 2008-2010, she was with Turkcell Research and Development Applied Research and Technology, Istanbul. Between 2010 and 2021, she was with Istanbul Technical University.

Gunes is currently an Associate Professor of Electrical Engineering at Polytechnique Montréal. She is a Marie Curie Fellow and received the Turkish Academy of Sciences Outstanding Young Scientist (TÜBA-GEBIP) Award in 2019. In addition, she is an adjunct research professor at Carleton University. She is an associate technical editor of the IEEE Communications Magazine, an associate editor of IEEE Communication Letters, an associate editor of IEEE Wireless Communications Letters, and an area editor of IEEE Transactions on Machine Learning in Communications and Networking. She is a member of the IEEE WCNC Steering Board. She serves as secretary of the IEEE Satellite and Space Communications Technical Committee and Chair of the IEEE special interest group “Satellite Mega-constellations: Communications and Networking”. Gunes is a Distinguished Lecturer of Vehicular Technology Society Class of 2022. Her research interests include space information networks, satellite networking, wireless network coding, wireless security, space security, and wireless testbeds.
1 A novel construction technique for some classes of quasi-cyclic codes

Akram Saleh, Mohammad Reza Soleymani
Concordia University

Let $R$ be an arbitrary finite commutative chain ring, $\gamma$ be a fixed generator of the maximal ideal of $R$, and $F_q = R/\gamma$. In this paper, using the Generalized Discrete Fourier Transform, we derive the generator matrix of repeated-root quasi-cyclic codes of length $n=\ell m$, where $q=2^t$, $m=2^{m^\prime}\ell(m^\prime,2^t)=1$ and $\text{ord}_{m^\prime}(2^t)=m^\prime-1$, over $R$. Then, we specialize this result to derive the generator matrix for nonrepeated-root quasi-cyclic codes of length $n=\ell m$ where $\text{ord}_m(q)=m-1$. Our work presented in this paper can be used to find all classes of quasi-cyclic codes whose co-index satisfies these conditions. We use this method to list some binary quasi-cyclic codes with index 2 and find optimal and self-dual codes among them. We also concentrate on a class of repeated-root QC codes of length $p^{kn}\ell$ over the field of $F_q$, $q=p^\alpha$, $\ell(n,p)=1$. We show that these codes are equivalent to a class of nonrepeated-root quasi-twisted (QT) code of length $n\ell$ over the chain ring $F_q+uF_q+\ldots+u^{p^k-1}F_q$, $u^{p^k}=0$. It simplifies the current construction algorithms for this class of QC code.

2 MEMS and LTCC cleanrooms

Ines Amor, Ammar Kouki
ETS

The poster is a presentation for our laboratories MEMS and LTCC. Our MEMS cleanroom provides a controlled environment for the fabrication and assembly of precision microscale devices. Equipped with advanced contamination control systems, including HEPA filters and strict gowning protocols, we ensure minimal particulate and chemical interference. Precise temperature and humidity control systems maintain optimal conditions, guaranteeing consistent and reliable fabrication processes. Our first of its kind LTCC cleanroom in Canada is dedicated to the fabrication of advanced ceramic microelectronics. The LTCC cleanroom features specialized equipment and infrastructure tailored to requirements of LTCC manufacturing processes. As a leading hub for LTCC research and development, our cleanroom empowers innovation and fosters collaboration in the field of ceramic microelectronics.
3 Silicon photonic broadband polarization-insensitive switch based on polarization-mode diversity conversion

Weijia Li, Luhua Xu, Zixian Wei, Jinsong Zhang, Deng Mao, Yannick DMello, David Plant
McGill University

We present a 2 × 2 polarization-insensitive switch on a 220-nm silicon-on-insulator platform, employing a balanced Mach-Zehnder interferometer (MZI) structure. This design incorporates polarization-insensitive adiabatic couplers, polarization rotators based on mode hybridization and evolution, and thermo-optic mode-insensitive phase shifters with wide waveguides. The switch exhibits broadband polarization-insensitive characteristics, with extinction ratios larger than 15 dB, insertion losses less than 2.3 dB, and polarization-dependent losses less than 1 dB for wavelengths ranging from 1500 nm to 1600 nm. The power consumption required for simultaneously switching the fundamental transverse electric (TE0) and transverse magnetic (TM0) polarized modes is 29.1 mW. These results highlight the potential of the switch as a building block for on-chip polarization-division-multiplexed optical interconnects.

