Program

New York time	Sunday, September 12	Monday, September 13	Tuesday, September 14	Wednesday, September 15	Thursday, September 16	Friday, September 17
9:00 - 9:15		OC: *Opening Ceremony*				K6: *Keynote Speaker - IoT Connect*
9:15 - 10:00		AG: *IEEE Canada Awards Gala*	K2: *Keynote Speaker*	K3: *Keynote Speaker*	K5: *Keynote Speaker*	
10:00 - 10:10			B4: *Break*	B6: *Break*	B8: *Break*	
10:10 - 10:15						
10:15 - 10:30		K1: *Keynote Speaker*				IS: *IoT Connect Invited Speakers*
10:30 - 11:15	T1: *Tutorial 1 - Edge-based distributed inference for efficient IoT Applications*	B2: *Break*	P2: *Panel 2 - NSERC Research Grants and Alliance Opportunities*	P4: *Panel 4 - Power System Transformation World-wide*	P6: *Panel 6 - IEEE Standards*	
11:15 - 11:30	T2: *Tutorial 2 - IoT Workshop: Part 1*	Tech1: *Technical Sessions*	Tech4: *Technical Sessions*		Tech10: *Technical Sessions*	
11:30 - 12:00		Tech1.1: *Technical Session 1.1 (parallel with Session 1)*				B10: *Break*
12:00 - 12:30						
12:30 - 13:00		LT1: *McNaughton Winner Talk*	LT2: *IEEE Canada Award Winners Addresses*	K4: *Keynote Speaker*	LT3: *IEEE Canada President Elect Candidates Forum*	IS1: *IoT Connect Invited Speaker*
13:00 - 13:30	B1: *Break*					
13:30 - 14:00	T3: *Tutorial 3 - Collaborative Intelligence for the Internet of*	Tech2: *Technical Sessions*	Tech5: *Technical Sessions* Tech5.1: *Technical Session*	Tech7: *Technical Sessions* Tech8:	Tech11: *Technical Sessions*	

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14:00 - 15:00			*5.1 (parallel with Tech 5)*	*Technical Sessions*		
15:00 - 15:30			B3: *Break*	B5: *Break*	B7: *Break*	B9: *Break*	Tech13: *Technical Sessions*
15:30 - 16:00	*Things* T4: *Tutorial 4 - IoT Workshop: Part 2*	P1: *Panel 1 - Evolving Dynamics of Industry-Academia Collaboration* Tech3: *Technical Sessions*	P3: *Panel 3 - Where Next? Innovation and Partnerships in Emerging Technologies* Tech6: *Technical Sessions*	P5: *Panel 5 - Net Zero Emissions and the Technology Required* Tech9: *Technical Sessions*	P7: *Panel 7 - Women in Engineering* Tech12: *Technical Sessions*	CC: *Closing Ceremony*
16:00 - 16:30		Tech3.1: *Technical Session 3.1 (running parallel with Sesssion 3)*				

Sunday, September 12

Sunday, September 12 10:00 - 13:00

T1: Tutorial 1 - Edge-based distributed inference for efficient IoT Applications

Amr Mohamed, Aiman Erbad, and Mohsen Guizani
Room: Virtual
Chair: Mohsen Guizani (Qatar University, Qatar)

Abstract: Traditional cloud-based IoT architectures suffer from many issues, including scalability, communication and computational efficiency, in addition to privacy. This motivated the need for new emerging trends such as Edge, Fog, and Pervasive Computing, where we merge hierarchical computing with efficient communication, leveraging learning-based distributed optimization, in order to resolve many of the issues highlighted above. In this tutorial, we will highlight the motivation behind distributed AI models for Internet of Things (IoT) applications, and cyber-physical systems (CPS), in light of traditional cloud-based architectures. We will discuss state-of-the-art contributions we have recently published regarding distributed inference/classifications in IoT, and multi-drone systems, taking into consideration privacy and mobility of network users. We will motivate the need for segment-based vs layer-based inference for achieving different objectives as part of distributed inference over resource-constrained IoT devices.

Biographies: Amr Mohamed (S' 00, M' 06, SM' 14) received his M.S. and Ph.D. in electrical and computer engineering from the University of British Columbia, Vancouver, Canada, in 2001, and 2006 respectively. He has worked as an advisory IT specialist in IBM Innovation Centre in Vancouver from

1998 to 2007, taking a leadership role in systems development for vertical industries. He is currently a professor in the college of engineering at Qatar University. He has over 25 years of experience in wireless networking research and industrial systems development. He holds 3 awards from IBM Canada for his achievements and leadership, and 4 best paper awards from IEEE conferences. His research interests include wireless networking, and edge computing for IoT applications. Dr. Amr Mohamed has authored or co-authored over 200 refereed journal and conference papers, textbooks, and book chapters in reputable international journals, and conferences. He is serving as a technical editor for international journals and has served as a technical program committee (TPC) co-chair for many IEEE conferences and workshops.

Aiman Erbad is an associate Professor at the 2Division of Information and Computing Technology, College of Science and Engineering, Hamad Bin Khalifa University, Qatar. Dr. Erbad obtained a PhD in Computer Science from the University of British Columbia (Canada), and a Master of Computer Science in Embedded Systems and Robotics from the University of Essex (UK). Dr. Erbad received the Platinum award from H.H. The Emir Sheikh Tamim bin Hamad Al Thani at the Education Excellence Day 2013 (PhD category). Dr. Erbad research interests span cloud computing, multimedia systems and networking, and his research is published in reputed international conferences and journals.

Mohsen Guizani (S'85-M'89-SM'99-F'09) received the B.S. (with distinction) and M.S. degrees in electrical engineering, the M.S. and Ph.D. degrees in computer engineering from Syracuse University, Syracuse, NY, USA, in 1984, 1986, 1987, and 1990, respectively. He is currently a Professor at the Computer Science and Engineering Department in Qatar University, Qatar. Previously, he served in different academic and administrative positions at the University of Idaho, Western Michigan University, University of West Florida, University of Missouri-Kansas City, University of Colorado-Boulder, and Syracuse University. His research interests include wireless communications and mobile computing, computer networks, mobile cloud computing, security, and smart grid. He is currently the Editor-in-Chief of the IEEE Network Magazine, serves on the editorial boards of several international technical journals and the Founder and Editor-in-Chief of Wireless Communications and Mobile Computing journal (Wiley). He is the author of nine books and more than 500 publications in refereed journals and conferences. He guest edited a number of special issues in IEEE journals and magazines. He also served as a member, Chair, and General Chair of a number of international conferences. Throughout his career, he received three teaching awards and four research awards. He also received the 2017 IEEE Communications Society WTC Recognition Award as well as the 2018 AdHoc Technical Committee Recognition Award for his contribution to outstanding research in wireless communications and Ad-Hoc Sensor networks. He was the Chair of the IEEE Communications Society Wireless Technical Committee and the Chair of the TAOS Technical Committee. He served as the IEEE Computer Society Distinguished Speaker and is currently the IEEE ComSoc Distinguished Lecturer. He is a Fellow of IEEE and a Senior Member of ACM.

T2: Tutorial 2 - IoT Workshop: Part 1

Reza Vahidnia, BCIT
Room: Virtual 1
Chair: Reza Vahidnia (British Columbia Institute of Technology, Canada)

1. Introduction to IoT o Genesis of IoT o IoT vs. M2M o IoT value chain o IoT clusters and use cases o IoT challenges
2. IoT Network Architecture and Design o IT vs. IoT network architect o IoT network challenges and architectural drivers o IoT standardized architectures - IoTWF o Simplified IoT

Architecture o IoT Data Management and Compute Stack
3. Connecting Smart Objects o Smart object - characteristics o IoT Communication criteria o IoT Access Technologies o IEEE 802.15.4: Zigbee, 6LowPAN, Thread o IEEE 1901.2a: NB-PLC o IEEE 802.11: WiFi o Bluetooth

Reza Vahidnia: Faculty BCIT and IoT Specialist Reza is a faculty at British Columbia Institute of Technology. He was a Project manager of a consortium including TELUS, Microsoft, Canfor, UBC and Vigil Technologies established to develop an Industrial IoT Device Ecosystem. Product development prime responsible to define the scope of smart city initiative and analyze the technical and business requirements and manage the product life cycle through stage-gate processes.

Jonathan Bassan: Director Internet of Things - BCIT Research Lab The "Internet of Things", or IoT, refers to the billions of physical devices around the world that are now connected to the Internet, all collecting and sharing data. Connecting all these different objects and adding sensors to them adds a level of digital intelligence to devices, enabling them to communicate real- time data without involving a human being. The IoT is making the fabric of the world around us smarter and more responsive, bridging the digital and physical universes.

BCIT is providing IoT courses and provides opportunities for industry to test out their IoT solutions

Sunday, September 12 13:00 - 13:30

B1: Break

Sunday, September 12 13:30 - 16:30

T3: Tutorial 3 - Collaborative Intelligence for the Internet of Things

Ivan Bajic, Simon Fraser University
Room: Virtual
Chair: Ivan V. Bajic (Simon Fraser University, Canada)

This tutorial is about edge-cloud Collaborative Intelligence (CI), a framework in which AI models are distributed between the edge devices and the cloud. Typically, the front-end of an AI model is deployed on an edge device, where it performs initial processing and feature computation. These intermediate features are then sent to the cloud, where the back-end of the AI model completes the inference. CI has been shown to have the potential for energy and latency savings compared to the more typical cloud-based or fully edge-based AI model deployment, but it also introduces new challenges, which require new science and engineering principles to be developed in order to achieve optimal designs. In CI, a capacity-limited channel is inserted in the information pathway of an AI model. This necessitates compression of features computed at the edge sub-model, which in turn requires a solid understanding of the structure of the model's latent space. Errors introduced into features due to channel imperfections would need to be handled at the cloud side in order to perform successful inference. Moreover, issues related to the privacy of transmitted data need to be addressed. This tutorial will introduce the background material needed to tackle some of these challenges, and will discuss some of the recent progress made on scalable latent space design, feature compression, error resilience, and privacy in the context of CI.

Ivan Bajic is a Professor of Engineering Science at Simon Fraser University. His professional interests revolve around signal processing, machine learning, and their applications in image and video processing, coding, communications, and collaborative intelligence. He is currently serving as the Vice Chair of the IEEE Multimedia Signal Processing Technical Committee and as Senior Area Editor of IEEE Signal Processing Letters. He has previously served on editorial boards of several journals, including IEEE Signal Processing Magazine, IEEE Transactions on Multimedia, and Signal Processing: Image Communication.

He was born in Belgrade, Serbia, in 1976 and received his B.Sc.Eng. degree (summa cum laude) in Electronic Engineering from the University of Natal, South Africa, in 1998, and M.S. degree in Electrical Engineering, and in Mathematics, and Ph.D. degree in Electrical Engineering from Rensselaer Polytechnic Institute, Troy, NY, USA, in 2000, 2002, and 2003, respectively.

Besides professional life, he is also a wine enthusiast. He has been fortunate enough to visit some of the top wine producing regions in the world in the last number of years, including the Napa and Sonoma valleys in California, Cape Town/Stellenbosch region in South Africa, La Rioja in Spain, Douro valley in Portugal, Chianti in Italy and, closer to home, Okanagan and Cowichan valleys in British Columbia, as well as the Olympic Peninsula wineries in Washington State.

Collaborative Intelligence for the Internet of Things

Ivan V. Bajic (Simon Fraser University, Canada)

Our world is at the beginning of the technological revolution that promises to transform the way we work, travel, learn, and live, through Artificial Intelligence (AI). While AI models have been making tremendous progress in research labs and overtaking scientific literature in many fields, efforts are now being made to take these models out of the lab and create products around them, that could compete with established technologies in terms of cost, reliability, and user trust, as well as enable new, previously unimagined applications. Foremost among these efforts involves bringing AI "to the edge" by pairing it with the multitude of sensors that is about to cover our world as part of the Internet of Things (IoT) and 5th generation (5G) communication network initiatives. This tutorial is about edge-cloud Collaborative Intelligence (CI), a framework in which AI models are distributed between the edge devices and the cloud. In CI, typically, the front-end of an AI model is deployed on an edge device, where it performs initial processing and feature computation. These intermediate features are then sent to the cloud, where the back-end of the AI model completes the inference. CI has been shown to have the potential for energy and latency savings compared to the more typical cloud-based or fully edge-based AI model deployment, but it also introduces new challenges, which require new science and engineering principles to be developed in order to achieve optimal designs. In CI, a capacity-limited channel is inserted in the information pathway of an AI model. This necessitates compression of features computed at the edge sub-model, which in turn requires a solid understanding of the structure of the model's latent space. Errors introduced into features due to channel imperfections would need to be handled at the cloud side in order to perform successful inference. Moreover, issues related to the privacy of transmitted data need to be addressed. The main topics to be covered in this tutorial include: • The case for edge-cloud distributed AI - Energy, latency, and performance considerations • Overview of applications - Video surveillance, autonomous driving, speech recognition, medical diagnostics • Information theory for collaborative intelligence - Entropy, mutual information, data processing inequality • Feature compressibility - Bounds on feature compressibility in non-generative deep models • Feature privacy - A "privacy fan" model for collaborative intelligence • Invariance to linear partial differential equations - Applications to latent-space inpainting and motion analysis • Feature scalability by structured latent space design - Building efficient multi-task models • Standardization

activities - JPEG-AI and MPEG-VCM

T4: Tutorial 4 - IoT Workshop: Part 2

Room: Virtual 1
Chair: Reza Vahidnia (British Columbia Institute of Technology, Canada)

4. LPWA and Cellular IoT o LPWAN Technology Attributes o Un-licensed LPWAN o LoRaWAN o Sigfox o Cellular LPWAN o NB-IoT o LTE-M
5. EC-GSM-IoT 5. o 5G as a catalyst for IoT innovation o The Path to future 5G IoT o Evolution of LTE-M towards 5G IoT requirements
6. IoT Application Protocols o HTTP o MQTT o CoAP
7. IoT Platforms o IoT Platform building blocks o IoT Platforms in Action o Different IoT Platform Types

Monday, September 13

Monday, September 13 9:00 - 9:15

OC: Opening Ceremony

Xianbin Wang, Jason Gu
Room: Virtual
Chair: Xianbin Wang (Western University, Canada)

Monday, September 13 9:15 - 10:10

AG: IEEE Canada Awards Gala

Celia Desmond
Room: Virtual
Chair: Celia L Desmond (World Class Telecommunications, Canada)

Monday, September 13 10:15 - 11:15

K1: Keynote Speaker

IEEE in an Internet Dominated World
Dr. Susan (Kathy) Land - IEEE President
Room: Virtual
Chairs: Ahmed Refaey (Manhattan College, USA & Western University, Canada), Xianbin Wang (Western University, Canada)

As we work together to support the mission and vision of the IEEE, we must remain steadfast in our support for the use of a standardized and peer-reviewed approach in support of scientific research. This will remain is a critical tool for successfully navigating our complex world. Without it, we would be forced to rely solely on intuition, other people's authority, and blind luck.

IEEE President Land will discuss cancel culture, social media, its possible impact on the science and technology community and the role IEEE and our members must play.

Bio: Susan K. (Kathy) Land is a Program Manager for the U.S. Department of Defense's Missile Defense Agency. She has more than 30 years of industry experience in the application of software engineering methodologies, the management of information systems, and leadership of software development teams.

Kathy served as the 2018 Vice President, IEEE Technical Activities. She also served two additional terms on the IEEE Board of Directors as Division VIII Director/Delegate in 2011 and 2012 and as Division V Director/Delegate in 2014 and 2015. She was President of the IEEE Computer Society in 2009. Kathy was a member of the IEEE-USA Board of Directors in 2013 and 2016.

Monday, September 13 11:15 - 11:30

B2: Break

Monday, September 13 11:30 - 12:30

Tech1: Technical Sessions

Chair: Fahmi Khalifa (Mansoura University, Egypt & University of Louisville, USA)

11:30 Angle of Arrival Estimation in Indoor Environment Using Machine Learning

Aysha Alteneiji (Khalifa University, United Arab Emirates); Ubaid Ahmad (EBTIC, Khalifa University, United Arab Emirates); Kin Fai Poon (Khalifa University, United Arab Emirates); Nazar Thamer Ali (Khaifa University, United Arab Emirates); Nawaf Almoosa (Khalifa University, United Arab Emirates)

Many localization techniques have been developed over the past decades. Angle of Arrival (AoA) is one of the most common techniques due to its high accuracy. In this paper, an AoA estimation framework for a multipath radio environment is proposed. A Convolutional Neural Network (CNN), which is a part of Deep Learning (DL), is employed to learn the mapping between the eigenvectors of the spatial covariance matrix of received array signals and angles of arrival. The CNN architecture is discussed with a detailed description of the hyper-parameters. The results present the AoA estimation with varied Signal-to-Noise Ratio (SNR), number of snapshots and path separation angle. Simulation results show that the proposed approach outperforms the traditional MUltiple SIgnal Classification (MUSIC) algorithm with less execution time especially in demanding scenarios of low SNR and limited snapshots. The proposed approach provides an improvement of at least 73% compared with MUSIC at a very low SNR.

pp. 1-6

11:45 Detection of COVID-19 Using Deep Convolutional Neural Network on Chest X-Ray (CXR) Images

Goon Sheng Tang (UCSI University, Malaysia); Li Sze Chow (UCSI University, Malaysia & University of Sheffield, United Kingdom (Great Britain)); Mahmud Iwan Solihin (UCSI University, Malaysia); Norlisah Ramli, Nadia Fareeda Gowdh and Kartini Rahmat (University of Malaya, Malaysia)

Our study aims to investigate the best performing Convolutional Neural Networks (CNN) suitable for COVID-19 detection on Chest X-Ray (CXR) images. We applied five state-of-art CNN models

in this study: DarkNet-19, ResNet-101, SqueezeNet, VGG-16, and VGG-19. These CNN models were pre-trained with natural images for classification. Therefore, we used transfer learning to modify the fully connected layer and output layer for a binary classification between COVID-19 and normal lungs. The models were trained using our combined dataset of CXR images obtained from the public domain, COVIDx, and private domain, University of Malaya (UM). The CXR images were pre-processed with reflection along the horizontal and vertical axis before being fed into the CNN models. Then another combined dataset from both COVIDx and UM was used to test the performance of the models. The numbers of correctly and wrongly predicted classes were tallied and represented with a confusion matrix. Then, the specificity, sensitivity, precision, F1-score, and accuracy were measured to evaluate the performance of each model. Our study demonstrated an accuracy above 90% for all five models. Gradient-weighted Class Activation Mapping (Grad-CAM) was used to visualize the significant activation regions that contributed to the model's decision. We have also applied the COVID-Net-CXR-Large model to our combined dataset for testing to evaluate its performance in multiclass classification. The current CNN models require further improvement and modification before they can be applied clinically as a secondary tool for the diagnosis of COVID-19 cases.
pp. 7-12

12:00 Classification of Partial Discharge Signals Using 1D Convolutional Neural Networks

Sara Mantach (University of Manitoba, Canada); Hamed Janani (Verint Systems, Canada); Ahmed Ashraf and Behzad Kordi (University of Manitoba, Canada)

For decades, partial discharge (PD) measurement has been used as a common tool for assessing the insulation condition of high voltage (HV) systems. Background noise and interference resulting from the measurement environment and other power electronic devices in the setup make PD diagnosis challenging and more difficult. Signal processing tools employed for PD classification usually require a significant effort and expertise to extract semi-automated features from the time domain PD signals. The performance of a PD detection system depends heavily on the quality of these features. With the emergence of new technologies, wherein the interference pulses become more similar to PD pulses, automatic feature extraction has become a necessary prerequisite to have a reliable PD detection system. Therefore, the implementation of techniques based on deep neural networks that enable automated feature extraction and classification is needed. In this paper, a one dimensional convolutional neural network has been designed that takes a set of time series waveforms as the input and is capable of classifying PD sources in the presence of additive Gaussian noise and discrete spectral interference.

Presenter bio: Sara Mantach is currently a PhD candidate in the Electrical and Computer Engineering department at University of Manitoba. Since January 2019, she has worked under the supervision of Professor Behzad Kordi in the McMath High Voltage Lab. She received her B.E. degree in Electrical and Computer Engineering in 2015 from the American University of Beirut in Lebanon, and then received her M.E.Sc degree in Electrical and Computer Engineering from Western University in 2018. Her master’s thesis was about simulating Corona Discharge and EHD Flows using simplified models Numerical Models. Her current research is focused on the development of machine learning algorithms; specifically deep learning algorithms; in order to classify and localize sources of partial discharges that take place in the insulation of high voltage systems.

pp. 13-17

12:15 Very Short-Term Wind Speed Prediction Techniques Using Machine Learning

Aman Samson Mogos, Md. Salauddin, Xiaodong Liang and Chi Yung Chung (University of Saskatchewan, Canada)

Wind speed prediction plays an essential role in planning and operation of wind power systems. An accurate wind speed prediction can reduce costs and enhance the proper use of resources. Wind speed series have high nonlinearity and volatility. In this paper, data-driven models using machine learning (ML) algorithms have been developed to predict a very short-term wind speed. Historical wind speeds lagging up to 20 minutes with 1 minute time interval are used to predict the current and future (up to 5 minutes with 1-minute interval) wind speed. A performance comparative analysis of four ML algorithms including Multiple- Layer Perception Regressor (MLPR), Random Forest Regressor (RFR), K-nearest Neighbors Regressor (KNNR), and Decision Tree Regressor (DTR), is conducted, and their accuracy is evaluated by their R2 values, mean absolute error (MAE), standard deviation (SD) of MAE, mean absolute percentage error (MAPE), SD of MAPE and root mean square error (RMSE). It is found that MLPR gives the best prediction accuracy of 95.3%.
pp. 18-23

Tech1.1: Technical Session 1.1 (parallel with Session 1)

Chair: Ahmed Soliman (University of Louisville, USA)

11:30 Design & Development of an AI-Powered Baby Monitoring System

Kajan Ravindran, Mohamed Ibrahim, Hyon Lee and Umar Qureshi (Ontario tech University, Canada); Khalid Abdel Hafeez (Ryerson University, Canada)

Being parents in a world with increasing responsibilities does not prove to be an easy task. Recent advancements make artificial intelligence and computer vision attractive platforms in the reimagining of parental-aid devices like baby monitors. Drawing on market research of existing devices and opinions of previous baby-monitor users, we employed IoT design principles to develop a cheap and convenient baby monitoring system that uses artificial intelligence to provide aid to parents. The system proved to be effective, as features such as cry and roll detection performed as expected. Further optimizations in the artificial intelligent models can be made to increase system efficiencies, allowing the system to be more performant on specialized hardware.
pp. 24-29

11:45 LAWA: Loss-Aware Workload Assignment in Data Centers

Zahra Esmaeilnezhad and Douglas Down (McMaster University, Canada)

Information technology (IT) equipment consumes a significant amount of power in data centers. As part of this consumption, there is significant wastage due to the power loss of servers. To date, workload assignment algorithms have not taken server power losses into account. In this paper, we find that focusing on server power losses in constructing a workload assignment algorithm may have a significant impact in reducing the power consumption of data centers. In particular, this savings may be significant as compared to the commonly employed approach of server consolidation.
pp. 30-35

12:00 Implementing Multistage Interconnection Networks on FPGA Using Chisel Language

Andy Gallay (Polytechnique Montreal, Canada); Tarek Ould-Bachir (Polytechnique Montréal, Canada)

This paper discusses the utilization of the highly parametrizable Chisel language for FPGA designs. More specifically, the paper discusses the implementation of multistage interconnection networks (MINs) on an FPGA using Chisel. The MIN considered in this paper uses the well-known butterfly topology and a latency-insensitive design approach. The paper compares Chisel's performance against handcrafted VHDL, and demonstrates that Chisel simulation capabilities allows one to explore and study the behavior of a design in various situations. Our findings show that Chisel

performs very well in both space and speed. Chisel's powerful testing capabilities revealed a limitation inherent to the MIN's architecture, and a cost effective solution is proposed.
pp. 36-41

12:15 Improving the Efficiency of Embedded Data Logging on NAND Flash for IoT Systems
Scott Fazackerley (Okanagan College & University of British Columbia, Canada); Ramon Lawrence (University of British Columbia Okanagan, Canada)
A key requirement for many Internet of Things (IoT) systems is the collection and storage of time-based sensed data. Edge-devices are typically embedded systems with limited capabilities and power constraints. The fundamental challenge of storing time series data on embedded systems with raw flash memory has received minimal attention. This work develops an efficient technique for providing record-level consistency that significantly improves upon the typical, sequential storage approach. Simulation results demonstrate a reduction in the memory operations performed, time spent on data storage, energy consumed, and memory wear on the device.
Presenter bio: Scott Fazackerley holds a Ph.D., M.Sc.and B.Sc (Hons) in Computer Science from the University of British Columbia and a Dip.T (Hons) in Industrial Automation and Robotics from the British Columbia Institute of Technology. He is a college professor at Okanagan College in the Department of Electronic Engineering Technology and a member of the Database Research Group at the University of British Columbia Okanagan. His work focuses on the use of IoT systems for improvements in agricultural practices. His current research focus examines in network data storage and processing challenges as well as improvements in data representation, aggregation and clustering in wsn's to improve field deployment lifetime and reduced network traffic. Scott has also spent numerous years in industry focusing on IoT systems development and deployment.
pp. 42-47

Monday, September 13 12:30 - 13:30

LT1: McNaughton Winner Talk

Teleoperation, Force Sensing, Haptics and Control Issues in Medical Robotic
Dr. Rajni Patel, Western University, ON
Chair: Celia L Desmond (World Class Telecommunications, Canada)

Abstract: Teleoperated (leader-follower) robotic systems offer advantages to the user of increased dexterity and precision, tremor filtering, motion repeatability, and the possibility of autonomous or semi-autonomous functions. In the time of a pandemic such as COVID-19, they provide a means of improved safety for healthcare workers through the possibility of performing certain functions from short or long distances such as patient monitoring, assessment and treatment. However, these teleoperated systems also have some disadvantages, primarily as a result of limitations of the current technology. These issues will be discussed in the talk in the context of two specific areas of application: robotics-assisted medical interventions and robotics for neurological movement disorders. Particular focus will be on issues arising from the absence of accurate haptic (sense of touch) feedback which prevents transmission to the user of realistic interaction forces between a robot and a patient or objects in the robot's environment. The role of haptics-based teleoperation will be discussed based on experimental studies to highlight the key issues associated with incorporating force sensing, haptics and teleoperation in patient-oriented robotic systems and the advantages and potential uses of such interaction in specific applications.

Bio: Dr. Rajni Patel received the PhD degree in Electrical Engineering from the University of Cambridge, England in 1973 and currently holds the position of Distinguished University Professor and

Tier-1 Canada Research Chair in the Department of Electrical and Computer Engineering with cross appointments in the Department of Surgery and the Department of Clinical Neurological Sciences at Western University. Dr. Patel is a founding member of Canadian Surgical Technologies and Advanced Robotics (CSTAR) and serves as its Director of Engineering. He has over 35 years of research experience in the design, simulation, prototyping and control of advanced robotic systems. He has also made significant contributions to the development and application of intelligent control techniques, and computational and robustness issues in control system design. From 1991 to 2000, Dr. Patel collaborated with the Canadian Space Agency (CSA) and Bombardier Inc. on three of CSA's Strategic Technologies in Automation and Robotics (STEAR) programs. Since 2000, Dr. Patel's research has focused on applications of robotics, teleoperation and haptics in minimally invasive surgery and therapy, surgical training and skills assessment, and more recently on applications for neurological movement disorders including those due to Parkinson's disease and stroke. Dr. Patel is a Life Fellow of the IEEE, Fellow of the Royal Society of Canada, the Canadian Academy of Engineering, and the American Society of Mechanical Engineers (ASME). He has served on the editorial boards of several journals including the IEEE Transactions on Robotics, the IEEE/ASME Transactions on Mechatronics, the IEEE Transactions on Automatic Control, Automatica, and the Journal of Medical Robotics Research. Dr. Patel is the Editor of "Minimally Invasive Surgical Robotics", Volume 1 (of 4 volumes) of the Encyclopedia of Medical Robotics published in 2018.

Monday, September 13 13:30 - 15:30

Tech2: Technical Sessions

Chair: Ahmed Elnakib (University of Mansoura, Egypt)

13:30 Sea Ice Detection from the RADARSAT Constellation Mission Experiment Data

Hangyu Lyu, Weimin Huang and Masoud Mahdianpari (Memorial University, Canada)

The RADARSAT Constellation Mission (RCM) is a new generation of Canadian Synthetic Aperture Radars collecting data with higher spatial and temporal resolutions than previous RADARSAT missions. In this paper, the RCM data are used for the first time to detect sea ice in the Eastern Arctic area with a pixel-based classifier. HH, HV, cross polarization ratio, and Gray-Level Co-Occurrence Matrix (GLCM) texture features are extracted from the dual-polarized RCM data with a medium resolution (50m) for a random forest classification model. The overall detection accuracy (over 90%) confirms the superior capacity of RCM data for sea ice monitoring.

pp. 48-51

13:45 The Impact of Vote Counting Policy on the Performance of PBFT

Vojislav B. Mišić and Jelena Mišić (Ryerson University, Canada); Xiaolin Chang (Beijing Jiaotong University, China)

Practical Byzantine Fault Tolerance (PBFT) is the protocol of choice for many application that require a distributed agreement or consensus between a number of participants. While PBFT assumes that all participants have an equal say in the final decision, many applications, and recently introduced identity management systems in particular, require that the weights are unequal so that they reflect the trust placed in participants that belong to different categories. To apply PBFT in those scenarios, we propose to introduce a small change to the manner in which the votes are counted in the COMMIT phase. We present the details of two alternative solutions in which orderers' votes are counted separately in two or three groups or committees, and investigate the performance impact of these changes on the mean time to accept a data block and the number of nodes involved in making the final decision. Our results indicate that the proposed solutions impose a slight performance penalty which may be countermanded by reducing the quorum numbers

needed in different subsets of the original committee.
Presenter bio: Vojislav B. Mišić (M '92, SM '08) is Professor of Computer Science at Ryerson University in Toronto, Ontario, Canada. He received his PhD in Computer Science from University of Belgrade, Serbia, in 1993. His research interests include blockchain technology, Internet of Things, wireless networks, and systems and software engineering. He has authored or co-authored seven books, 23 book chapters, and over 300 papers in archival journals and at prestigious international conferences. He serves on the editorial boards of IEEE Transactions on Cloud Computing, Ad hoc Networks, Peer-to-Peer Networks and Applications, and International Journal of Parallel, Emergent and Distributed Systems. He served as Editor-in-Chief of Cyber-Physical Systems. He is a Senior Member of IEEE and member of ACM.
pp. 52-57

14:00 Multiple Leader PBFT Based Blockchain Architecture for IoT Domains

Haytham Qushtom, Jelena Mišić and Vojislav B. Mišić (Ryerson University, Canada)
In this paper we propose to implements blockchain technology for Internet of Things (IoT) networks that use Practical Byzantine Fault Tolerance (PBFT) consensus algorithm. To eliminate the reliance on a single leader and improve performance, we propose to allow multiple leaders to propose request batches independently and, possibly, concurrently, by using different overlay networks. Nodes participate in parallel consensus rounds without contention, and they only contend with others to reserve the next available spot for the atomic insertion of a new transaction batch or block into the replicated blockchain ledger. We develop an analytical model for the multiple leader PBFT ordering service by using a Discrete-time Markov chain. Our evaluations show that our model outperforms the original multiple entry point PBFT protocol in a wide range of parameter values, and that it scales well with the number of orderer nodes in the PBFT committee and block arrival rate.
pp. 58-63

14:15 Reinforcement Learning for Resource Allocation in Steerable Laser-Based Optical Wireless Systems

Abdelrahman Said Elgamal, Osama Zwaid Alsulami, Ahmad Adnan Qidan, Taisir El-Gorashi and Jaafar Elmirghani (University of Leeds, United Kingdom (Great Britain))
Vertical Cavity Surface Emitting Lasers (VCSELs) have demonstrated suitability for data transmission in indoor optical wireless communication (OWC) systems due to the high modulation bandwidth and low manufacturing cost of these sources. Specifically, resource allocation is one of the major challenges that can affect the performance of multi-user optical wireless systems. In this paper, an optimisation problem is formulated to optimally assign each user to an optical access point (AP) composed of multiple VCSELs within a VCSEL array at a certain time to maximise the signal to interference plus noise ratio (SINR). In this context, a mixed-integer linear programming (MILP) model is introduced to solve this optimisation problem. Despite the optimality of the MILP model, it is considered impractical due to its high complexity, high memory and full system information requirements. Therefore, reinforcement Learning (RL) is considered, which recently has been widely investigated as a practical solution for various optimisation problems in cellular networks due to its ability to interact with environments with no previous experience. In particular, a Q-learning (QL) algorithm is investigated to perform resource management in a steerable VCSEL-based OWC systems. The results demonstrate the ability of the QL algorithm to achieve optimal solutions close to the MILP model. Moreover, the adoption of beam steering, using holograms implemented by exploiting liquid crystal devices, results in further enhancement in the performance of the network considered.
pp. 64-69

14:30 Holistic Performance, Reliability and Thermal Understanding of HPC Real Utilization on Silicon Architecture

Gamal Refai-Ahmed (Xilinx Inc., USA); Hoa Do (Xilinix Inc., USA); I-Ru Chen (Xilinx Inc., USA); Jae-Gyung Ahn (Xilinx, USA); Huayan Wang, Xin Wu and Suresh Ramalingam (Xilinx Inc., USA)

The power density and total power from the package have been increased significantly. The rapid rate of power density increases from one generation to the next not only happens at the device level but also happens at the localized area on the devices. The objective of this study is to build more understanding of the localized high-power density in silicon blocks with respect to the impact in temperature gradient and reliability of the silicon. Conventionally, individual design block power usage numbers are often reported from circuit simulations without considering physical location of transistors and metal wires. However, in a silicon block design, certain transistors may consume significantly more power than others due to higher load capacitance, current draw, frequency, or toggle rate. Therefore, the power distribution is uneven within the design block even in the same use case. In order to gain a better understanding of power density peak spot inside of a single design block, in this study, the transistor activity is dynamically analyzed with circuit simulation vectors of an actual Versal product use case and the spatial power distribution of a 0.5mm x 0.5mm design block is reported in an granularity of 10um x 10um and 1um x 1um respectively. The analysis results show that the local heat flux can be several magnitudes higher when the design block is analyzed in more granularity. The local heat flux creates local hot spot that was overlooked. The max hotspot temperature would not be captured by the sensor because this specific hotspot sensor location would not be known at first hand due to uncertainty of the exact location created by the local hot spot. Understanding that there can be temperature sensors located some distance(700um) away from hotspot, reporting out the temperature, the device max temperature can be higher than the system monitor readout. Given this max temperature discrepancy, a correlation for max temperature based on heat flux density, source area, heat sink resistance, and senor location would be defined to estimate the max temperature. When the semiconductor chip has hot spots, it affects reliability of the chip. Most of reliability mechanisms result in shorter lifetime with higher temperature and temperature gradients. When a small portion of product has local temperature increase by whatever reason, long-term circuit performance should be altered due to enhanced or reduced aging effect. The device long term reliability is reassessed based on the new discovered localized hot spot.

pp. 70-77

14:45 Adversarial Human Activity Recognition Using Wi-Fi CSI

Harshit Ambalkar and Xuyu Wang (California State University, Sacramento, USA); Shiwen Mao (Auburn University, USA)

Human activity recognition has been used for various applications in Internet of Things (e.g., health monitoring, security, and sport-related monitoring). Wi-Fi channel state information (CSI) is widely used for activity recognition, where CSI can capture human activities that influence wireless channel. In this paper, we study the impact of adversarial attacks on deep neural network (DNN) based human activity recognition with Wi-Fi CSI. First, we discuss the system framework, where activity recognition can be considered as a classification problem and a specific DNN model is introduced. Then, we discuss adversarial attack problem for DNN-based human activity recognition and formulate three white-box attacks. In the experiment with a public Wi-Fi CSI dataset, our results show that the performances of DNN-based human activity classification are greatly influenced by three white-box adversarial attacks.