4 Exploring low-loss wide-band Substrate-Integrated Image Guides (SIIG) for terahertz applications

Mohammad Moradi, Mohammad S. Sharawi, Ke Wu
Polytechnique Montréal

This paper proposes and explores high-performance Substrate-Integrated Image Guide (SIIG) techniques for THz applications. Due to its low-loss transmission, planar geometry, and shared ground planes, the SIIG structure is an ideal candidate for THz integrated circuits and systems development. By conducting modal analysis and selecting proper parameters for geometrical design considerations, the SIIG can provide the best possible performances in the THz regime. An alumina substrate is utilized to fabricate two SIIG prototypes for WR-5.1 and WR-3.5 frequency bands. The experimental results indicate that one fabricated prototype exhibits a mean insertion loss of 0.578 dB/cm over a frequency range of 135 GHz – 225 GHz using a dual-line parameter extraction technique. The other fabricated prototype of SIIG presents an average insertion loss of 1.431 dB/cm in the frequency range of 215 GHz – 335 GHz. Those results demonstrate a promising potential of the SIIG techniques for THz applications. A detailed description of an SIIG structural analysis and also its design procedure are provided.
5 A wireless power transfer system suitable for ingestible bioelectronic capsules

Hassan Naseri
INRS-EMT

A wireless power transfer (WPT) system has been developed and verified for use in biomedical capsules that are ingested into the body. The system is made up of a full-duplex antenna, a half-wave rectifier, and a WPT transmitter (Tx). A two-port full-duplex antenna is used to enable seamless telemetry and also serves as a receiver for WPT Tx, eliminating the need for a multiplexer circuit. The proposed rectifier is able to convert radio frequency (RF) to direct current (dc) with an efficiency of 80% when supplied with 1 dBm input power. Additionally, a patterned patch antenna has been created to serve as the WPT Tx for the biomedical capsule. The performance of the antenna, rectifier, and WPT Tx are assessed individually before the entire WPT system is validated by placing the capsule (which has the integrated rectifier antenna) inside minced pork meat and powering it using the WPT Tx. The features of this WPT system, including its small size, high gains, high efficiency in converting RF to dc, ability to simultaneously power and transmit data wirelessly, and high-power transfer efficiency, make it well-suited for use in modern capsule devices.

6 Multi-way relaying systems based on network polar codes

Ruilin Ji, Harry Leib
McGill University

Relaying techniques are commonly used in cooperative communication to combat channel fading impairments in wireless systems. Network coding is often jointly implemented with cooperative communication which improves the system performance. Polar codes have drawn much research interest in recent years, because of their lower decoding complexity, and high performance. In this work, polar codes are employed in a multi-way selective detect-and-forward (DF) cooperative relaying system. We show that such system can be represented as a systematic linear block code. Monte-Carlo simulation results reveal that the error performance of such a system using polar codes is comparable to when using LDPC codes with log-BP decoding. In such a multi-way DF scheme a relay transmits only when it detects correctly the information from the user terminals. We consider a hard threshold technique at the terminals to detect when a relay transmits. This threshold technique can reduce significantly the performance loss due to intermittent relay transmissions.
7 Design and implementation of an IoT middleware for cities of the future

Sikandar Ejaz, Ramanunni Menon Parakkal, Ursula Eicker, Yann-Gael Guéheneuc

Concordia University

A city has many different energy, data, capital, and resources flowing through it daily. What distinguishes a conventional city from a sustainable next-generation city is the presence of frameworks within the city that enable it to monitor, manage and control the various flows in an optimal/cost-efficient manner. This is obviously not a trivial matter, as a city is a dynamic entity constantly changing and growing daily. This implies that any framework created must be well-thought-out, open-ended and extendable so that it can grow and change with the city itself. With the availability of hardware, software and computational power at reasonable prices (that are capable of monitoring and accumulating information within a city and managing them effectively), algorithms that make it possible to analyze the data, and a thermo-electrical network that is on the verge of being changed forever with the push for a vast and new array of distributed energy resources (DERs) and energy storage systems (ESS) (that would make efficient satisfaction of our energy demands possible), the need for a cross-disciplinary analysis, design and implementation (at least for a small sub-sector of the systems as proof of concept) of a holistic and scalable IoT (Internet-of-Things) framework has never been more prescient. This Ph.D. research work is devoted to designing and implementing an IoT framework for monitoring and controlling differing flows in an intelligent building and efficiently using them accordingly.

8 Reconfigurable microwave photonic filter with linear amplitude response based on quantum dash optical frequency comb source for instantaneous frequency measurement

Yuxuan Xie, Mostafa Khalil, Jiaren Liu, Zhenguo Lu, Philip J. Poole, John Weber, Lawrence R. Chen

McGill University

In this paper, we experimentally demonstrate an instantaneous frequency measurement system based on a microwave photonic (MWP) filter with linear amplitude responses using a quantum dash mode-locked laser as optical frequency comb source. By applying power shaping for the comb lines, two MWP filters have been implemented with both positive and negative slope in the frequency range of 2-20 GHz. These two MWP filters could work individually to do the frequency measurement with a root mean square error (RMSE) about 55 MHz. Moreover, the system is reconfigurable, which allows these two filters work together to achieve a RMSE 42.2 MHz.
9 RF Inter/Intra-chip communication in Silicon Photonics