Presenter bio: XUYU WANG received the B.S. in degree in electronic information engineering and the M.S. degree in signal and information processing from Xidian University, Xi'an, China, in

2009 and 2012, respectively, and the Ph.D. degree in electrical and computer engineering from Auburn University, Auburn, AL, USA, in 2018. He is currently an Assistant Professor with the Department of Computer Science, California State University, Sacramento, CA, USA. His research interests include deep learning, the Internet of Things, indoor localization, RFID sensing, computer vision, health sensing, and wireless systems. He was a co-recipient of the Second Prize of the Natural Scientific Award of Ministry of Education, China, in 2013, the Best Demo Award from the IEEE SECON 2017, the Best Student Paper Award from the IEEE PIMRC 2017, and the IEEE ComSoc MMTC Best Journal Paper Award in 2018.
pp. 78-82

15:00 A GPU Hyperconverged Platform for 5G vRAN and Multi-Access Edge Computing
Anupa Kelkar (NIVIDIA, USA); Chris Dick (NVIDIA, USA)
In this paper we present the NVIDIA hyper- converged platform supporting 5G connectivity and Mobile Edge Computing (MEC). 5G connectivity is realized with our Aerial [1] GPU-based cloud native 5G gNB. We introduce AI-on-5G on a converged accelerator to showcase our innovation in being able to host Aerial vRAN baseband processing, AI/ML training and inference, data analytics and other workloads. In other words, a data center at the edge that is provisioned with 5G connectivity as a service. We describe 3 uses-cases that highlight how existing NVIDIA AI/ML development frameworks, together with Aerial, can be leveraged to bring Industry 4.0 to reality. As an open platform Aerial is positioned to be industry transformational by providing researchers with a platform for next generation wireless and AI research. Aerial seeds the research ecosystem with a first-class out-of- the-box (OOB) experience with a standards compliant 5G NR PHY. Researchers can run the supplied 3GPP compliant test vectors, and perform over-the-air experiments, using standard servers equipped with a GPU-based PCIe card. The PHY code base can be tailored to support research that combines AI/ML with 5G wireless.
pp. 83-88

Monday, September 13 15:00 - 15:30

B3: Break

Monday, September 13 15:30 - 16:30

P1: Panel 1 - Evolving Dynamics of Industry-Academia Collaboration

Panel Leader: Deyasini Majumdar - IEEE Canada
Chair: Rossitza Marinova (Concordia University of Edmonton, Canada)

Panelists: Witold Kinser - Professor University of Manitoba & Ex-Vice President, IEEE EAB Mohammad Moshirpour - MEng Software Program Director, University of Calgary Julia Elvidge - Ex-President & Co-Founder Chipworks, Co-Founder SheBoot, Advisor Invest Ottawa Tom Murad - Country Lead - Engineering & Technical Excellence, Siemens Mobility

Abstract: A key measure of a productive tech ecosystem in any society is the successful transition of new graduates from academia into industry. While the academic system primarily focuses on building a broader knowledge base, a very important factor for successful transition of the trainees is their industry-readiness. Hence, the need for dynamically evolving industry-academia collaborations.

While technological trends largely dictate the needs of the dynamically evolving industrial ecosystem, recent times have highlighted the need for easily scalable methods that can help effectively empower students transitioning into industry.

This panel discussion aims to focus on the dynamically evolving requirements of the tech ecosystem and the challenges and trends that drive current and next-gen industry-academia interfaces.

Tech3: Technical Sessions

Chair: Shahram Mollahasani (University of Ottawa, Canada)

15:30 A Physical-Layer Security Approach for IoT Against Jamming Interference Attacks

Eman Hammad (University of Toronto, Canada); Abdallah Farraj (NovoSek, Canada)

Connectivity and security of Internet of Things (IoT) remain a challenge particularly when considering devices' limited processing capacity and energy efficiency requirements. This is further complicated in heterogeneous networks with channel sharing and massive IoT deployments (mMTC) with competing and adversarial devices. This work considers a heterogeneous communication environment with IoT devices transmitting over a wireless channel in the presence of adversarial IoT devices inducing jamming interference attacks. We utilize an iterated game-theoretic formulation to propose a physical-layer approach to achieve information availability for an IoT device under interference attacks. We describe the interactions of a selected IoT device with adversary devices, study the impact of interference on signal quality, and quantify the information availability metric for the IoT device. Further, to alleviate the scheduling overhead, we propose a game-theoretic transmission strategy for uncoordinated IoT channel access to achieve the target security metric while conserving the device transmission resources. Results of this work illustrate how by using the proposed transmission strategies, the selected IoT device can achieve its desired security performance over time.

pp. 89-94

15:45 Indistinguishability and Non-Deterministic Encryption of the Quantum Safe Multivariate Polynomial Public Key Cryptographic System

Randy Kuang (Chief Scientist, Canada); Michel Barbeau (Carleton University, Canada)

Multivariate Polynomial Public Key (MPPK) is a cryptographic system, over a prime Galois field. A key pair is generated using a multiplier multivariate polynomial and two multiplicand univariate solvable polynomials. They yield two product multivariate polynomials. The first variable is used for carrying the message or secret and others are used as noise sources. The public key consists of all the coefficients of the product multivariate polynomials, except the two constant coefficients, in terms with coefficients attached to the message variable, and a noise function or a polynomial of only noise variables generated from the constant term of the multiplier multivariate polynomial by multiplying a private random variable R. The private key is made of both univariate solvable multiplicand polynomials and the private R. Encryption takes a secret message and random numbers for noises, adding noise that is automatically cancelled by decryption. Decryption is achieved evaluating a solvable equation. We review security analysis that can be employed to crack MPPK secrets and private keys. Finally, we discuss indistinguishability and non-deterministic encryption, key properties of MPPK.

pp. 95-99

16:00 Efficient Multiplier and FPGA Implementation for NTRU Prime

Huapeng Wu and Xi Gao (University of Windsor, Canada)

As quantum computing age is emerging on horizon, many of the current cryptography standards,

e.g., RSA and Elliptic Curve Cryptography, are shown to be compromised under quantum attacks according to Shor's algorithm. A multiple-round competition has been launched by NIST to decide the next generation post-quantum cryptography (PQC) standards since 2017. Entering the final round, NTRU Prime system, proposed in 2016, remains one of a few that have a chance to be part of the future PQC standard. In this work, efficient multiplication architecture is proposed for Streamlined NTRU Prime system. To the best of our knowledge, this work is the first attempt at hardware architecture and implementation of NTRU prime system. Our FPGA implementation results have also shown the proposed multiplier compares favorably to the similar work on the original NTRU system.
pp. 100-104

16:15 Detecting DDoS Attacks Using an Adaptive-Wavelet Convolutional Neural Network

Maryam Ghanbari and Witold Kinsner (University of Manitoba, Canada)

This paper introduces an architecture of a convolutional neural network (CNN) to detect a distributed denial of service (DDoS) attack. The main procedure is the application of an adaptive mother wavelet that is created using a genetic neural network (GNN) to increase the detection rate of the DDoS. In addition, an adaptive-wavelet CNN is trained to extract features from Internet traffic containing DDoS attacks to classify the Internet traffic data (ITD) with DDoS attacks (DDoS ITD) as normal or anomalous. Moreover, a multi-objective optimization based on a genetic algorithm and a weighted cost function based on an information-theoretic measure are used to train and evaluate the adaptive-wavelet CNN. Finally, the adaptive-wavelet CNN's classification efficiency is assessed to find the detection rate of the proposed architecture. The adaptive-wavelet CNN detects the DDoS attack with 95% accuracy.
pp. 105-111

Tech3.1: Technical Session 3.1 (running parallel with Sesssion 3)

Chair: Ahmed Shaffie (University of Louisville, USA)

15:30 Understanding Power of Graph Convolutional Neural Network on Discriminating Human EEG Signal

Tina Behrouzi and Dimitrios Hatzinakos (University of Toronto, Canada)

Electroencephalogram (EEG) based biometric is an emerging field in security systems, which provides a higher reliability compared to the conventional identification methods. EEG devices capture the temporal brain waves of individuals that are unique and cannot be reproduced. The individual variability of EEG signals can be derived from its functional connection, which is best represented by a graph. Although a Graph Convolutional Neural Network (GCNN) has improved the classification of graph data in recent years, GCNN is still not well addressed for the EEG biometric identification system. We introduce a novel GCNN model that overcomes the lack of performance on small graph data. Furthermore, we investigate the performance of recent GCNN benchmarks considering both model loss and complexity. The proposed GCNN results in more that 95% accuracy with considerably low computational cost for 3 databases recorded in 8 different human states. Our experiment shows that adding an extra graph convolution or pooling layer does not necessarily result in better performance.
pp. 112-118

15:45 Reinforcement Learning Algorithms: An Overview and Classification

Fadi AlMahamid (University of Western Ontario, Canada); Katarina Grolinger (The University of Western Ontario, Canada)

The desire to make applications and machines more intelligent and the aspiration to enable their

operation without human interaction have been driving innovations in neural networks, deep learning, and other machine learning techniques. Although reinforcement learning has been primarily used in video games, recent advancements and the development of diverse and powerful reinforcement algorithms have enabled the reinforcement learning community to move from playing video games to solving complex real-life problems in autonomous systems such as self-driving cars, delivery drones, and automated robotics. Understanding the environment of an application and the algorithms' limitations plays a vital role in selecting the appropriate reinforcement learning algorithm that successfully solves the problem on hand in an efficient manner. Consequently, in this study, we identify three main environment types and classify reinforcement learning algorithms according to those environment types. Moreover, within each category, we identify relationships between algorithms. The overview of each algorithm provides insight into the algorithms' foundations and reviews similarities and differences among algorithms. This study provides a perspective on the field and helps practitioners and researchers to select the appropriate algorithm for their use case.
pp. 119-125

16:00 A CNN-Based Hybrid Model and Architecture for Shilling Attack Detection
Masha Ebrahimian and Rasha Kashef (Ryerson University, Canada)
Recommendation systems are widely used in various areas to personalize recommendations and suggestions to users. However, they are vulnerable to shilling attacks in which malicious users try to promote their products or diminish their competitors'. Therefore, detecting shilling attacks can significantly improve the quality of recommender systems and user experience. With the increasing complexity of attacks and changes in attackers' behavior, more advanced approaches are required to find the hidden patterns in data. This paper proposes a CNN-based hybrid model and architecture to integrate self- learning and flexible aspects of CNN with other approaches to enhance the prediction results of shilling attacks. Two benchmark datasets are used in the experimental analysis, the Movie-Lens 100K and Netflix. The performance of the proposed hybrid models is compared to that of the traditional deep learning and machine learning detection methods. Experimental results show that the superiority of hybrid models over individual models depends on the sparsity level of data and divergence of results.
pp. 126-132

16:15 Code Authorship Attribution Using Content-Based and Non-Content-Based Features
Parinaz Bayrami and Jacqueline E. Rice (University of Lethbridge, Canada)
To attribute authorship (author identification) means to identify the true author of a sample of work among many candidates. Author identification is an important research field in natural language. Machine learning approaches are widely used in natural language analysis, and previous research has shown that similar techniques can be applied in the analysis of computer programming (artificial) languages. This paper focuses on the use of machine learning techniques in the identification of authors of computer programs. We focus on identifying which features capture the writing style of authors in the classification of a computer program according to the author's identity. We then propose a novel approach for computer program author identification. In this method, features from source code of the programs are combined with authors' sociological features (gender and region) to develop the classification model. Several experiments were conducted on two datasets composed of computer programs written in C++. Our models are able to predict an author's identity with a 75% accuracy rate.
pp. 133-138

Tuesday, September 14

Tuesday, September 14 9:00 - 10:00

K2: Keynote Speaker

Future Optical Network Architecture
Prof. Vincent Chan - MIT & President IEEE ComSoc
Chairs: Ahmed Refaey (Manhattan College, USA & Western University, Canada), Xianbin Wang (Western University, Canada)

Future optical networks with orders of magnitude increase in data rates and large granularity bursty traffic need an architecture with high efficiency and also adapt dynamically to fluctuating offered loads and rapidly changing networks states. Moreover, applications and computing will impose new requirements on the network infrastructure such as time deadlines. The current network management and control systems only adapt quasi-statically (from minutes to days) due the smoothing effects of significant statistical multiplexing of traffic. Future networks will see increase in demands mostly due to large granularity sessions. These granular sessions present large dynamic range and bursty offered traffic to the network, resulting in unpredictable congestions and blocking. We will explore efficient and agile network algorithms to adapt quickly to changing network conditions: a cognitive network management and control system resides in the network control plane as a collection of coordinated algorithms that sense and infer network states, decide and implement fast scheduling of flows, predict intention of users/ applications and take appropriate actions, perform rapid load balancing, and handle resiliency via reconfiguration, restoration and reconstitution of failed network assets.

Bio: Vincent Chan, the Joan and Irwin Jacobs Professor of EECS, MIT, received his BS(71), MS(71), EE(72), and Ph.D.(74) degrees in EE from MIT. From 1974 to 1977, he was an assistant professor, EE, at Cornell University. He joined MIT Lincoln Laboratory in 1977 and had been Division Head of the Communications and Information Technology Division until becoming the Director of the Laboratory for Information and Decision Systems (1999-2007). In July 1983, he initiated the Laser Intersatellite Transmission Experiment Program and the follow-on GeoLITE Program. In 1989, he formed and chaired the All-Optical-Network Consortium among MIT, AT&T and DEC, the Next Generation Internet Consortium, ONRAMP among AT&T, Cabletron, MIT, Nortel and JDS, and a Satellite Networking Research Consortium formed between MIT, Motorola, Teledesic and Globalstar. He chaired the Defense Science Board Task Force on Defense Communications, Networks and Satellite Communications and the Department of Homeland Security's Science and Technology Advisory Committee. He also has been active with start-ups and was a Board Member of a Fortune-500 network company and a member of the Draper Corporation. After chairing the Strategic Planning Committee of ComSoc from 2018-2019, he is serving as the President of the IEEE Communication Society since January 2020.