Ajaypal Singh Dhillon, Frédérick Melanson, Odile Liboiron-Ladouceur
McGill University

There are more connected devices in the world today than there are humans. This ever-expanding universe of connected devices necessitates the development of communication systems at spectrum rich high frequencies with increased bandwidth, reduced size, weight, and power (SWaP) budget. Despite significant breakthroughs, the conventional electronic high frequency wireless systems have severe drawbacks such as bandwidth limitation, large propagation loss, high power consumption, limited tunability, weak electromagnetic interference (EMI) immunity and scaling issues. A promising way to alleviate these fundamental limitations is to a

Jiawei Qiu

integrated microwave photonics (IMWP), a discipline that combines RF engineering and optoelectronics. IMWP shifts the signal generation, processing, distribution, and antenna remoting tasks from radio domain to photonic domain, thereby accessing abundant bandwidth and ultra-low attenuation. A number of IMWP based systems have been demonstrated recently. Monolithic implementation of photonic front-end combining optical beamforming, photodetector, and antenna array is one of the ultimate challenges (not yet implemented) for photonic designers and motivation of this research. An antenna integrated into IMWP chip will reduce electrical power loss by averting the frequency dependent off-chip parasitic interconnects from photodetector to antenna and will eliminate the need for a matching network to transforms the system impedance to 50Ω.

10 AI for human motion

Antonios Valkanas, Boris Oreshkin, Félix Harvey, Louis-Simon Ménard, Florent Bocquelet, Mark Coates
McGill University

Understanding and predicting human motion has widespread applications in robotics, human-computer interaction and computer animation. To produce high quality human motion, e.g., in movies or video games, motion capture sessions require actors and equipment that can cost thousands of dollars per day. We propose a technique that is capable of automatically generating high fidelity human motion from a handful of user hand crafted frames based on modern machine learning advances and open source motion capture data. We make our trained model and source code openly available to the academic community and, in collaboration with Unity Technologies, implement our model in the Unity game engine, thus making our full model potentially available to all game developers worldwide for free.
11  Two-layer three-way Horst power divider and combiner based-on microstrip line with fixed impedance characteristic

Abdelkader Zerfaine
McGill University

A two-layer three-way power divider/combiner (PDC) based on a fixed impedance transmission line is presented. The design is optimized through even/odd modes analysis. To provide design guidelines, graphical representations with closed-form equations are also provided. The theoretical bandwidth is estimated according to a performance criterion that takes into account the balance between isolation and input matching. The two-layer configuration provides better isolation between opposite ports despite the compact size. To validate the simulations, the three-way PDC is fabricated and measured. The measured results demonstrate excellent matching, isolation, and transmission performance with an overall fractional bandwidth (FBW) of 20%, which is consistent with the calculated bandwidth.

12  Analysis of moving bodies with the FDTD method

Mohammad Marvasti, Halim Boutayeb
UQO

We propose an original and thorough analysis of the behavior of electromagnetic waves in the presence of moving bodies by using the Finite Difference Time Domain (FDTD) method. Movements are implemented by changing positions of the objects at each time step, through the classical FDTD time loop. This technique is suitable for non-relativistic speeds, thus for most encountered problems in antennas and propagation domain. The numerical aspects that need to be considered are studied. Then, different bodies in motion are examined: plane wave source with matching resistors, observation point, inclined Partially Reflecting Surface (PRS), line source, and metallic cylinder illuminated by a plane wave. The results are compared with those of special relativity which are considered as the references. Some aspects of special relativity are present in the direct FDTD approach, such as the independence of the velocity of electromagnetic wave propagation with the speed of the source and Lorentz local time (with a different physical interpretation). It is shown that the amplitude of the electric field for a moving matched plane wave source does not increase with the speed of motion. Moreover, for a moving scattering metallic wire, one can observe a phenomenon similar to shock waves.
13 Characteristic mode analysis of manufactured SCMR and CSCMR systems

Ferdaous Abderrazak, Larbi Talbi, Eva Antonino Daviu, Miguel Ferrando Bataller
UQO

A Conventional Strongly Coupled Magnetic Resonance (CSCMR) system provides higher Power transfer efficiency and less sensitivity to misalignment compared to a traditional Strongly Coupled Magnetic Resonance (SCMR) system. This presentation proposes, for the first time, a physical investigation of manufactured SCMR and CSCMR systems based on the Theory Characteristic Modes. For both systems, the high inductive nature of the coupling between the transmitting and the receiving units and the efficiency of the two configurations are drawn using the current distributions of the dominant mode, its intensity, and the high density of the magnetic flux lines in between. Notably, both systems are deployed in a wide range of industrial applications, such as: EV Charging, consumer electronics devices (smartphones, tablets, smartwatches, and wireless earbuds), biomedical devices, IoT devices and sensors, industrial automation and robotics for wireless charging of battery-powered equipment, wearable technology, and energy harvesting. For more details:

14 Space-time coded differential modulation for reconfigurable intelligent surfaces

Jiawei Qiu, Harry Leib
McGill University

Reconfigurable intelligent surface (RIS) technology is an enabler for creating favorable wireless communication environments. Many works considered modulation formats for RIS, however, all proposed schemes need channel state information (CSI) for detection. Similarly, most of the work on space–time coding also assumed that perfect channel estimates are available. To bypass the need for CSI, differential space-time modulation (DSTM) has been introduced. Our work considers a differential reflecting modulation (DRM) technique for RIS that enables differential detection bypassing the resource-consuming channel estimation. Furthermore, we integrate differential space-time codes in DRM allowing demodulation without channel estimates. Based on simulation results, we find that the proposed DRM pays an acceptable SNR penalty compared to non-differential modulation with coherent detection, for not requesting CSI. We also show the superiority of the DSTM integrated with DRM over the original DRM scheme in particular cases.
Using rate splitting to combat the effect of imperfect CSIT in multibeam multicast NOMA satellite communication systems
Sareh Majidi, M. Reza Soleymani, Yousef Shayan
Concordia University
In this paper we consider the application of rate splitting in multibeam multicast satellite systems using non-orthogonal multiple access schemes to combat the effect of imperfect channel state information at transmitter (CSIT). Rate splitting (RS) is applied to cancel the inter-beam interference under imperfect CSIT and NOMA scheme is used in each beam to improve spectrum efficiency. The combination of these two techniques gives more flexibility to improve max-min fairness (MMF) rate and sum-rate. Additionally, we derive the power allocation optimization problems to maximize the minimum rate and sum-rate of the proposed scheme. In this paper, the Rate-WMMSE relationship and AO algorithm are used to transfer the nonconvex optimization problems into a convex problem. The numerical results show that the proposed scheme outperforms the state-of-the-art systems.

Ultra-compact 60 GHz Near-field Focusing configuration using SIW slot array loaded by transmission coding metasurface lens
Rasoul Ebrahimzadeh, Bijan Zakeri, Amirashkan Darvish, Seyed Ehsan Hosseininejad
UQO
This work proposes an ultra-compact Near-field Focusing (NFF) setup at 60 GHz. The proposed configuration is included a planar substrate integrated waveguide (SIW) slot array as a feeder for a three-layer transmissive coded metasurface lens. A comprehensive design methodology is presented, encompassing unit cell design, coded metasurface lens synthesis, and planar slot array design. The metasurface transmission performance is studied and validated by numerical and analytical approaches. Then, the planar slot array design considerations are elaborated, investigating the amplitude and phase of the resulting waves to ensure that quasi plane waves are produced in the nearfield region (around 0.4λ). Finally, the slot array is used to illuminate the designed metasurface where the distance between the feeder and metasurface lens is 2 mm, which shows the integrability and being packed of the proposed setup, contrary to the conventional metasurface-based NFF structures. There are fair agreements between analytical, numerical, and measurement methods to verify the presented approach. It turns out that the proposed device can focus waves close to the diffraction limit, which results in a high-resolution efficiency.
17 Diffusing Gaussian mixtures for generating categorical data
Florence Regol, Anja Kroon, Mark Coates
McGill University

Learning a categorical distribution comes with its own set of challenges. A successful approach taken by state-of-the-art works is to cast the problem in a continuous domain to take advantage of the impressive performance of the generative models for continuous data. Amongst them are the recently emerging diffusion probabilistic models, which have the observed advantage of generating high-quality samples. Recent advances for categorical generative models have focused on log likelihood improvements. In this work, we propose a generative model for categorical data based on diffusion models with a focus on high-quality sample generation, and propose sampled-based evaluation methods. The efficacy of our method stems from performing diffusion in the continuous domain while having its parameterization informed by the structure of the categorical nature of the target distribution. Our method of evaluation highlights the capabilities and limitations of different generative models for generating categorical data, and includes experiments on synthetic and real-world protein datasets.