Tuesday, September 14 10:00 - 10:30

B4: Break

Tuesday, September 14 10:30 - 12:30

P2: Panel 2 - NSERC Research Grants and Alliance Opportunities

Félix Moore - NSERC, Jennifer Mills - NSERC
Chair: Felix Moore (NSERC, Canada)

Abstract: NSERC will discuss Discovery Grants results for 2021, NSERC news, Research Grants and Scholarships Programs Updates and Alliances Programs updates

Tech4: Technical Sessions

Chairs: Lei Lei (University of Guelph, Canada), Yehya Senousy (University of Louisville, USA)

10:30 Low-Overhead Data Synchronization Enabled by Prescheduled Task Period in Time-Sensitive IoT Systems

Haide Wang, Pengyi Jia and Xianbin Wang (Western University, Canada)
Time-sensitive applications in Internet of Things (IoT) systems rely heavily on the temporal coherence among its distributed constituents during data fusion and analysis. The inconsistent clock output inherent to the unstable and heterogeneous clock oscillator embedded at each IoT device will inevitably lead to inaccurate data processing and deteriorated overall performance. In this paper, a low-overhead data synchronization scheme is proposed to achieve accurate temporal consistency prior to fusing the massive data collected from the distributed IoT devices. More specifically, a task period is scheduled for each sensor device to deliver the sampled data to SN. By comparing the difference between the predefined period and the real observed one, the clock parameters can be estimated accurately so that the misalignment of the data can be compensated accordingly. Simulation results show that the proposed scheme can enhance the data fusion accuracy with significantly reduced network overhead.
pp. 139-143

10:45 LoRa Gateway Placement Optimization Based on a Data-Driven Low Height Path Loss Model

Andrew Bidell, Yuan Liu and Hao Liang (University of Alberta, Canada)
The development of long-range (LoRa) communication technology has led to its adoption in low-height networks, where the radio links must operate at ground level (e.g., for smart irrigation networks, smart metering networks, suburban areas, and wildlife tracking systems). In this work, a modified low height LoRa path loss model based on real-world measurements is proposed along with a novel optimization approach for planning ultra-low height networks, where the radio attenuation rate and gateway placement optimization problem are investigated in details. Accordingly, a dynamic programming (DP) algorithm is developed, and its performance is evaluated in a case study based on a practical smart irrigation system for a golf course with a star-topology LoRa network.
pp. 144-149

11:00 A Game-Theoretic Approach for Uncoordinated Access to Cognitive Resources

Abdallah Farraj (NovoSek, Canada); Eman Hammad (University of Toronto, Canada)

Cognitive radio networks are evolving as a strong enabler of Internet of Things (IoT) connectivity in newer generations of wireless communication systems such as 5G and beyond 5G (B5G). This connectivity presents challenges specifically in heterogeneous networks with spectrum sharing and primary users' constraints. The setup considered in this work is representative of a heterogeneous environment of IoT users (devices) competing for channel access with present primary users. This work proposes a game-theoretic strategy for uncoordinated channel access in a communication environment to alleviate the overhead of coordination and protect primary user's constraints. A multi-user cognitive environment is investigated in this article, where secondary users of the system communicate over a channel licensed to the primary user while satisfying the outage probability requirements of the primary user of the channel. Focusing on one secondary user, we devise a channel access strategy that achieves the intended performance objectives while satisfying the quality of service constraints. The secondary user of interest is modeled as a resource-constrained device that chooses to transmit over the channel only during select time intervals. The dynamical interaction between the secondary users is modeled using iterated zero-determinant game-theoretic strategies. The results of this work indicate that the selected secondary user has the potential to achieve its long-term target performance using the iterated game-theoretic strategies and show the impact of the strategy parameters on the performance metrics.

pp. 150-155

11:15 Satellite Image and Received Signal-Based Outdoor Localization Using Deep Neural Networks

Hind Mukhtar and Melike Erol-Kantarci (University of Ottawa, Canada)

This paper proposes an outdoor localization scheme using image classification and deep learning by using information from satellite images and signals in the LTE band. We propose a two-step solution comprised of image differencing using satellite images to classify users into regions, and feed forward neural networks that take channel state information (CSI) data as an input to predict the user's longitude and latitude. We use real data collected from an LTE-A mobile communication system to assess the performance of our technique. Our results show an improvement in localization accuracy using the region based approach, despite the limited data provided from the single input, single output (SISO) system, as we achieve a mean absolute error (MAE) of 5.83 m. The proposed technique can be supplementary to GPS in urban canyons with weak GPS penetration.

pp. 156-161

11:30 TCNS: An Efficient Trusted Cooperative Node Selection Model for Internet of Vehicles

Jiazhi Chen and Xianbin Wang (Western University, Canada)

Internet of Vehicles (IoV) is an emerging technology to provide efficient and safe transportation by enabling vehicles to cooperate with each other or infrastructures through vehicle-to-everything (V2X) communications. However, cooperation among moving vehicles usually requires complex decision-making schemes to choose cooperative vehicles for security and quality guarantee, thus leading to a long time delay, which directly reduces collaboration efficiency among vehicles. In this regard, trust among vehicles can be utilized as a lightweight decision criterion to accelerate collaboration among moving vehicles. In this paper, we propose a trusted cooperative node selection model (TCNS) for IoV to select cooperative vehicles in an efficient way. In comparison with the traditional trust models, the proposed TCNS improves the accuracy of selecting appropriate cooperative peers by performing both direct and indirect trust evaluation in multi-dimension. Our proposed indirect trust evaluation model can achieve trust assessment without relying on infrastructure support in the vicinity. Furthermore, most of our trust evaluation steps are

conducted in edge servers and roadside units (RSUs) as background processes, which saves time for trust establishment. The simulation results obtained show that our proposed model reduces the cooperation time effectively and increases the cooperation efficiency within vehicular networks.
Presenter bio: JIAZHI CHEN is currently an M.E.Sc. student in the Department of Electrical and Computer Engineering at Western University. Since September 2020, she has worked under the supervision of Dr. Xianbin Wang; Her research interests include network security, trust management, the Internet of Things (IoT), and machine learning.
pp. 162-167

11:45 Learning-Assisted Access Management for Dense 3D Small Cell Networks

Samantha Sriyananda (University of Western Ontario, Canada); Xianbin Wang (Western University, Canada); Serguei Primak (University of Western Ontario, Canada)

Efficient access management for wireless devices in a small cell (SC) network is with a significant importance in meeting Quality of Service (QoS) aspects of the services and the applications under constrained radio resource (RR) conditions. Furthermore, with ongoing network densification, future networks are to be designed with 3-Dimensional (3D) SCs and more efficient RR allocation mechanisms, while considering location specific information like location based propagation characteristics. In this study, random access channel (RACH) congestion problem is addressed for 3D SC networks while considering the conditions arisen due to 3D spatial positions of the devices, their data types, QoS needs and other priority requirements. As a solution, a learning-assisted fast RR allocation and access prioritization algorithm is presented using Q-learning (QL) and Slotted-ALOHA (S-ALOHA) principles together with device-network coordination. Approximately, 68%, 43%, 29% and 16% better occupancy rates are shown for the initial iterations of the algorithm for the case of maximum or a greater number of devices giving impressive results.
pp. 168-172

12:00 Nested Column Generation Algorithm for the Routing and Spectrum Assignment Problem in Flexgrid Optical Networks

Adham Mohammed and Brigitte Jaumard (Concordia University, Canada)

With the ever increasing demand for optical networks, many decisions about network planning are becoming increasingly challenging. One of these crucial decisions is the network provisioning, known as the Routing and Spectrum Assignment (RSA) problem. What makes this problem practically challenging to service providers is the significant difference in size between the realistic problem instances and the instances that can be solved using the existing algorithms. Motivated to solve larger problem sizes, we propose a decomposition model and a nested column generation algorithm for the RSA problem. Compared to recent studies, the proposed algorithm produces higher-quality solutions for larger data instances quite efficiently. Furthermore, it provides a measure of the solution accuracy, i.e., an upper bound on the maximum distance of the solution obtained compared to the optimal solution.
Presenter bio: Adham is a research engineer specializing primarily in Operations Research & Analytics, followed by Machine Learning & Data Science. He has research experiences in various, diverse sectors, with the recent four years working mainly in network optimization in telecommunication applications.
pp. 173-177

12:15 Novel Design of Irregular Polar Codes for Latency Reduction in Fast Polar Decoders

Hossein Khoshnevis, Congzhe Cao and Deyuan Chang (Huawei Technologies Canada Research Center, Canada); Chuandong Li (Huawei Technologies (Canada), Canada)

Polar codes used with successive cancellation decoders (SCDs) provide a hardware-friendly low-

complexity solution for a variety of applications. However, SCDs suffer from high latency. A set of fast SCDs has been proposed in the literature to reduce this latency. Irregular polar codes can reduce the decoding complexity and improve the error rate compared to original polar codes. Throughout this paper, irregular polar codes are designed to reduce the latency of fast SCDs instead of improving the error rate. The proposed code design technique can substantially reduce the latency of fast SCDs compared to using original polar codes.
Presenter bio: Hossein Khoshnevis (M'19) received the B.Sc. degree in electrical engineering from the University of Isfahan, Isfahan, Iran, in 2009, the M.Sc. degree in computer science from Saarland University, Saarbrücken, Germany, in 2012, and the Ph.D. degree in electrical and computer engineering from Carleton University, Ottawa, ON, Canada, in 2018. During his master's studies, he was with IMPRS at the Max Planck Institute for Informatics. During his Ph.D. studies, he was a member of the Huawei-Carleton collaborative research project and later joined Huawei Technologies Canada Research Centre, Ottawa, ON. His research interests include coding theory, digital communications, and signal processing.
pp. 178-182

Tuesday, September 14 12:30 - 13:30

LT2: IEEE Canada Award Winners Addresses

Andreas Moshovos, Lukas Chrostowski, Lawrence Whitby, Chi Yung Chung
Chair: Celia L Desmond (World Class Telecommunications, Canada)

Andreas Moshovos: Empowering Innovation in Computing: The Role of Computer Architecture
Abstract: Computing applications have transformed our world, from science, to medicine, commerce and communications. Many of those applications would not have been possible without the ever more powerful, energy efficient and cost effective computing devices that are available today. Computer architecture has in part made such devices possible and continues to fuel further advances. This short presentation will review the role of computer architecture and some of the opportunities that lie ahead for further innovation.

Lukas Chrostowski: Teaching how to Design-Fabricate-Test Silicon Photonic Circuits

Lawrence Whitby: My Experience as a Volunteer

Chi Yung Chung: Grid Modernization: Challenges and Opportunities

Tuesday, September 14 13:30 - 15:00

Tech5: Technical Sessions

Chair: Turgay Pamuklu (University of Ottawa, Canada)
13:30 Optimal Planning of Distributed Generation Using Improved Grey Wolf Optimizer and Combined Power Loss Sensitivity
Mohamed Sodani, Hamed Aly and Timothy Little (Dalhousie University, Canada)
This paper introduces a hybrid method for finding the best location and size of distribution generation (DG) sources in a distribution system. The strategy employs Combined Power Loss Sensitivity (CPLS) and the algorithm Improved Grey Wolf Optimizer (I-GWO), with CPLS

determining candidate locations for DG, and I-GWO determining the best location and size based on CPLS suggestions for candidate buses. The overall aim of this approach is to improve system stability, enhance voltage profile, and minimize power loss. The work evaluates the novel strategy using IEEE-33 and IEEE-69 bus radial distribution systems and investigates three kinds of DG to make comparisons of key efficiency and performance metrics. The test results show that, in comparison to Other optimization methods, the proposed hybrid approach with multi-objective functions offers optimal results.
pp. 183-188

13:45 Smart Inverter Modeling Toolbox for EMT Simulation Studies of Power Systems

Nayeem Ninad (Renewable Energy Integration, CanmetENERGY, Natural Resources Canada, Canada); Jean-Philippe Bérard (CanmetENERGY, Natural Resources Canada (NRCan), Varennes, QC, Canada); Syed Ali (Opal-RT Technologies, Canada)

Recently smart inverter interfaces for distributed energy resources (DERs) have been proposed to allow DER devices to implement grid support functions. Applying these functions to address the impact of DER integration to power systems requires studies including electro-magnetic transient (EMT) analysis. To simplify the process of setting up such studies, a comprehensive toolbox based on MATLAB/Simulink allowing users to implement, test and perform EMT studies with smart inverter interfaced DERs is presented in this paper. The toolbox allows the user to define and implement all the grid support functions as defined in IEEE 1547-2018 as well CSA C22.3 No. 9. Some case studies with a solar PV generation system interfaced with a smart inverter are also presented to demonstrate the effectiveness of the toolbox.
pp. 189-194

14:00 Experimental Investigation of 21-Level Inverter Using SHE Modulation Technique for Harmonics Mitigation

Vijay Sirohi (Punjab Engineering College, India); Tejinder Singh Saggu and Jagdish Kumar (PEC University of Technology, India); Balbir(Bob) Gill (British Columbia Institute of Technology, Canada)

Commonly used converters for high and medium electric drives for renewable energy applications are multilevel inverters because these converters operate at the low switching frequency that automatically minimizes the losses occurring in switching period. But, lower switching frequency is liable to produce lower order harmonics which increases line current distortion. The conventional converters have more harmonics than multilevel inverters (MLIs) at the output. The percentage of harmonics decrease when number of levels increase in the output. This paper represents a hybrid MLI, which has 21-level output with less distortion in the voltage. The main focus of this paper is to produce more levels in the output voltage and then eliminate lower order harmonics by some appropriate modulation technique. Selective Harmonics Elimination (SHE) modulation technique is implemented for that purpose. Inverter is modeled and simulated in the MATLAB/SIMULINK software. The obtained simulation results are verified using a hardware prototype for the authenticity of the proposed model.

Presenter bio: Vijay Sirohi received B.Tech. degree in electrical and electronics engineering from Gautam Buddha Technical University, Lucknow, India, in 2014, and the M.Tech. degree in electrical engineering from the PEC University of Technology, Chandigarh, India, in 2018. He is currently pursuing the Ph.D. degree with the Punjab Engineering College, Chandigarh. His research interest includes power electronics converters, multilevel converters topologies, electric drives and modulation techniques.
pp. 195-200

14:15 Complete Equivalent Model of Hybrid Three-Level and Modular Multilevel Converter for Accelerated Electromagnetic Transient Simulation

Jintao Han and Levi Bieber (University of British Columbia, Okanagan, Canada); Liwei Wang (University of British Columbia, Canada); Wei Li (OPAL-RT Technologies Inc., Canada)

The hybrid three-level and modular multilevel converter (H3LC) is an innovative power converter architecture for transmission of high voltage direct current (HVDC) electricity, which features high converter efficiency, small converter footprint, and DC fault ride-through capability. However, its large number of semiconductor switches require significant computational effort for electromagnetic transient (EMT) type modeling. Fast EMT models are expected to shorten the design time of the converter while maintaining its accuracy. This paper introduces a complete equivalent model (CEM) of the H3LC, which reduces the circuit complexity and improves simulation efficiency without compromising simulation accuracy.

pp. 201-205

14:30 An FPGA-Based Real-Time Simulation of a Hybrid Fuel Cell/Battery Source

Karim Meddah and Tarek Ould-Bachir (Polytechnique Montréal, Canada); Mohamed Becherif and Amel Benmouna (UTBM, Femto-ST/FCLab UMR CNRS, France)

This paper presents a new approach for the modeling and real-time simulation of an embedded hybrid power source comprised of a fuel cell (FC) and a battery. The proposed modeling is based on a state-space-like representation of the system equations obtained from the modified-augmented nodal analysis. Systematic formulation of system equations is presented and the solution to the non-linear equations are discussed. The proposed model was implemented on an entry level Field Programmable Gate Array (FPGA), and demonstrates sub-microsecond simulation time-step capability. The real-time solution is obtained by precomputing the system equations for all switch state combinations, and using the backward Euler integration scheme for solving differential equations. A fixed-point number representation is utilized for speed and reduced configurable resource utilization. Our results show a high fidelity of the proposed model over a wide range of simulation time-steps and switching frequencies.

pp. 206-210

14:45 Continuous Control Set Model Predictive Control for Multilevel Packed E-Cell Inverter

Amirabbas Kaymanesh (École de Technologie Supérieure, Canada); Ambrish Chandra (Ecola de Technologie, Superieure, Canada); Kamal Al-Haddad (Ecole de technologie supérieure, Canada)

his paper introduces a continuous control-set model predictive control (CCS-MPC) for the grid-tied multilevel Packed E-Cell inverter known as PEC to achieve a low and constant switching frequency with reduced complexity, while dc- link capacitors are tuned in an integrated manner into the utilized modulator without requiring their dynamic models. The proposed CCS-MPC is founded on defining a cost function and minimalizing its derivative concerning the PEC-generated voltage. The produced continuous control signal is then applied to a hybrid pulse width modulation (PWM) technique that supports the PEC inverter multilevel operation. Although utilization of a modulation method is essential through the designed CCS-MPC, its cost function only considers the injected current regulation, and tuning several weighing factors is not required. Besides, by employing the proposed CCS-MPC as a simplified model predictive-based controller, a reduced number of voltage sensors are employed which increases the system reliability and reduces its implementation cost. Nonetheless, in this paper, the CCS-MPC technique for the multilevel PEC inverter in a grid-connected mode is defined thoroughly. Finally, provided simulation/experimental results demonstrate the feasibility and operation of the proposed controller applied on a single-phase PEC inverter.

pp. 211-216

Tech5.1: Technical Session 5.1 (parallel with Tech 5)

Chairs: Deyasini Majumdar (IEEE Canada, Canada), Rossitza Marinova (Concordia University of Edmonton, Canada)

13:30 Cybersecurity Education in Rural Indigenous Canada

Sarah Plosker (Brandon University, Canada); Gautam Srivastava (Brandon University & China Medical University, Canada)

Canada is one of the largest countries by area in the world. Rural populations of Canada have for decades suffered from lacking the infrastructure necessary to offer technological advancements to its citizens. Finally, in recent years, we have seen our Canadian government take the initiative to ensure our remote citizens have the Internet capabilities needed to operate in our digital world. With advancement also comes challenges, which in the context of this paper involves the additional risk to Canadian citizens to cyber-threats. Through an educational initiative funded Nationally, this paper discusses the efforts to offer cybersecurity education to rural Indigenous citizens in the province of Manitoba, Canada. We discuss in detail our initial progress, recent workshops with results, and the future of this program post-COVID-19.

Presenter bio: Associate Professor of Computer Science

pp. 217-222

13:45 Digital Twins for Personalized Education and Lifelong Learning

Witold Kinsner (University of Manitoba, Canada)

This paper discusses a new model of digital twins suitable not only for industries but for personalized education and life-long learning. In the past, professional education lasted for a lifetime through all the industrial revolutions, including the third. During those revolutions, not only the pace of knowledge doubling has accelerated from a lifetime to months, but the half- life of pertinent knowledge has also shortened. Are we capable of adjusting to that pace? How can we learn all that is needed in the old Prussian model of education based on one-program-fits-all? Since professionals have to migrate through multiple job environments, we should revamp the educational system at the core. The new system must be personalized to match the diversity of individual abilities and styles of learning. The new system must also be based not only on the traditional body of knowledge (BoK), but also on the body of experience (BoX) and body of memetics (BoM). The new personalized system of learning must be sufficiently agile and interactive so that it would become evolving in its symbiosis with humans. For that to happen, we should consider coexisting with memetic symbiotic autonomous cognitive systems, specifically involving digital twins. This paper addresses some aspects of this view.