18 High-density high efficient single-stage bidirectional PFC converter based on board EV charger
Nil Patel, Luiz A C Lopes
Concordia University

This article proposes a novel zero-current assisted soft-switching bidirectional single-stage single phase isolated power factor correction (PFC) based converter for the plug-in EV charger. A new EV charger includes a current-fed full-bridge converter on the grid side that is affiliated with a full-bridge converter at the dc-side coupled via a high-frequency transformer (HFT). AC-side current can be controlled to obtain power factor correction with high THD suppression. The AC-side switches are naturally commutated and attained zero current switching (ZCS) without any external passive components. Additionally, zero current turn is accomplished for DC-side switches, making the converter assured for the EV charger with great merits. Furthermore, the converter adopts a modified control strategy and novel modulation method for promising soft-switching operation and bidirectional power flow. To ensure that the proposed EV charger is feasible, simulation results using PSIM 11.04 software and experimental results of the 1.5 kW have been formulated, showing that the high performance of PFC operation and analysis are perfectly matched.
19  Channel estimation for reconfigurable intelligent surface-assisted full-duplex MIMO with hardware impairments

Alexander Fernandes
McGill University

We consider the problem of channel estimation in a multiple-input-multiple-output (MIMO) full-duplex (FD) wireless communication system assisted by a reconfigurable intelligent surface (RIS) with hardware impairments (HI) occurring at the transceivers and RIS elements. We propose an unbiased channel estimator that requires knowledge of only the first and second order statistics of the HI, for which we derive closed form expressions. The proposed estimator reduces to the maximum likelihood estimator (MLE) in the case of ideal hardware. We also describe FD and HD orthogonal pilot schemes that minimize the mean square error of the MLE in the case of ideal hardware. We verify the performance of the estimator under varying conditions of transceiver and RIS HI via numerical simulations.

20  Dual band cell of EBG structure for printed gap technology along with two 90 degree bends line

Mehek Moutushy, Rahman Mou
Concordia University

Electromagnetic Bandgap (EBG) surfaces are high impedance surfaces, which forbid propagating waves in all directions within a frequency range due to its isotropic characteristics. The most common EBG realizations used in gap waveguides are a textured surface, which are made of periodic metal pins or mushroom-type textures. A dual electromagnetic gap (EBG) is realized by a unit cell of three substrates sandwiched between two metal plates. The unit cell consists of two stacked dielectric substrates topped by an aired substrate below the top metallic plate. The unit cell consists of a large mushroom patch on the bottom grounded substrate etched on its top and connected to the lower metal plane by a conducting via. The intermediate substrate has four smaller mushroom patches of total size smaller or equal to the bottom patch, and each is connected to the lower patch by conducting vias. The total size of the one-unit cell is 1.8mm. The unit cell is designed to achieve two stop band gaps; one is for the lower band for 13-24 GHz and another for the upper band 34-44 GHz. Inserting a so-called printed ridge perturbing the periodicity creates propagating modes within the EBG bands, guiding the electromagnetic waves between the upper conductor and the ridge and suppressing them elsewhere. The simulated results are presented. With the same unit cell, a line with two 90-degree bends is designed covering almost same dual frequency bands. They could have the potential to be used for various dual-band applications such as dual band millimeter applications as well as filter design.
6G mobile services for smart cities

Aboubacar Salou Moussa
Université Laval

The development of mobile communications has evolved through different generations, with 5G currently being deployed. In the future, 6G mobile networks are expected to emerge around 2030, offering significant advances in areas such as medical technology, driverless cars, smart cities, industry 4.0 and entertainment. These new services will place greater demands on smart cities, which use information and communication technologies (ICT) to improve operational efficiency, the sharing of public information, the quality of government services and the well-being of citizens. As a benefit, we examine the potential challenges and considerations associated with deploying 6G mobile services in smart cities, such as infrastructure requirements, spectrum availability, security, and privacy concerns. An overview of the transformative potential of 6G mobile services to shape the future of smart cities, highlighting the need for interdisciplinary collaboration and strategic planning to take full advantage of this technology. Index terms- 6G, smart cities, future services.

Net 400-Gbps/λ IMDD transmission using a single-DAC DSP-free transmitter and a thin-film lithium niobate MZM

Essam Berikaa, Md Samiul Alam, David V. Plant
McGill University

The insatiable growth of datacenter traffic mandates increasing the capacity of cost-effective intensity modulation direct detection (IMDD) systems to meet the foreseen demand. This Letter demonstrates the first, to the best of our knowledge, single-digital-to-analog converter (DAC) IMDD system achieving a net 400-Gbps transmission using a thin-film lithium niobate (TFLN) Mach–Zehnder modulator (MZM). Employing a driver-less DAC channel (128 GSa/s, 800 mVpp) with neither pulse-shaping nor pre-emphasis filtering, we transmit (1) 128-Gbaud PAM16 below the 25% overhead soft-decision forward error correction (SD-FEC) bit error rate (BER) threshold and (2) 128-Gbaud probabilistically shaped (PS)-PAM16 under the 20% overhead SD-FEC threshold, which respectively correspond to record net rates of 410 and 400 Gbps for single-DAC operation. Our results highlight the promise of operating 400-Gbps IMDD links with reduced digital signal processing (DSP) complexity and driving swing requirements.
23  6G Wireless Networks for high-accuracy positioning  
*Caleb Ludinga Lodi, Ronald Beaubrun*  
*Université Laval*

The demand for high-speed wireless communication has grown rapidly over the past few years. This trend will continue in the future and it is expected that the fifth generation (5G) communication system, will not be able to meet future demands by 2030. Therefore, the upcoming sixth generation (6G) communication systems will overcome the limitations of 5G by enhancing network capacity. This will allow 6G systems to support innovative services like immersive telepresence, holographic teleportation, connected robotics, and extended reality (XR). These services demand flexible wireless features, including communication and extremely precise location capabilities. To meet these requirements, the integration of Terahertz (THz) bands into communication systems is necessary. Unlike previous mobile communication systems, 6G will focus on making localization an integral part of the system. Location in 6G is essential, not only for location-based communications, but also for enhancing the performance of wireless communications in various ways, including channel estimation, beam alignment, medium access control, routing, and network optimization. Therefore, achieving high-precision location is critical to unlock the full potential of 6G wireless networks. In light of this, we propose a method for 6G localization that shows that THz-based location provides more accuracy than mmWave-based location. In other words, the same level of location performance can be achieved in the THz band with less transmit power or smaller carbon footprint. Key Words: 6G wireless Networks, High-accuracy positioning, THz Band.

24  Round preserving asymptotic compression of prior-free interactive communication protocols  
*Claude Crépeau, Gurleen Padda, Dave Touchette*  
*Université de Sherbrooke*

We demonstrate that the amortized communication complexity of simulating a prior-free interactive communication protocol with round preservation is equal to its information cost by developing a prior-free reverse Shannon theorem with side information at the receiver. We first show that the communicating parties can produce a reliable estimate of the joint type or empirical distribution of their inputs with high probability using a sub-linear amount of noiseless communication. This estimate is then used in our protocols for prior-free Slepian-Wolf coding and the prior-free reverse Shannon theorem. These results are then generalized to the interactive setting to obtain our main result.
25 Enhanced multi-scale feature extraction model boosted by a soft margin SoftMax Loss and accelerated first-orders optimizer for facial expression

Armin Nabaei, M. Omair Ahmad, M.N.S. Swamy
Concordia University

This poster proposes an efficient emotion detection algorithm using face images when only small data sets are available for training. Based on this knowledge that all elements are irrelevant to the image classification task, The main objective for this model is selecting a subset of salutary feature vector elements. This poster's proposed deep neural network consists of a seminal branch boosted with an auxiliary classifier. The second part of this paper focuses on the development of canonical SoftMax Loss, which suffers from reaching gold labels promptly and readily, leading the training process toward over-fitting since a lack of ability to determine adequate variant patterns for some class labels. This modified Loss performs a functional controller task with rigorous criteria on penalizing negative examples and forcing the model to push dissimilar embedding vectors apart, conversely compacting similar labels (enhancing inter-class discrepancy and intra-class density. The fundamental theory of proposing the modified optimizer is combating vanishing gradient with increasing back propagation gradient flow and assuming a non-convex problem. This paper’s framework is experimented with widely used facial image databases (FER-2013, RAF-DB, CK+), and demonstrates its superiority by acquiring top accuracy (two top-1 and one top-2 results), respectively 93.30% on FER-2013, 90.73% on RAF-DB, and 100% for CK+.

26 Axial element rotation technique for synthesizing cosecant squared pattern using linear array of microstrip antennas

Abdullah M. M. Abdelrahman, Ahmed A Kishk
Concordia University

Cosecant squared pattern is utilized for ground-based air-surveillance system to uniformly cover an area of interest. In this work, we present a realization of such pattern type using linear array of microstrip antennas (MSAs). The patches are uniformly fed, whereas their feeding phases and axial rotation angles are optimized using built-in MATLAB particle swarm optimization (PSO) function. The maximum side lobe level (SLL) is below –19 dB, whereas the field of view (FOV) angle is 45o. The coincidence between our synthesized beam and the required mask within the (FOV) zone is measured by the root mean square (RMS) error, which does not exceed 0.0142 dB. The proposed array uses simple MSA, which can be mounted on moving aerospace surfaces. Moreover, gain function in the FOV can be increased by constructing surface array from our linear array.
27 Score-based generative modeling for MIMO detection without knowledge of noise statistics
Toluwaleke Olutayo, Benoit Champagne
McGill University
Motivated by recent advances in deep generative probabilistic modelling, we propose a robust multiple-input multiple-output (MIMO) symbol detector that aims to perform maximum likelihood (ML) detection without knowledge of the noise statistics. While the optimal MIMO detector (under uniform priors) is the ML detector, its implementation requires knowledge of the noise distribution. Furthermore, for some types of additive noise such as impulsive noise, the probability density function (PDF) of the noise does not admit a closed form expression thus making ML detection intractable. To overcome these limitations, our proposed approach learns a score function of the noise distribution directly from data. Subsequently, the learned score function is used to transform the noise distribution to a known (and tractable) prior distribution through the use of a stochastic differential equation. Via numerical simulations, the proposed detector is shown to outperform recent benchmark approaches for various types of additive noise, and to achieve near optimal ML performance where applicable.