Presenter bio: Professor, Department of Electrical and Computer Engineering, University of Manitoba. Fellow of the Engineering Institute of Canada. Fellow of Engieers of Canada. Registered Professional Engineer. Member of IEEE and ACM. Research interests: intelligent and cognitive machines and systems, multifractal signal processing; multiscale and polyscale analysis and synthesis; security, biomedical applications; aerospace electronics and control systems.

pp. 223-228

14:00 A Personalized Cyber-Physical Laboratory for a Real-Time Systems Interfacing Course

Witold Kinsner, Hongru Li, Siobhan Reid and Vinh Vu (University of Manitoba, Canada); Zhou Zhou (Pollard Banknote Limited, Canada); Michael Lambeta (Facebook, USA); Oleg Shevchenko and Glen Kolansky (University of Manitoba, Canada)

This paper describes an example of a successful attempt to migrate an intensive hardware-software lab into a fully personalized scheme with team interactions. Each student in the course performed each lab individually, and was expected to collaborate with another selected or assigned class team

member remotely. When completed, the team demonstrated the lab results to the Teaching Assistants and the Instructor through a secure Learning Management System installed at the university. The importance of this lab scheme is that it is universal in that the specific form and method of delivery of this scheme is suitable for other secure networking environments.
Presenter bio: Professor, Department of Electrical and Computer Engineering, University of Manitoba. Fellow of the Engineering Institute of Canada. Fellow of Engieers of Canada. Registered Professional Engineer. Member of IEEE and ACM. Research interests: intelligent and cognitive machines and systems, multifractal signal processing; multiscale and polyscale analysis and synthesis; security, biomedical applications; aerospace electronics and control systems.
pp. 229-233

14:15 Development of Hybrid AI Model for Car Steering Shaft Assembly by Combining Gaussian Process Regression and Artificial Neural Network

Yanjun Qian (University of Waterloo, Canada); Jongmun Kim (Korea Electrotechnology Research Institute, Korea (South)); Hyock-Ju Kwon (University of Waterloo, Canada)
This paper presents a case study to apply artificial intelligence (AI) to the assembly of automotive parts. The sliding load of a car steering shaft assembly is controlled by selecting an appropriate size of the ball slider corresponding to the shaft and the tube. The manual assembly currently conducted by skilled workers has a low selection accuracy and long process time, which is the bottleneck of the whole manufacturing process. To increase the selection accuracy, an expert system based on a hybrid AI model was developed by combining Gaussian process regression and artificial neural network. The AI-based system could recommend suitable ball size corresponding to the over ball diameters measured on the tube and shaft. The system achieved 91.32% prediction accuracy in the test cases.
pp. 234-238

14:30 Feed-Forward Neural Network-Based Approach for Performance Analysis and Evaluation of the Laser Polishing of H13 Tool Steel

Honghe Wu (Western University, Canada); Evgueni Bordatchev (National Research Council of Canada & Western University, Canada)
Modification and reconfiguration of the surface topography by the laser polishing (LP) process is a new innovative, non-material additive nor removal technology enabling new and/or enhancing existing value-adding surface functionalities, such as improving surface quality, visual appearance, wettability, friction, and others. However, the resultant surface is dependent upon many process parameters which makes selecting optimal process parameters to achieve desired surface topography complicated and unrepeatable. This study proposes and demonstrates that feed-forward neural network (FFNN) can reliably model the LP of H13 tool steel and predict the laser polished surface topography parameters such as areal waviness and roughness with a probability of 70%. © 2021 Her Majesty the Queen in Right of Canada, as represented by the National Research Council of Canada; equal contribution of co-authors
pp. 239-243

Tuesday, September 14 15:00 - 15:30

B5: Break

Tuesday, September 14 15:30 - 16:30

P3: Panel 3 - Where Next? Innovation and Partnerships in Emerging Technologies

Moderator: Philippa King - Director Advanced Technology Platform Programs, OCI
Chair: Philippa King (Ontario Centre of Innovation, Canada)

Abstract: Industry academic partnerships are a key driver in innovation and building a globally competitive economy. This panel brings together the perspectives of industry, both large and small, and academia to discuss where's next in digital technologies and the opportunities that lie therein for collaboration. The panel will highlight examples of successful collaborations supported by funding programs such as ENCQOR 5G and speak to the continued support opportunities that are available to help foster industry academic partnerships and innovation.

Panelists; 1- Ericsson/ Ciena executive 2- SME representative 3- Academic representative 4- OCI representative

Tech6: Technical Sessions

Chair: Roghayeh Joda (University of Ottawa, Canada)

15:30 CDM Based Virtual FMCW MIMO Radar Imaging at 79GHz

Shahrokh Hamidi (University of Waterloo); Safieddin Safavi Naeini (University of Waterloo, Canada)

In this paper, we will be using a 79 GHz Multiple Input Multiple Output (MIMO) Frequency Modulated Continuous Wave (FMCW) radar and apply the Code Division Multiplexing (CDM) method to increase the number of elements virtually. This, in turn, enhances the angular resolution of the radar. The major contribution of our work comes from the fact that by exploiting the CDM method we will make it possible for multiple FMCW radars to operate in close proximity of each other. In fact, using coded signals the effect of interference can be alleviated considerably.

pp. 244-247

15:45 Millimeter-Wave Circular Synthetic Aperture Radar Imaging

Shahrokh Hamidi and Safieddin Safavi Naeini (University of Waterloo, Canada)

In this paper, we present a high resolution microwave imaging technique using a compact and low cost single channel Frequency Modulated Continuous Wave (FMCW) radar based on Circular Synthetic Aperture Radar (CSAR) technique. We develop an algorithm to reconstruct the image from the raw data and analyze different aspects of the system analytically. Furthermore, we discuss the differences between the proposed systems in the literature and the one presented in this work. Finally, we apply the proposed approach to the experimental data collected from a single channel FMCW radar operating at 79 GHz and present the results.

pp. 248-253

16:00 Noise Removal from ECG Signals by Adaptive Filter Based on Variable Step Size LMS Using Evolutionary Algorithms

Ramin Shaddeli and Navid Yazdanjue (Iran University of Science and Technology, Iran); Saeed Ebadollahi (IUST, Iran); Mohammad Mahdi Saberi (Iran University of Science and Technology, Iran); Balbir(Bob) Gill (British Columbia Institute of Technology, Canada)

Nowadays, the electrocardiogram (ECG) signal is widely used to detect cardiovascular diseases. Several studies are conducted on noise removal of ECG signal based on the adaptive filter with least-mean Square (LMS) algorithm. In this paper, for improving the traditional LMS method, the evolutionary algorithms are used to select the variable optimal step size of LMS, causing the least error between the main and filtered ECG signals. The proposed Adaptive Noise Cancellation System (ANC) includes Wavelet Transform and IIR-Notch filter to reduce the baseline Wander and Power Line Interference noises. Afterward, an additive white noise generator unit is employed to evaluate the performance of the three adaptive models involving GA-LMS, PSO-LMS, and GA-PSO-LMS algorithms in terms of Signal to Noise Ratio (SNR) and Mean Square Error (MSE). Eventually, to evaluate the performance of the proposed models in terms of the MSE and SNR criteria, we conduct comprehensive experiments on the ECG records of the MIT-BIH database. The obtained results of variable step size, GA-LMS, PSO-LMS, and hybrid GA-PSO-LMS, demonstrate more efficiency in filtered signal compared to constant step size LMS. Besides, in most cases, the Hybrid GA-PSO-LMS method has superiority over two other proposed methods concerning the SNR and MSE criteria.

pp. 254-260

Wednesday, September 15

Wednesday, September 15 9:00 - 10:00

K3: Keynote Speaker

Foundation for Localization-of-Things in 5G Ecosystem and Beyond
Prof. Moe Win - MIT
Chairs: Melike Erol-Kantarci (University of Ottawa, Canada), Ahmed Refaey (Manhattan College, USA & Western University, Canada), Xianbin Wang (Western University, Canada)

Abstract: The availability of real-time, high-accuracy location awareness is essential for numerous wireless applications, particularly those involving Internet-of-Things and the 5G ecosystem. The coming years will see the emergence of network localization and navigation in challenging environments with sub-meter accuracy and minimal infrastructure requirements. This will call for the Localization-of-Things (LoT), a new paradigm referring to locating, tracking, and navigating collaborative and non-collaborative nodes (e.g., sensors, vehicles, and objects). Our work relying on statistics, optimization, and communication theory approaches LoT from different perspectives. This talk will give an overview of LoT, examining our recent research results in this exciting new field, from the perspectives of theoretical framework, cooperative algorithms, network operations, and network experimentation.

Moe Win is a Professor at the Massachusetts Institute of Technology (MIT) and the founding director of the Wireless Information and Network Sciences Laboratory. Prior to joining MIT, he was with AT&T Research Laboratories and NASA Jet Propulsion Laboratory. His research encompasses fundamental theories, algorithm design, and network experimentation for a broad range of real-world problems. Current research topics include network localization and navigation, network interference exploitation,

and quantum information science.

Professor Win is a Fellow of the AAAS, the EURASIP, the IEEE, and the IET. He has served the IEEE Communications Society as an elected Member-at-Large on the Board of Governors, as elected Chair of the Radio Communications Committee, and as an IEEE Distinguished Lecturer. He was honored with two IEEE Technical Field Awards: the IEEE Kiyo Tomiyasu Award and the IEEE Eric E. Sumner Award. His publications, co-authored with students and colleagues, have received several awards. Other recognitions include the IEEE Communications Society Edwin H. Armstrong Achievement Award; the Copernicus Fellowship and the Laurea Honoris Causa from the Università degli Studi di Ferrara; and the U.S. Presidential Early Career Award for Scientists and Engineers. He is an ISI Highly Cited Researcher.

Wednesday, September 15 10:00 - 10:30

B6: Break

Wednesday, September 15 10:30 - 12:30

P4: Panel 4 - Power System Transformation World-wide

Maike Luiken - Past President, IEEE Canada; Juan Carlos Montero - Costa Rican National Power Control Center (CENCE); Jianwei (Jay) Liu - PJM; Wei-Jen Lee - The University of Texas at Arlington
Chair: Maike Luiken (Carbovate & Western University, Canada)

Speaker - Juan Carlos Montero - Global Power System Transformation Practices: Central America

Abstract: Central America Electricity Market had changed on the last years from six independent energy markets and balancing areas to have an addition regional market and heavy operational coordination. As new renewable energy is integrated on the grid and DER starts to increase, an improvements on grid codes, operational practices and markets rules are required to operate the grid on a safe way and also improve the optimization of the energy resources on the region. We will review how the market was created based on standard energy resources, issues detected with the new resources on the system , improvements ongoing and improvements that could be important on the future of the grid.

Biography: Juan Carlos Montero is the Former IEEE Power & Energy Society Vice President of Membership & Image. He has previously held several other volunteer leadership roles within the IEEE Power & Energy Society at the local and international levels. Mr. Montero received the Bachelor and Licentiate degree on Electrical Engineering from the University of Costa Rica. He is the Electrical Operational Planning Coordinator in the Costa Rican National Power Control Center (CENCE). He is also Part-Time Lecturer Professor at the University of Costa Rica. Mr. Montero is a Senior Member of the IEEE.

Speaker - Jianwei (Jay) Liu - IEEE System Operator Survey (Part 1) System Operator Strategic Technical Priorities & (Part 2) - Localized Technology Adoption and Standards

Biography: Dr. Jay Liu is currently a Senior Lead Engineer of Infrastructure Coordination at PJM. He has 30 years experiences in power industry on infrastructure planning, implementation and operation. He has developed, coordinated and integrated more than 20,000 MW conventional and renewable

energy resources into the power grids. He also participated and coordinated more than 2000+ Transmission and Distribution projects through the planning and implementation phases, including the recent competitive planning projects at PJM. Prior to PJM, Dr. Liu worked at ISO New England as Lead EMS Specialist and at JSTIC as Investor's representative for more than 5,000 MW IPP energy projects. He obtained his B.E. and M.E. degrees both in power system at Southeast University in Nanjing China, in 1992 and 1996 respectively, and his Ph.D. degree in electrical engineering at University of Waterloo, Ontario, Canada in 2004. He also got his MBA degree from PennState University in 2010.

Dr. Liu is a senior member of IEEE, Chair of Natural Disaster Mitigation Methods and Operation Technology Working Group, and a member of PES Industry Technology Support Leadership Committee.

Speaker - Wei-Jen Lee - Power System Transformation - The Role of Industrial Sector

Speaker - Maike Luiken - Sustainable Energy and Its Role in the Global Power System Transformation

Biography: Maike Luiken, PhD, SMIEEE, IEEE-HKN, FEIC, is 2021 IEEE Vice President - Member & Geographic Activities. She served as President of IEEE Canada in 2018 - 2019 and, in 2018, as Chair, Policy Track, IEEE Internet Initiative. Currently Adjunct Research Professor at Western University, she was the founding Director of the Bluewater Technology Access Centre (now Lambton Manufacturing Innovation Centre) following eight years as Dean at Lambton College with a number of portfolios: School of Technology and Applied Sciences, Business Development, Sustainable Development and Applied Research. Her strategic leadership in the development of the applied research & innovation capacity and portfolio led to Lambton College becoming one of the three top Research Colleges in Canada. Her areas of interest and expertise span diverse technical areas from ICT, energy and water to advanced manufacturing and nanotechnologies as well as technology design principles, ethics in design and policy associated with their implementation. She has particular interest in how progress in one area, e.g., in ICT, enables advances in other disciplines and in how deployment of various technologies contributes - or not - to achieving sustainable development.

Maike Luiken has experience in the public and private sectors in Canada and has worked in the USA and Germany. She owns a small technology consulting practice and is a co-owner and a managing director at a start-up company.

Wednesday, September 15 12:30 - 13:30

K4: Keynote Speaker

Aerial: An AI/ML Enabled Software Defined Radio Approach for Next Generation Wireless
Dr. Chris Dick - NVIDIA
Chairs: Ahmed Refaey (Manhattan College, USA & Western University, Canada), Xianbin Wang (Western University, Canada)

As the rollout of 5G progresses and research for 6G begins, the key themes of softwarization, virtualization, open systems and artificial intelligence form foundational principles for communication systems of the future.

The application of AI/ML to wireless communication is an extremely active research area with many 10's to 100's of papers published weekly reporting new results on the application of AI/ML to the

physical layer (L1), MAC layer (L2) and at the network optimization level.

To realize the Industry's vision of an AI/ML powered wireless future, a full stack solution supporting a software defined radio (SDR) approach for the vRAN, together with optimized silicon for AI, coupled with application development frameworks for AI/ML development is essential. NVIDIA GPU technology and associated CUDA programming model, together with a rich suite of AI/ML SDKs (Software Development Kits) provides these capabilities.

In this talk we present The Aerial software-defined GPU-based cloud native 5G NR RAN platform. Aerial implements not only 5G NR the baseband signal processing, but using GPU virtualization supports additional concurrently operating workloads, such as AI/ML inference, training and data analytics on this one hyper-converged system. We provide an overview of the L1 signal processing pipeline and describe efficient mechanisms for data movement between the GPU and NIC-based fronthaul interface using a GPU-enabled Data Plane Development Kit (DPDK). A brief survey of some of the promising deep learning approaches for L1 and L2 enhancements is presented.

Bio: Dr Chris Dick joined NVIDIA in 2020 where he is a wireless architect and the technical lead for the application of Artificial Intelligence and Machine Learning to 5G and 6G wireless. From 1998 to 2020 he was a Fellow and the DSP Chief Architect at Xilinx.

In his 30 years working in signal processing and communications he has delivered silicon and software products for 3G, 4G and 5G baseband DSP and Docsis 3.1 cable access. He has performed research and delivered products for digital front-end (DFE) technology for cellular systems with a particular emphasis on digital pre-distortion for power amplifier linearization. Chris has also worked extensively on silicon architecture and compilers for machine learning. Prior to moving to Silicon Valley in 1998 he was a tenured academic in Melbourne Australia for 13 years. He has over 200 publications, 70 patents and is an adjunct Professor at Santa Clara University where he has taught courses on real-time signal processing and machine learning for 18 years. In 2018 he was awarded the IEEE Communications Society Award for Advances in Communication for research in the area of full-duplex wireless communication.

Wednesday, September 15 13:30 - 15:00

Tech7: Technical Sessions

Chair: Khan A Wahid (University of Saskatchewan, Canada)

13:30 Efficient Model Based Grid Intersection Detection for Single-Shot 3D Reconstruction

Kasra Sadatsharifi and Mohamed A. Naiel (University of Waterloo, Canada); Mark Lamm (Christie Digital Systems, Canada); Paul Fieguth (University of Waterloo, Canada)

The crucial role of pixel correspondences in the process of projector-camera calibration and 3D reconstruction is to determine the relationship between camera and projector view. Consequently, acquiring accurate pixel correspondences with a robust detection method can result in accurate 3D reconstruction for a given scene. Single-shot structured light (SSSL) binary patterns are now commonly projected onto target scenes, where they usually consist of white grid lines separating different square tags ordered in such a way to encode the projector pixels. This paper introduces a new technique for detecting the intersection of grid lines to obtain the pixel correspondences of a given SSSL system, where ultimately the detected intersections represent the pixel correspondences. Our SSSL projected pattern contains horizontal and vertical grid lines which allows us to parameterize the lines fitting the grid lines. Experimental results show that the

proposed method offers at least 50 times faster computation than a recent connected component analysis-based method at the cost of sparser pixel correspondences and a slight decrease in the accuracy of the 3D reconstructed point cloud.
pp. 261-266

13:45 A Study of Saliency Methods for Tree Detection in Aerial Images of Rural Areas

Naiane Sousa (Universidade Federal de Goias, Brazil); Juliana Félix (Universidade Federal de Goiás, Brazil); Gabriel Vieira (Federal Institute Goiano, Brazil); Bruno Rocha (Universidade Federal de Goias, Brazil); Fabrizzio Soares (Universidade Federal de Goiás, Brazil & Southern Oregon University, USA)

In this paper, we propose a study to evaluate how saliency methods can highlight and support the segmentation of trees in aerial images. An analysis of the use of the Green-Red Vegetation Index (GRVI) in this context is also carried out, and a combination of GRVI along with saliency methods is also analyzed. Our results indicate that saliency methods show great potential to support the detection of trees in aerial images of rural areas. When planted areas are considered, the GRVI method alone cannot highlight tree regions. Finally, the combination of GRVI with saliency methods has shown small or no improvement when compared to the results using only saliency methods.

Presenter bio: Associate Professor at Southern Oregon University (SOU) and Informatics Institute at the University of Goiás (UFG). Ph.D. in Electrical Engineering, MSc in Electrical and Computing Engineering, Graduated two programs: Computer Science and Data Processing. He works with Machine Learning, Image Processing, Computer Vision, Human-Computer Interaction, and Applied Computing. Nowadays, he is Computer Science Chair at SOU and advises Ph.D., Mastering, and Undergrad Students at UFG.
pp. 267-270

14:00 I-Generalized and Kullback-Leibler Divergences for Content-Based Image Retrieval

Bruno Rocha (Universidade Federal de Goias, Brazil); Daniela Ferreira (Universidade Federal de Uberlandia, Brazil); Celia Barcelos (Federal University of Uberlândia, Brazil); Fabrizzio Soares (Universidade Federal de Goiás, Brazil & Southern Oregon University, USA)

Technological advancement has increased the amount of information is generated every day. The social and economic relevance of image recovery systems has created the need for improvement. Computing similarity between two images is a fundamental step in a CBIR system to retrieve images of interest. A proper similarity measure choice is the essence for efficient and effective image retrieval. Therefore, recent studies have used Bregman divergences in researches because of its flexibility in similarity analysis. Thus, this work aims to propose an efficient and robust method using the divergences of Bregman I-Generalized and Kullback Leibler to be used as measures of similarity in CBIR systems. The model bag of the visual word approach based on image subregions was used to characterize the images. Experiments used public databases: Holiday and Caltech101. A result shows our proposal achieved satisfactory gains when compared to Euclidean and Cosine distances in different classifiers. Moreover, our approach shows promising and competitive results when compared to methods presented in the literature. Therefore, using divergences with appropriate treatment can be used as similarity functions in parametric classifiers to minimize semantic gap em CBIR.

Presenter bio: Associate Professor at Southern Oregon University (SOU) and Informatics Institute at the University of Goiás (UFG). Ph.D. in Electrical Engineering, MSc in Electrical and Computing Engineering, Graduated two programs: Computer Science and Data Processing. He works with Machine Learning, Image Processing, Computer Vision, Human-Computer Interaction, and Applied Computing. Nowadays, he is Computer Science Chair at SOU and advises Ph.D.,

Mastering, and Undergrad Students at UFG.
pp. 271-274

14:15 An Effective Method for Automated Railcar Number Detection and Recognition Based on Deep Learning

Ran Zhang, Zhila Bahrami and Zheng Liu (University of British Columbia Okanagan, Canada)
Railway transportation is of great value to the economy. Railcars usually travel at fast speeds in complex environments. Accurately detecting and recognizing the railcar numbers contributes significantly to logistic management. Therefore, this paper presents a deep-learning-based method for automated railcar number detection and recognition. It consists of two steps, i.e., railcar number detection and recognition, which are conducted by two separated deep learning models. In the detection process, both the whole region of railcar number and text instances are detected so our method is able to remove the detected noisy text regions, i.e., false positives. The cropped text areas in the railcar number regions are sent to the text recognizer. Crucially, the text is recognized on word level so there is no need to conduct an extra step to separate all characters. Experimental results on the railcar number dataset demonstrate that our proposed method can effectively detect and recognize railcar numbers.
Presenter bio: Ran Zhang received his bachelor's degree in information engineering from Xidian University, Xi'an, China, in 2015, and master's degree in computer software and theory from Capital Normal University, Beijing, China, in 2018. He is currently pursuing the Ph.D. degree in electrical engineering with the School of Engineering, the University of British Columbia, Okanagan Campus, Kelowna, Canada. His research interests include computer vision and pattern recognition.
pp. 275-280

14:30 GroupNet: Detecting the Social Distancing Violation Using Object Tracking in Crowdscene

Anthony J Boyko and Mohamed Abdelpakey (University of British Columbia, Canada); Mohamed S Shehata (University of British Columbia & Memorial University, Canada)
COVID-19 affects everyone on a daily-basis causing adjustments in which society functions. One of these major adjustments is the need to measure how well people distance from each other, that is referred to as social distancing. Previous work to automate social distancing violations does not take into consideration the exceptions to minimum distance guidelines. In this paper, we propose GroupNet, a novel multi-object tracking social distancing violation detector through the addition of group detection to reduce the number of false positives that are currently missed in existing literature. We define the social distancing violation occurs when two individuals are within a specified Euclidean distance of two meters. GroupNet leverages the contextual information learned by group detection. Moreover, GroupNet uses a Joint Detection and Embedding (JDE) multi- object tracker as a backbone network for group detection. To map from pixel-wise coordinates to the real-world equivalent coordinate, a pre-processed affine matrix is used for the trans- formation. GroupNet determines if two individuals are a group through leveraging a re-identification component from a multi- object tracker. Location of bounding boxes are tracked over time to obtain individuals relative distance between each other. Group- Net uses regression analysis to determine if the relative distance between two individuals changes over time. The likelihood of the change in relative distance is non-zero determines group existence between individuals (i.e. group detection). Performance of GroupNet is evaluated by manual inspection of output images due to the lack of labeled ground truth data. Moreover, GroupNet through the provided experiments shows an improvement in the reduction in the number of false-positives due to group detection analysis alongside the addition of minimal false-negatives.
pp. 281-285

14:45 Arrhythmia Classification Using Hybrid Feature Selection Approach and Ensemble Learning Technique

Mohammad Mahbubur Rahman Khan Mamun and Ali Alouani (Tennessee Technological University, USA)

Early diagnosis of arrhythmia is very significant because the symptoms are not always prominent and may go unnoticed until a deteriorating heart health condition is reached. Due to progress in machine learning techniques and the availability of a larger dataset, it is now possible to analyze and propose better techniques to detect cardiac arrhythmia. This paper presents a new hybrid approach that uses feature selection followed by ensemble classification for the diagnosis of arrhythmia. The feature selection algorithm provides a list of strongly correlated features with arrhythmia and at the same time making sure to use minimum redundant information. Using the arrhythmia dataset from UCI for training and testing purposes, the performance of the proposed hybrid approach had 77.27% accuracy and 76% precision. This outperformed the eight individual estimators used in this paper for comparison.

pp. 286-291

15:00 LIME-Enabled Investigation of Convolutional Neural Network Performances in Covid-19 Chest X-Ray Detection

Eduardo Gasca Cervantes and Wai-Yip Geoffrey Chan (Queen's University, Canada)

The Coronavirus Disease (COVID-19) has caused millions of casualties across the globe. One inexpensive and noninvasive screening method for COVID-19 is the analysis of chest X-ray (CXR) images for pathological features in the lungs. These features are difficult to detect by humans, but convolutional neural networks (CNN) have proven effective at extracting them. This paper uses four ImageNet-pre-trained CNNs: VGG16, DenseNet201, ResNet50, and EfficientNetB3 to perform transfer learning to a task of COVID-19 CXR image detection on a dataset containing COVID-19, healthy, and viral pneumonia CXR images. We compare the performance of the retrained CNNs using standard measures and investigate the features they use for their predictions using local interpretable model-agnostic explanations (LIME). The networks are retrained on two classification tasks: Task 1 consists of classifying healthy and COVID-19 CXR images and task 2 consists of classifying viral pneumonia and COVID-19 CXR images. We find that DenseNet201 and VGG16 achieve higher accuracies than ResNet50 and EfficientNetB3 in both tasks. However, the LIME explanations reveal that VGG16 does not learn disease-relevant features in the lungs, while DenseNet201, ResNet50, and EfficientNetB3 use regions in the lungs to make their predictions. This observation is reinforced by comparing LIME explanations with ground-truth lung regions on an unseen dataset. The prospect of using "black box" deep neural networks for automatic screening of CXRs for COVID-19 can be improved with LIME-enabled investigations of model performance.

pp. 292-297

Tech8: Technical Sessions

Chair: Mostafa Farrokhabadi (University of Waterloo, Canada)

13:30 Data-Driven Wind Speed Forecasting Techniques Using Hybrid Neural Network Methods

Mehdi Abbasipour, Mosayeb Afshari Igder and Xiaodong Liang (University of Saskatchewan, Canada)

Wind power generation is a dominant form of renewable energy sources with significant technical progress over the past decades. One of the major challenges in wind power generation is the intermittent nature of wind speed. In this paper, wind speed prediction techniques are investigated using wind speed measurement data in Saskatchewan, Canada. Despite excellent wind power

potential in Saskatchewan, currently, only 6.5% of total electricity demand is supplied by wind power in this province. In this paper, three hybrid Neural Network methods (Wavelet Neural Network (WNN) trained by Improved Clonal Selection Algorithm (ICSA); WNN trained by Particle Swarm Optimization (PSO); and Extreme Learning Machine (ELM)-based Neural Network) are implemented and compared for wind speed forecasting using actual recorded wind speed data of Saskatchewan, which paves the way for economical operation, planning, and optimization of the current and future wind farms in Saskatchewan.
pp. 298-303

13:45 VRF Battery Characterization Using Microwave Planar Complementary Split Ring Resonators

Kalvin Schofield, Nazli Kazemi and Petr Musilek (University of Alberta, Canada)

The oxidation states of vanadium redox flow battery electrolytes need to be rebalanced for sustainable long term energy storage and battery performance monitoring. To achieve this, a complementary split-ring resonator is designed at 5.26 GHz to monitor the state of the charge of each electrolyte continuously in situ during battery operation. Sensor performance was tested on a 40 cell, 2.5 kW stack utilizing 40 L of electrolyte. Battery cycling was performed between 62 V-30 V (terminal voltage) with a max charge/discharge current of 40 A/45 A respectively. The transmission notch of the resonator measures resonance amplitude variation of ~ 1 dB during charging cycle with ~ 0.04 dB incertitude.
pp. 304-309

14:00 Comparative Analysis of Time Series and Artificial Intelligence Algorithms for Short Term Load Forecasting

Hana Beydoun, Ahmad Khan and Seyed Ali Arefifar (Oakland University, USA)

Short-term load forecasting (STLF) has been an interesting subject for power utility companies in the last few decades. In this paper, five different time series forecasting models are employed and integrated with Artificial Intelligence (AI) models to study the applicability of the methodologies for short term load forecasting. The AI models are employed and integrated with the seasonal ARIMA methodology to study their effects on STLF, whereas the emerging Facebook Prophet model is utilized along with the conventional Holt-Winter's to evaluate against the original and hybrid ARIMA models. The hybrid ARIMA approach involves modeling the ARIMA residuals and increasing the input features space to include weather parameters in addition to previous days load data. For our case study pertaining to modeling and predicting the load on a short-term basis using the data from a Michigan based utility, the Holt-Winters' model performance exceeded the performance of the remaining methodologies, where it achieved an accuracy of 99% and 98.6% in both the training and testing phases, respectively.
pp. 310-316

14:15 Design and Development of an Intelligent Tool for Retail Electric Provider Plan Selection

Daniel Mabuggwe (Ontario Tech University, Canada); Walid Morsi (Ontario Tech University (UOIT), Canada)

In this paper, an intelligent tool for retail electric provider plan selection is designed and developed for the residential customers and prosumers. The main objective of this tool is to provide decision support to the residential customers to enable them to make a feasible selection of local distributed energy resources such as rooftop solar photovoltaic and battery energy storage as well as plug-in electric vehicles that will maximize the savings on their energy bill. In conjunction with decision support in finding feasible combinations of resources, a suitable retail electric provider is also chosen that will minimize their annual energy bill. In total, 48 homes were evaluated, 17

representative profiles of rooftop solar photovoltaic, home battery energy storage and plug-in electric vehicles as well as 24 retail electric provider plans consisting of flat, tiered and time-of-use plans were evaluated from Austin, Texas. This tool was designed using a knowledge base of rules for decision support and the difference in the minimum annual energy bills, before and after the resources are added to the homes, are used to calculate the personalized energy bill savings of the prosumers. This tool was implemented in MATLAB App-designer software.
pp. 317-322

14:30 Optimal Real-Time Scheduling of Battery Operation Using Reinforcement Learning

Carolina Quiroz Juarez and Petr Musilek (University of Alberta, Canada)

Adoption of battery energy storage systems working with solar photovoltaic distributed systems for residential house- hold applications strongly depends on their return on investment. Battery energy storage system (BESS) technology costs have been strongly decreasing during the last decade. However, such a tendency has to be supported by optimal BESS real-time operation strategies that adapt to the stochastic operation conditions (residential load, solar generation, and electricity prices) and minimize the customer's electric bill. This work presents a real-time adaptive BESS controller that implements a load- shifting strategy under time-of-use and feed-in-tariff (microFIT) regulatory incentives. The optimization of the battery operating strategy is carried out by a Q-learning algorithm and later encoded in a neural network that implements the optimal strategy at a fraction of the computation cost. Real residential demand and solar generation profiles during the summer and winter seasons in Edmonton, Canada, are utilized to train and test the controller. Two battery technologies, lithium-ion and vanadium redox flow, are simulated; real charge-discharge experimental data from an installed system was used. The proposed adaptive controller outperforms the optimal strategy, both during the summer and winter testing periods.
pp. 323-329

14:45 A New Approach to Design New Orthogonal Wavelets Using Unsupervised Clustering Applied to Nonintrusive Load Monitoring

Jessie Gillis (University of Ontario Institute of Technology, Canada); Walid Morsi (Ontario Tech University (UOIT), Canada)

This study aims to address the problem of load identification using single-point sensing. The problem of load identification forms the basis for nonintrusive load monitoring, which is an important application in future smart metering infrastructure. This work introduces a novel approach that uses orthogonal wavelet design and the unsupervised clustering of wavelet basis functions for single-point sensing. The coefficients of the discrete wavelet filters of length-6 and length-8 are computed using the minimum properties of the orthogonal wavelet filters. Covariance analysis is then applied to identify the set of orthogonal wavelets that best fits the load signals after clustering the newly generated wavelets using the unsupervised machine learning. To automate the classification process, a decision tree classifier is then applied to induce the classification models. The results have shown that the use of length-8 filters may improve the classification accuracies when compared to length-6 filters, which is mainly due to the large number of wavelets functions.
pp. 330-336

Wednesday, September 15 15:00 - 15:30

B7: Break

Wednesday, September 15 15:30 - 16:30

P5: Panel 5 - Net Zero Emissions and the Technology Required

Dale Tardiff, Chair: Gamal Refai-Ahmed, Vice-Chair; Ray Barton -Outreach and Partnership Committee
Chair: Dale Tardiff (Innovative Power Solutions Inc, Canada)

Panelists: Soheil Asgarpour - Petroleum Technology Alliance of Canada Peter Devita - Engineers for the Profession Barrie Kirk - CAVCOE Jiri Skopek - Jiri Skopek Architect and Planner

Abstract: There is much discussion of reaching zero emission by various proposed dates. As with any goal, a plan, or roadmap is required to reach this target. In the case of reducing emissions of greenhouse gases significant sectors of the economy are impacted. Some notable examples are energy production and transportation.

In this panel discussion, possible technologies that can be implemented by several sectors will be introduced. The intention is to initiate a discussion and get people thinking about various ideas and what their impact could be. Our expectation is that participants will have an increased understanding of the technology requirements and technical challenges to be overcome in attempting to reach net-zero economy.