28 Computer aided-transmissive metamaterial-based lens with multiple beam steering functionalities for 5G and beyond
Noureddine Melouki, Tayeb A. Denidni
INRS-EMT
In this poster, a metamaterial-based transmitting planar/conformal meta-lens is proposed as a reconfigurable phase controlled system for electromagnetic beam manipulation. The full structure is composed of N x M independently tunable metaatoms, using a 1-bit current reversal-based technique, providing two phase states, namely the 0 and 180 degrees, by switching two pin diodes ON/OFF states. CST Microwave Studio is used for both the unit cell and full structure analysis, where a standard horn antenna is used to illuminate the meta-lens. The far-field beam-steering mechanism of the proposed antenna is achieved by calculating the required phase compensations for each meta-atom, to redirect the beam to a predefined angle. Simulation results show multiple unique beam manipulating techniques, such as a single high-beam, a dual-beam steering, in addition to simultaneous Orbital Angular Momentum (OAM) generation, and beam steering functionalities, at different angles, and this capability can be further extended to enable wider 3D spherical beam scanning, with different beam deflection schemes, making the proposed meta-lens a potential low-cost candidate for high-gain beam steering mm-wave wireless communication systems.
29 Reconfigurable half mode substrate integrated waveguide phase shifter

Franky Dakam Wappi, Bilel Mnasri, Halim Boutayeb, Larbi Talbi
UQO

A phase shifter is an important piece of equipment in telecommunication systems such as microwave radars and antenna arrays. There are several phase shifters according to the scientific literature. In this paper, we propose the design steps of a new single-layer, semi-mode substrate integrated waveguide (HMSIW) phase shifter that integrates three microstrip lines connected to three PIN diodes that are connected at each end to a radial stub. This circuit generates a controllable phase shift between the two HMSIW ports.

30 A case study on the use of lava neuromorphic framework for radio resource allocation

Ajay Kumar LakshmiPura Vijaykumar
Concordia University

Lava is an open-source software framework for developing neuro-inspired applications and mapping them to neuromorphic hardware. Lava is the only existing neuromorphic framework that comes with specifically designed optimization solvers. This paper presents a case study on the use of Lava neuromorphic framework for radio resource allocation in wireless networks. First, the problem is formulated as an integer linear program (ILP). Then, it is reduced to a quadratic unconstrained binary optimization (QUBO), a format that can be solved using Lava. To evaluate the performance of the proposed Lava-based approach, we compare our results to the ones obtained with classical CPU-based solvers. Finally, we highlight the advantages of using the Lava framework to solve practical optimization problems, as well as the challenges that still remain to be solved.

31 A 5G-enabled innovative smart footwear for health monitoring

Peyman PourMohammdi, Tayeb A. Denidni
INRS-EMT

A Smart Footwear for Health Monitoring is shown in the poster. To this purpose, a highly efficient single-layer mmwave antenna array has been designed and integrated to the interface circuit.
Overcoming energy challenges in lunar permanently shadowed regions: Laser power beaming

Mohamed Naqbi, Irfan Azam, Gunes Karabulut Kurt
Polytechnique Montréal

The Moon offers enormous potential for space exploration, particularly its permanently shadowed regions (PSRs). Scientists harbor a keen interest in these zones as they could contain water ice, a resource convertible into fuel, directly consumable by humans, or usable as a base material for the production of breathable oxygen. However, these shadow zones pose energy challenges. The temperatures in these zones are extremely low (−200°C), as they are never exposed to solar radiation. The Artemis mission program highlights the importance of these challenges. Soon, exploration of these regions will be undertaken by rovers, while the establishment of lunar facilities is a goal set for the more distant future.

Laser power beaming could be an excellent and innovative solution for powering rovers within these PSRs, given that batteries don’t survive well at temperatures as low as −200°C. Other applications could be envisioned, such as producing solar energy from locations on the Moon's south pole that are always exposed to sunlight and transferring this power to the areas that are perpetually shadowed. There are numerous challenges to surmount for these power transfer systems to become economically viable. They must be more efficient than traditional cables and able to deliver the proper amount of power to various receivers, such as the rovers. The whole system, including the solar collector, batteries, fiber laser source, optical elements, thermal management system, laser power converter, and power electronics, should take the environmental factor into account during its design. With continual advances in photonics and power electronics, the system could become fully operational in the coming years, as demonstrated by the experiments of American startup Powerlight.