Tech9: Technical Sessions

Chair: Wei Shi (University of British Columbia, Canada)

15:30 Modeling of MoS2 Tunnel Field Effect Transistor in Verilog-A for VLSI Circuit Design

Md Khan and Naheem Adesina (Louisiana State University, USA); Jian Xu (Louisiana State University, Canada)

This paper presents the design of an inverter, half adder, and ring oscillator using compact models of MoS2 channel- based tunnel field effect transistor (TFET). The TFET models (both n and p-type) are written in high-level hardware language Verilog-Analog (Verilog-A) following the analytical model of [1] and the output characteristics of the components are simulated in Cadence/ Spectre software. The performance of the designed inverter (a basic building block of VLSI circuit) is analyzed by extracting its different parameters, such as transfer characteristics, power dissipation and consumption, delay, power delay product. The simulated outputs (sum & carry) obtained from the half adder circuit exactly match the truth table of the circuit. Moreover, our observation reveals that the ring oscillator can operate at a higher frequency with lower power consumption in comparison to the existing CMOS and GFET technologies. We have also reported an improvement to the limiting factor of ring oscillator performance i.e. phase noise at two different offset frequencies. With all the output characteristics obtained from the commercial software simulation, we expect our model to be applicable to a real-time low-power VLSI circuit.

pp. 337-342

15:45 Thermal Stress Analysis and Stabilization of Metal and SU-8 Coatings for Tri-Layer Mirror

Mehdi Allameh and Shirin Ramezanzadehyazdi (University of Manitoba, Canada); Byoungyoul Park (National Research Council of Canada, Canada); Cyrus Shafai (University of Manitoba, Canada)

This article describes the fabrication and stress analysis of a tri-layer metal-polymer stack, for use as a thin film mirror. The effect of SU-8 hard bake on the final stress was investigated. The results showed that 275 degrees Celsius is sufficient temperature to enable thermally stable SU-8 2025. Chromium and Aluminum were investigated as metal layers and deposited on different samples using thermal evaporation and sputtering. Thermal evaporation is the recommended technique for having higher tensile stress causing a smooth mirror surface. Experiments showed that annealing metal layers after deposition increases the tensile stress and provides a thermally stable metal layer.

pp. 343-347

16:00 High Q-Factor Graphene-Based Inductor CMOS LC Voltage Controlled Oscillator for PLL Applications

Naheem Adesina and Ashok Srivastava (Louisiana State University, USA)

This work examines the design of high Q-factor inductor for LC voltage-controlled oscillator (VCO) in TSMC 0.18μm n-well CMOS process technology and 1.5 V supply voltage. The planar structure of graphene and its sufficient relation time make it easier to pattern graphene into helical structures without additional contacts at each corner. The inductor is modelled with the widely accepted π-model and the results show that graphene inductor achieves a high Q-factor with reduced parasitics and losses when compared with Cu wire inductor. Following this, we employed the inductor in the design of 2 GHz LC VCO. From the Cadence/Spectre simulations, we obtained that the tuning range of voltage-controlled oscillator is 1.62 GHz to 3.93 GHz and the phase noise measured is -124.8 dBc/Hz at 1 MHz offset frequency. In addition, the VCO has a figure of merit (FoM) of 206.4 dBc/Hz and consumes 3.66 mW power.

Presenter bio: Naheem Olakunle Adesina (nadesi1@lsu.edu) is currently pursuing his Ph.D degree in Electrical and Computer Engineering from Louisiana State University, Baton Rouge, USA. He received his B.Tech degree from Ladoke Akintola University of Technology, Ogbomoso, Nigeria and M.Sc. degree from Obafemi Awolowo University, Ile-Ife, Nigeria. Naheem has won academic awards and scholarship. His research interests focus on memristive devices, analog and mixed signal VLSI design, 2D material and transistor, information and signal processing.

pp. 348-354

16:15 Design and Implementation of an 8-Bit, 256-Step Digitally-Controlled Phase Shifter at 2.1 GHz with Minimum 1.41o Phase Change for Its LSB Step Size

Shakeeb Abdullah (Carleton University & NRC, Canada); Gaozhi (George) Xiao (National Research Council Canada, Canada); Rony E. Amaya (Carleton University, Canada)

As technology advances, the requirement and need for smaller and finer phase-control for phase steps less than 2o is arising (if the demand is not here already). Unfortunately today, most phase shifters have minimal resolution of 5.625o and that has been the status quo for quite some time now. The objective of this paper's research and investigation is to show how one can implement phase shifts as low as 1.41o (or lower) for use as the phase shifter's least-significant-bit (LSB). The paper shows a design and proof-of-concept of a phase shifter at 2.1 GHz simulated on FR4 substrate using off the self surface mount device (SMD) components. The phase shifter in this paper had eight phase shifting blocks for 8-bits of resolution (control). The architecture of the eight blocks were purposely designed differently to showcase the flexibility and use of a diode loaded phase shifting trimmer as the first couple units of the phase shifter - for the smallest phase changes of 1.41o and 2.81o. Phase shifting blocks 3-4 (for 5.625o and 11.25o phase change) were designed

using hybrid couplers, and blocks 5-8 (for 22.5o, 45o, 90o, and 180o phase change) were designed using T-bridge topology (since modern technology already incorporates them). The diode loaded trimmer was used for the fine tuning steps since diodes are almost always readily available in all kits, they take up low layout area, and are easy to implement.
pp. 355-358

Thursday, September 16

Thursday, September 16 9:00 - 10:00

K5: Keynote Speaker

Federated Learning and its applications to Internet of Things
Prof. Mohsen Guizani - Qatar University
Chairs: Ahmed Refaey (Manhattan College, USA & Western University, Canada), Xianbin Wang (Western University, Canada)

As the Internet-of-Things devices are being widely adopted in all fields, such as smart houses, healthcare, and transportation, large amounts of data are being collected, shared, and processed. This fact raises many challenges on how to make the best use of this huge amount of data to improve the IoT systems' security using artificial intelligence, taking into consideration the resource limitations in IoT devices and issues regarding data privacy. Different techniques have been studied and developed throughout the years. For example, Federated Learning (FL), which is an emerging learning technique that is very well known for preserving and respecting the privacy of the collaborating clients' data during model training. The concepts of FL and Hierarchical Federated Learning (HFL) are evaluated and compared with respect of detection accuracy and speed of convergence, through simulating an Intrusion Detection System for Internet-of-Things applications. Different kinds of datasets (e.g., NSL-KDD) are used in our work to prove that our developed schemes are superior compared to other schemes in terms of training loss, testing accuracy, and speed of convergence. HFL also showed its efficiency over FL in reducing the effect of the non-identically and independently distributed data on the collaborative learning process.

In this Keynote, we review the current efforts by experts around the world to mitigate some of these challenges. Then, we showcase our research activities to contribute to these efforts and advocate possible solutions using AI and other tools. We provide ways on how to manage the available resources intelligently and efficiently in order to offer better conditions and provide improved services. Finally, we discuss some of our research results to support a variety of applications including how to secure these devices for successful healthcare service delivery in different aspects.

Bio: Mohsen Guizani (S'85-M'89-SM'99-F'09) received the B.S. (with distinction), M.S. and Ph.D. degrees in Electrical and Computer engineering from Syracuse University, Syracuse, NY, USA. He is currently a Professor at the Computer Science & Engineering Department in Qatar University, Qatar. Previously, he worked in different institutions: University of Idaho, Western Michigan University, University of West Florida, University of Missouri-Kansas City, University of Colorado-Boulder, and Syracuse University. His research interests include wireless communications and mobile computing, applied machine learning, cloud computing, security and its application to healthcare systems. He was elevated to the IEEE Fellow in 2009. He was listed as a Clarivate Analytics Highly Cited Researcher in Computer Science in 2019 and 2020. Dr. Guizani has won several research awards including the "2015

IEEE Communications Society Best Survey Paper Award" as well 4 Best Paper Awards from ICC and Globecom Conferences. He is the author of nine books and more than 800 publications. He is also the recipient of the 2017 IEEE Communications Society Wireless Technical Committee (WTC) Recognition Award, the 2018 AdHoc Technical Committee Recognition Award, and the 2019 IEEE Communications and Information Security Technical Recognition (CISTC) Award. He served as the Editor-in-Chief of IEEE Network and is currently serves on the Editorial Boards of many IEEE journals/Transactions. He was the Chair of the IEEE Communications Society Wireless Technical Committee and the Chair of the TAOS Technical Committee. He served as the IEEE Computer Society Distinguished Speaker and is currently the IEEE ComSoc Distinguished Lecturer.

Thursday, September 16 10:00 - 10:30

B8: Break

Thursday, September 16 10:30 - 12:30

P6: Panel 6 - IEEE Standards

Innovations to Standardization: The Role of Standards in Innovation
Glenn Parsons, Panel Chair
Chair: Glenn Parsons (Ericsson, Canada)

Abstract: Some people believe that standards and innovation are opposites. Is this true? Is this a misperception? In other words, is it possible that standards actually support innovation? The panel brings together standardization experts to explore the relationship between industry innovation and standardization. The panel discussion aims to address these issues and more.

Speakers: Mehmet Ulema, Manhattan College Alex Gelman, NetOvation Glenn Parsons, Ericsson Rudi Shubert, IEEE SA

Tech10: Technical Sessions

Chairs: Ebrahim Ghafar-Zadeh (York University, Canada), Vijay Parsa (University of Western Ontario, Canada)

10:30 COVID-Net MLSys: Designing COVID-Net for the Clinical Workflow

Audrey Chung (DarwinAI, Canada); Maya Pavlova (University of Waterloo, Canada)
As the COVID-19 pandemic continues to devastate globally, one promising field of research is machine learning- driven computer vision to streamline various parts of the COVID-19 clinical workflow. These machine learning methods are typically stand-alone models designed without consideration for the integration necessary for real-world application work- flows. In this study, we take a machine learning and systems (MLSys) perspective to design a system for COVID-19 patient screening with the clinical workflow in mind. The COVID- Net system is comprised of the continuously evolving COVIDx dataset, COVID-Net deep neural network for COVID-19 patient detection, and COVID-Net S deep neural networks for disease severity scoring for COVID-19 positive patient cases. The deep neural networks within the COVID-Net system possess state-of-the-art performance, and are designed to be integrated within a user interface (UI) for clinical decision support with automatic report generation to assist clinicians in their treatment decisions.
pp. 359-363

10:45 A Multi-Agent Krill Herd Algorithm

Amir Andaliby Joghataie (University of Victoria & Nokia Canada, Canada); T. Aaron Gulliver (University of Victoria, Canada)

Metaheuristic algorithms are powerful tools for solving optimization problems. The Krill Herd Algorithm (KHA) is a new nature-inspired metaheuristic algorithm. A Multi-Agent System (MAS) is a system that contains multiple interacting agents. These agents are autonomous entities that interact with their environment to achieve specific goals. Agents can also learn or use their knowledge to accomplish a task. Multi-agent systems can solve problems that are very difficult or even impossible for monolithic systems to solve. In this paper, a modification of KHA is proposed which incorporates MAS to obtain a new Multi-Agent Krill Herd Algorithm (MA-KHA). The performance of the proposed algorithm is evaluated using several benchmark global optimization problems. Numerical results are presented which show that MA-KHA performs better than existing krill herd algorithms.

pp. 364-369

11:00 Optimal Bidding Strategy in Day-Ahead Electricity Market for Large Consumers

Behrouz Banitalebi, Srimantoorao Appadoo and Aerambamoorthy Thavaneswaran (University of Manitoba, Canada)

Electricity price forecasting has become an essential task for electricity buyers and sellers participating in competitive power markets. Compared to the existing point forecasting methods, probabilistic forecasting approaches provide more in- formation about the future forecasts of electricity prices. This paper uses the double exponential smoothing (DES) and triple exponential smoothing (TES) methods to compute volatility forecasts of day-ahead electricity prices. Moreover, we use the elastic net regularization to compute regularized forecasts for volatility. Sample sign correlation of standardized electricity prices (standardized by volatility forecasts) is used to identify the conditional distribution of the electricity price series. Validation of the regularized volatility forecasts is demonstrated using the publicly available hourly Ontario electricity prices. Our data analysis shows that TES forecasts of volatility outperform DES forecasts. Besides, elastic net regularization decreases the mean absolute error of the TES day-ahead volatility forecasts from 11.98 to 11.07. Energy procurement of a large consumer is modelled as an optimization problem to find the optimal bidding strategy. First, a gradient boosting regression (GBR) method computes the optimum electricity prices to be placed in the day-ahead market. Then, a linear programming method is used to obtain the optimum strategy by computing the quantities that need to be bought from the market for the upcoming day. Our simulation results indicate that using probabilistic forecasts of electricity prices leads to a more flexible and efficient bidding strategy than using the point forecasts.

pp. 370-375

11:15 Toward Using Few-Shot Learning for Prediction of Complex In-Service Defects of Composite Products: A Case Study

Mohamad Khajezade and Milad Ramezankhani (University of British Columbia Okanagan, Canada); Fatemeh Fard (University of British Columbia, Canada); Mohamed S Shehata (University of British Columbia & Memorial University, Canada); Abbas Milani (University of British Columbia Okanagan, Canada)

Numerical modelings for industrial trials, which are used to predict expensive defects, are unrealistic. As a result, since generating annotated data is very expensive in the industry, a model is needed that can be adapted to real-world parameters with a handful of real experiments. Thus, this paper investigates applying the model-agnostic meta-learning algorithm, which is one of the state-of-the-art models in few-shot learning, to create a machine learning model for predicting bunching

defects in manufacturing industrial hoses. This model is expected to extract the knowledge from simulated data from the bunching defects and adapt this knowledge for the real world using a few examples collected from real experiments. While the accuracy of the proposed algorithm is less than 15 percent, this paper shows a promising result if better-simulated data can be used.
pp. 376-382

11:30 Predicting Physiological Effects of Chemical Substances Using Natural Language Processing

Sourav Mukherjee (Fairleigh Dickinson University Vancouver, Canada); JJ Ben-Joseph (University of Maryland Baltimore County, USA); Marcelo Campos, Prashan Malla, Hieu Nguyen and Anh Pham (Fairleigh Dickinson University Vancouver, Canada); Tim Oates (University of Maryland, Baltimore County, USA); Vasudevan Janarthanan (Fairleigh Dickinson University, Canada)

In this paper, we apply natural language processing methods to develop models for predicting physiological effects of chemical substances based on their molecular structures. Using string representations of structure as a starting point, we vectorize molecules using two different approaches resulting in sparse and dense vector representations, respectively. We use these representations to train predictive models for a variety of physiological effects such as toxicity, cell cycle arrest and proliferation. Using standard chemical datasets, we empirically demonstrate that such models can achieve high predictive accuracy.
pp. 383-388

11:45 Tool Wear Monitoring Using Machine Learning

Ming Li and Mihai Burzo (University of Michigan-Flint, USA)

Monitoring tool wear conditions and estimating tool lives are crucial for automatic metal cutting manufacturing processes. Accurate estimation of tool wear status can optimize tool usage and tool replacement, which in turn leads to improvement of product quality and reduction of downtime and costs. Various methods have been proposed to evaluate tool wear conditions using multiple sensory signals during the cutting process. However, because the signal-to-noise ratio is extremely low in the machining process, the accuracy of tool wear evaluation still needs to be improved. In this paper, machine learning methods were explored to estimate the tool wear conditions based on the experimental data provided by the 2010 PHM society conference data challenge. A self-organizing map was designed to identify the tool wear conditions into 16 levels. According to the correlation coefficients between sensory datasets and the tool wear levels, 14 features were selected for tool wear estimation. A feed- forward backprop neural network and a support vector machine with the fine Gaussian kernel were constructed for tool wear estimation. The testing results showed that the root mean square for neural network model was 0.9866 and for the support vector model was 1.4985.
pp. 389-393

12:00 Time Frequency Representations and Deep Convolutional Neural Networks: A Recipe for Molecular Properties Prediction

Alain Beaudelaire Tchagang (NRC, Canada); Julio Valdes (Researcher at the National Research Council of Canada, Canada)

In recent years, Quantum Mechanics (QM) has been combined with Machine Learning (ML) algorithms to speed up the design of molecules, drugs and materials. These paradigms known as QM↔ML have been successful in providing the precision of QM at the speed of ML. In this work, we show that by integrating well-known signal processing (SP) techniques in the QM↔ML pipeline, we obtain a powerful methodology (QM↔SP↔ML) that can be used for representation, visualization and molecular properties predictions. Tested on the benchmark QM9 dataset, the new QM↔SP↔ML framework is able to predict the properties of molecules with a mean absolute error

below acceptable chemical accuracy, and yield better or similar results compared to other ML state-of-the-art techniques described in the literature.
Presenter bio: Alain B. Tchagang received his B.S. and M.S. degree in physics from the University of Yaoundé I, Cameroon, in 1996, and 1998 respectively, a "diplôme d'ingénieur de conception de génie électrique" from the "Ecole Nationale Superieure Polytechnique" de Yaoundé I, Cameroon in 2000. He then moved to the USA, where he obtained a M.S. degree in electrical engineering and a Ph.D. in biomedical engineering from University of Minnesota, MN USA in 2004 and 2007 respectively. From 2007 to 2008, he was a postdoc in computational systems biology in the department of computational biology, School of medicine, University of Pittsburg, PA USA. Since 2008, Alain works as research officer in the scientific data mining team, digital technologies research centre of the National Research Council of Canada. His research interests include machine learning, artificial intelligence, signal processing, and their applications.
pp. 394-398

Thursday, September 16 12:30 - 13:30

LT3: IEEE Canada President Elect Candidates Forum

Meet The Candidates
Chair: Maike Luiken (Carbovate & Western University, Canada)

IEEE Canada members select an IEEE Canada President-Elect and IEEE Region 7 Director-Elect every two years. We are in the midst of electing for 2022-3. The two candidates have made themselves to make presentations at CCECE 2021 and to take questions after. The deadline to cast your vote is 12:00 pm Eastern Time (16:00 UTC) on 1 October 2021, s this is a chance to meet and query our candidates

This session will be moderated by Maike Luiken, IEEE MGA Vice-President and IEEE Canada Past President.