Nowadays, the challenges associated with this transmission primarily concern thermal aspects, such as the survival and operation of devices at extreme temperatures and the dissipation of generated heat (by the laser). Moreover, it is crucial to ensure a fair and efficient distribution of the generated power to guarantee the continuous operation of the energy receivers. Research in this area could lead to significant advancements for future space missions.
The electromagnetic (EM) devices usually perform a single function. Combining several aims into one structure is an interesting research topic. Users today seek to interact with more user-friendly devices that are miniaturized and can perform multiple functions simultaneously. In order to develop novel EM structures, a multifunctional perspective is necessary. In this case, transparent metallic materials or lower amounts of commercial metal are used to design antennae and phase-transforming media. An example of a transparent conductor is indium tin oxide (ITO). The novel designs can also harvest sunlight using solar panels. DC power harvesting should not affect the EM characteristics of the antenna or the propagation characteristics. Solar cell integration and transparent phase engineering comprise the concept of multifunctional antenna. ITO-coated, cube satellite antennas are proposed at a frequency of 10 GHz. All six surfaces of the cubic antenna could be powered by its integrated solar panels. Further, a drone-to-satellite communication link is proposed in order to cover multiple pattern directions passively and improve drone durability. The proposed drone antenna would both direct the satellite uplink and harvest the sunlight. Having four beam directions implies an array of drones in a vast surveillance system of the natural Earth objectives. A new transparent phase engineering method is suggested for further analyzing the multifunction antenna mechanism. In the new surface formation, a plane wave will become a vortex wave. Based on a conical beam pattern and spiral phase plane, vortex waves are constructed. The structure is based on the previous drone to satellite device operating at 3 GHz. A recently proposed method for increasing the capacity of radio waves and increasing their diversity is to use vorticities that have infinite number of orthogonal modes. Numerical simulations demonstrate how a transparent phase transforming metasurface can be applied to generate a pure mode of +2, which could be useful as a multifunctional device with solar panels. Moreover, It is possible to prepare a 0 mode solely with the antenna. Antennas should be aligned with a direct position when receiving vortex mode or when identifying the modes. The multifunction vortex mode generation is undergoing consideration for practical perspectives, fabrication issues, and instrumentation.
Creating human and computer-readable representations of built environments and their systems is necessary for efficiently managing buildings. The efficient management of buildings, and by extension, building representations and models help reduce energy consumption, increase occupant comfort, and, consequently, reduce costs and increase productivity. Most commercial buildings come with a Building Energy Management System (BEMS) with readable representations of some aspects of the building and its systems. The primary function of a BEMS is control of the heating, ventilation, air-conditioning, and lighting. The representations in a BEMS do not wholly model a building, are vendor-specific, and consequently inhibit interoperability. There are several approaches to modeling built environments and providing readable representations of buildings. However, these approaches, have some challenges and limitations that we identify and overcome by introducing an object-oriented metamodel validated with BEMS data from three buildings focused on the mechanical, electrical, and plumbing entities of a building.
STARaCom est un *Regroupement stratégique* financé par le Fonds de recherché du Québec – Nature et technologies (FRQNT)

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Antonios Valkanas (McGill University)
« IA pour le mouvement humain »
“AI for human motion”
Superviseur/Supervisor: Mark Coates

Noureddine Melouki (INRS-EMT)
« Lentille à base de métamatériaux à transmission assistée par ordinateur avec plusieurs fonctionnalités de direction de faisceaux pour la 5G et au-delà »
“Computer aided-transmissive metamaterial-based lens with multiple beam steering functionalities for 5G and beyond”
Superviseur/Supervisor: Tayeb A. Denidni
Prix de 750 $ prize:

Peyman PourMohammadi (INRS-EMT)
« Une chaussure intelligente innovante compatible 5G pour le suivi de la santé »
“A 5G-enabled innovative smart footwear for health monitoring”
Superviseur/Supervisor: Tayeb A. Denidni

Prix de 500 $ prize:

Ferdaous Abderrazak (UQO)
« Analyse des modes caractéristiques des systèmes SCMR et CSCMR fabriqués »
“Characteristic mode analysis of manufactured SCMR and CSCMR systems”
Superviseur/Supervisor: Larbi Talbi
Statistiques de l’évènement
Event Statistics

Nombre total d’affiches d’étudiants(es) en compétition : 34
Nombre total de participants : 115
• Nombre d’étudiants diplômés : ~65
• Nombre de représentants de l’industrie

Nombre de photos prises par un photographe professionnel; 68

Total posters in competition: 34
Total attendees: 115
• Graduate student attendees: ~65
• Industry representatives: ~25

Number of headshots taken by professional photographer onsite: 68

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Nombre de photos prises par un photographe professionnel; 68
Photos by Owen Egan and Joni Dufour
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Co-Supervisor / Co-Superviseur(e) : Gunes Karabulut-Kurt (Polytechnique Montréal)
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