The candidates are:

Dr. Mohammed A. S. Khalid from University of Windsor

Dr. Thamir "Tom" F. Murad from Seimens Mobility

More details on their background and statements can be found at https://www.ieee.org/about/corporate/election/region7.html

Thursday, September 16 13:30 - 15:00

Tech11: Technical Sessions

Chair: Stephanie Willerth (University of Victoria, Canada)
13:30 Assistive Technology for Hearing-Impaired and Deaf Students Utilizing Augmented Reality
Ali Mohammed Ridha and Wessam Shehieb (Ajman University, United Arab Emirates)
Common universities and colleges worldwide are not equipped with technological techniques that can assist deaf and hearing-impaired students in their education, while few specialized universities are built for deaf students, sign language tutors, or in-class television captioning are included for

few majors only. A novel system is proposed and developed to help deaf and hearing-impaired students who are aiming to continue their education outside special centers and communicate normally with the societies that are not sign language educated. By introducing an intelligent software solution developed for affordable augmented reality glasses that will assist students in their educational journey with real-time transcribing, speech emotion recognition, sound indications features, as well as classroom assistive tools.
pp. 399-403

13:45 Design of Continuous Flow UVC Lamp for Office Air Germicide Elimination

Tanya Gachovska (Solantro Semiconductor Corp., Canada); Manishkumar Moorjmalani (Carleton University, Canada); Mahdi Tude Ranjbar (Solantro Semiconductor Corp., Canada); Georgi Gachovski (Furlani Foods, Canada); Constantin Pintilei (Nemko, Canada); Malek Amiali (ENSA, Algeria); Zied Bouida (Carleton University, Canada); Alfredo Herrera (University of Ottawa, Canada)

When the Coronavirus (COVID-19) pandemic started to hit in the beginning of 2020, a team led by the IEEE Humanitarian Activities Committee (HAC) and the IEEE Special Interest Group on Humanitarian Technologies (SIGHT) society was formed to brainstorm different ideas which can benefit people from Ottawa and all over the world. One of the discussed ideas was designing a UVC office lamp which can work in presence of humans to eliminate the air germicide. The lamp is designed with materials that can be easily bought on the market and is easy to be manufactured. The lamp has an Ultraviolet C (UVC) output power of 72 W. It also features with over-temperature protection and wireless diagnostic.
pp. 404-409

14:00 Combining Tabu Search and Genetic Algorithm to Determine Optimal Nurse Schedules

Justin Schrack, Roy Ortega, Kevin Dabu and Daniel Truong (British Columbia Institute of Technology, Canada); Michal Aibin (British Columbia Institute of Technology, Canada & Northeastern University, USA); Ania Aibin (British Columbia Institute of Technology, Canada)

The nurse scheduling problem (NSP) deals with assigning nurses to shifts in a schedule. These assignments must be made based on several hard and soft constraints specific to each nurse. Our solution attempts to solve this problem for smaller-scale clinics or private offices by creating weekly schedules that require only two nurses per shift and have only two shifts per day. We used thirty-four nurses with no specific specializations and can complete all nurse-related activities required by the clinic as sample data. Each nurse in the data pool can be scheduled more than once a week. Using techniques from genetic algorithms and tabu search, our algorithm assesses multiple possible solutions and returns only the most viable schedule based on the soft constraints.
pp. 410-416

14:15 CMOS Capacitive DNA Nano-Mass Measurement for DNA Storage Application

Hamed Osouli Tabrizi and Saghi Forouhi (York University, Canada); Morteza Ghafar-Zadeh (Biologically Inspired Sensors and Actuators Laboratory (BioSA), Canada); Sebastian Magierowski and Ebrahim Ghafar-Zadeh (York University, Canada)

In this paper, we present, for the first time, the advantage of CMOS capacitive sensor for the assessment of dried DNA from an aqueous sample for DNA storage applications. The proposed capacitive sensor consists of a differential capacitance to current converter block based on a core-CBCM circuit, a 300 MHz current controlled oscillator and a 12-bit counter that creates the digital output of the chip. The chip has been fabricated using AMS 0.35μm technology. We demonstrate the functionality and applicability of the proposed sensor for dried DNA nano-mass measurement using single-strand DNA samples. The sensor shows acceptable repeatability in quantifying the

DNA nano-mass with a sensitivity of 18.5 aF/ng mass of DNA based on the results described here.
pp. 417-421

14:30 Privacy Preserving Occupancy Detection Using NB IoT Sensors

Cody Chand, Angelo Villanueva and Matt Marty (British Columbia Institute of Technology, Canada); Michal Aibin (British Columbia Institute of Technology, Canada & Northeastern University, USA)

Occupancy detection is crucial when trying to lower the emissions that a building produces. Some buildings are equipped with motion sensors or cameras to find how many occupants are in a room. However, this is not entirely accurate as people could be stationary in situations like sitting at a desk or watching television. Using environmental sensors, we can determine if a room is occupied even if the occupants are not moving. When occupants are inside a room, they give off extra CO2 or increase the room's temperature. We can find the small differences in the environmental values used to accurately predict a room's occupancy levels. We use relatively inexpensive IoT sensors that almost every building's HVAC system should have in the near future. We apply K-means clustering with success to predict occupancy levels. Our algorithms can be used in smart thermostats to automatically adjust the room's heat depending on how many occupants are in a room.

Presenter bio: Dr. Michal Aibin was born in 1989 in Poland. He began his doctoral studies at the Department of Systems and Computer Networks at the Wroclaw University of Technology in 2012, where he was twice awarded the Dean Award and a scholarship to the best Ph.D. students. He received his doctoral degree in June 2017 by defending the thesis: "Dynamic Routing Algorithms for Cloud-Ready Elastic Optical Networks." He currently works at the British Columbia University of Technology, Vancouver, Canada, in the Department of Computing, where he was awarded the Employee Excellence Award in the Applied Research category. He is also a Visiting Associate Professor at Northeastern University, Boston, MA, United States. His research topics are related to the optimization of computer networks and RPAS technology. In particular, he applies Data Analytics, Machine Learning and Deep Learning concepts to enable technology advancements in areas mentioned above.

pp. 422-425

Thursday, September 16 15:00 - 15:30

B9: Break

Thursday, September 16 15:30 - 16:30

P7: Panel 7 - Women in Engineering

Awards Applications and Membership Advancement
Winnie Ye - Panel Chair
Chair: Winnie Ye (Carleton University, Canada)

Abstract : Various Panel members will discuss opportunities and awards for the advancement of women in engineering.

Learn from WIE professionals from across Canada about how to create a successful award application and how to move upward in your membership with IEEE.

Panelists: Dr. Winnie Ye - Professor - Carleton University, Ottawa, ON Dr. Hadis Karimipour - Professor - University of Calgary, Calgar, AB Dr. Maryam Davoudpour - Professor - Ryerson University, Toronto, ON Mr. Jeffrey Arcand - Software Engineering & IEEE Volunteer, Ottawa, ON Ms. Leanne Dawson - PhD Candidate, University of Calgary, Calgary, AB

Tech12: Technical Sessions

Chair: Daniela Constantinescu (University of Victoria, Canada)

15:30 Implementing an Improved Image Enhancement Algorithm on FPGA

Prit Patel (University of Windsor, Canada); Arash Ahmadi (University of Windsor, Canada & University of Southampton, United Kingdom (Great Britain)); Mohammed Khalid (University of Windsor, Canada)

As image enhancement works with the initial raw inputs at the front end of the image processing applications, it can be considered as a backbone of image processing, and offers a wide range of area of applications, and also have started being used in medical field over the past decade. On the other hand, these image enhancement techniques are bit demanding in choice of processing units when it comes to implementation due to the demand of high resolution. In this paper we present an improved image enhancement algorithm in terms of performance and its implementation on FPGA to satiate the necessity of high speed, powerful, and cost-effective processing unit by providing flexibility, parallelization, pipelining and reconfigurability. The FPGA implementation was obtained using High Level Synthesis from MATLAB specifications and implemented an improved image enhancement algorithm on Cyclone V by using Intel Quartus Prime CAD tool suite. We have considered an X-ray image size of 1000x1920p for implementation and achieved a quantitative improvement in PSNR values and hardware resource utilization along with the better visual interpretability by our proposed improvements.

pp. 426-431

15:45 Energy-Efficient Algorithm for Robot-Assisted Sensor Deployment

Joseph Valencic and Lovina Saxena (Norleaf Networks, Canada); Rohit Joshi (Cistel Technology, Canada); Marzia Zaman (Cistel Technology Inc., Canada)

In recent years, wireless sensor networks have gained considerable popularity due to their relatively lower cost and ability to obtain useful information from hard-to-reach locations. However, poor deployment of sensor nodes results in bad network connectivity and sensing coverage. In this paper, we have proposed a new algorithm for robot-assisted sensor deployment called Closest First (CF) which minimizes the distance traveled by the mobile robot while achieving a good distribution of sensors in the region of interest. We evaluated and compared the performance of our proposed distance traversal algorithm with three other robot-assisted sensor deployment algorithms via simulations while varying different parameters such as number of deficit sensors, carrying capacity of the mobile robot, number of deficit sensor cells, and surplus to deficit ratio. Simulation results showed that the proposed Closest First algorithm outperformed the other algorithms under different simulated scenarios.

pp. 432-436

16:00 Risky Zone Avoidance Strategies for Drones

Michel Barbeau (Carleton University, Canada); Joaquin Garcia-Alfaro (Institut Mines-Telecom, France); Evangelos Kranakis (Carleton University, Canada)

We consider the problem of a drone having to traverse a terrain. Traversal of the terrain exposes the drone to certain risks, e.g., concentration of chemicals, severe thunderstorm wind gusts or any disturbing weather phenomenon. The goal of the drone is to navigate the terrain while minimizing

the amount of risk. We develop a framework for quantifying the exposure to risk factors in a circular zone model. We propose risky zone avoidance navigation strategies for rectilinear or curvilinear drone trajectories. We validate the work using numeric simulations.
pp. 437-442

16:15 CPC-H2: Convolution Power-Based Cryptosystem and Digital Signature

Hamid Hajaje (University Mohammed V, Morocco); Zine elabidine Guennoun (Mohamed V University, Morocco); Mounib Khanafer (American University of Kuwait, Kuwait); Youssef Gahi (University Ibn Toufail, Morocco); Junaid Israr and Mouhcine Guennoun (University of Ottawa, Canada)

ElGamal system was introduced by Taher ElGamal in his landmark paper in 1985 [1]. ElGamal is an important asymmetric cryptosystem that is based on the discrete logarithm problem. In brief, this cryptosystem relies on the difficulty of computing discrete logarithms over finite fields [1]. Towards solving discrete logarithms, Shor demonstrated the existence of a polynomial algorithm that can solve these logarithms on quantum machines [2]. In this paper we propose the Convolution Power Cryptosystem (CPC-H2); an extension to the ElGamal cryptosystem that is based on a novel hard problem. CPC-H2 is designed to defend against a Chosen Ciphertext Attack. We show that CPC-H2 is less complicated and has a higher security level than the Number Theory Research Unit (NTRU).
pp. 443-449

Friday, September 17

Friday, September 17 9:00 - 10:00

K6: Keynote Speaker - IoT Connect

Edge Intelligence: Challenges and Opportunities
Soumaya Cherkaoui
Chairs: Ahmed Refaey (Manhattan College, USA & Western University, Canada), Xianbin Wang (Western University, Canada)

Dr. Soumaya Cherkaoui is a Full Professor at Department of Electrical and Computer Engineering of Université de Sherbrooke, Canada which she joined as a faculty member in 1999. Her research and teaching interests are in wireless networks. Particularly, she works on next generation networks (5G and beyond), Edge computing/Network Intelligence, and communication networks for verticals such as Connected and Autonomous Vehicles, IoT, and Industrial IoT. Since 2005, she has been the Director of INTERLAB, a research group which conducts research funded both by government and industry. Before joining U. Sherbrooke, she worked for industry as a project leader on projects targeted at the Aerospace Industry. Her work resulted in technology transfer to companies and to patented technology. Pr. Cherkaoui has published over 200 research papers in reputed journals and conferences. She has been on the editorial board of several journals including IEEE JSAC, and IEEE Systems, IEEE Network, IET Quantum Communication, Elsevier COMNET and Elsevier VehCom. Her work was awarded with recognitions and best paper awards including a best paper award at the IEEE Communications Society Flagship conference IEEE ICC in 2017. She has chaired prestigious conferences and workshops such as IEEE LCN 2019, and has served as a symposium co-chair for flagship conferences including IEEE ICC 2018, IEEE Globecom 2018, IEEE Globecom 2015, IEEE ICC 2014, and IEEE PIMRC 2011. She is currently an IEEE ComSoc Distinguished Lecturer. She is a Professional Engineer in Canada, a senior

IEEE Member, and is serving as the Chair of the IEEE Communications Society IoT-Ad hoc and Sensor Networks Technical Committee since 2020.

Friday, September 17 10:00 - 12:00

IS: IoT Connect Invited Speakers

Damla Turgut - University of Central Florida; Amr Mohamed - Qatar University; Ayman Radwan - Instituto de Telecomunicações and Universidade de Aveiro; Luca Foschini - Università degli Studi di Bologna
Chair: Ahmed Refaey (Manhattan College, USA & Western University, Canada)

Speaker: Damla Turgut - Title: Humans, AI, and IoT Biography: Damla Turgut is Charles Millican Professor of Computer Science at the University of Central Florida (UCF). She received her Ph.D. from the Computer Science and Engineering Department of the University of Texas at Arlington. She held visiting researcher positions at the University of Rome ``La Sapienza", Imperial College of London, and KTH Royal Institute of Technology, Stockholm, Sweden. Her research interests include wireless ad hoc, sensor, underwater, vehicular, and social networks, edge/cloud computing, smart cities, IoT-enabled healthcare and augmented reality, as well as considerations of privacy in the Internet of Things. She is also interested in applying big data techniques for improving STEM education for women and minorities. Her most recent honors include serving as IEEE ComSoC Distinguished Lecturer for 2021-22, the NCWIT 2021 Mentoring Award for Undergraduate Research (MAUR), the UCF Research Incentive Award, and the UCF Women of Distinction Award. She is the Vice-Chair of the Social Networks Technical Committee, an advisor of the SIG on Machine Learning for Ad Hoc, Sensor, and IoT Networks of the IoT-AHSN Technical Committee, a member of the IEEE ComSoc Emerging Technologies Standing Committee, a member of the steering committee of the IEEE LCN. Since 2019, she serves as the N2Women Board Co-Chair where she co-leads the activities of the N2Women Board in supporting female researchers in the fields of networking and communications. She has been a Technical Program/Symposium Co-Chair of IEEE GC/ICC conferences multiple times. She is a member of the ACM and a senior member of the IEEE.

Speaker: Amr Mohamed - Multi-agent Reinforcement Learning for Scalable Smart Health Applications

Biography: Amr Mohamed (S' 00, M' 06, SM' 14) received his M.S. and Ph.D. in electrical and computer engineering from the University of British Columbia, Vancouver, Canada, in 2001, and 2006 respectively. He has worked as an advisory IT specialist in IBM Innovation Centre in Vancouver from 1998 to 2007, taking a leadership role in systems development for vertical industries.

He is currently a professor in the college of engineering at Qatar University. He has over 25 years of experience in wireless networking research and industrial systems development. He holds 3 awards from IBM Canada for his achievements and leadership, and 4 best paper awards from IEEE conferences. His research interests include wireless networking, and edge computing for IoT applications. Dr. Amr Mohamed has authored or co-authored over 200 refereed journal and conference papers, textbooks, and book chapters in reputable international journals, and conferences. He is serving as a technical editor for international journals and has served as a technical program committee (TPC) co-chair for many IEEE conferences and workshops.

Speaker: Ayman Radwan - New Trends in IoT Networks towards 6G

Biography: Dr. Radwan has received his Ph.D. from Queen's University (Kingston, ON, Canada), in 2009, and his Master of Applied Science (M. A. Sc.) from Carleton University (Ottawa, ON, Canada). He has worked for a year at Queen's University, as a research assistant, before moving to Portugal, in January 2010. In January 2010, he joined Institute de Telecomunicações (IT), as a Senior Researcher and to help with EU project coordination and technical management. Since then, Dr. Radwan has been intensively active in European projects, coordinating and technically managing multiple EU projects. He has acted as the coordinator of multiple EU joint research projects, with multiple International partners. He was the co-PI of the EU FP7 Project "C2POWER" (10 partners and Budget: €5M). He also acted as the coordinator of the multi-partner projects: EU CELTIC "Green-T" project (17 partners and Budget: €6.5M) and the CELTIC Plus project "MUSCLES" (6 partners and Budget: €4.5M). He is currently coordinating the EU project CELTIC-NEXT "SAFE-HOME", with emphasis on eHealth, Smart-Home, and energy efficient fog-cloud networking. He was involved in multiple successful funded proposals, raising more than 2M€ in funding for his own institute.

His research interests include mobile network architecture targeting current and next generations of networking (specifically 5G and 6G), IoT networking, software defined networking, and fog-cloud networking and computing. He has more than 100 published highly cited peer-reviewed articles (with 22 h-index, and 1365 citations).

Dr. Radwan is an active IEEE Senior member, involved in multiple IEEE activities, including being an active reviewer for multiple journals and IEEE Comsoc conferences. He is an associate editor for IEEE Comm. Letters and IEEE Network. Additionally, he has been an active TPC member of ICC and Globecom, since 2008.

Speaker: Luca Foschini - Intelligent Management of Future IIoT Networks: A tale of IT/OT convergence and DevOps

Biography: Luca Foschini, Ph.D., is an Associate Professor of Distributed and Mobile Systems at the Computer Science and Engineering Dept. (DISI) of the University of Bologna. He has been habilitated as Full Professor in the national examination called Abilitazione Scientifica Nazionale 2020. His research interests span from from context-aware service composition to federated cloud resource management, from mobile crowdsensing to scalable online stream processing for smart cities, from edge computing management in Industry 4.0 to design and performance assessment of Industrial IoT (IIoT) platforms. His research has been sponsored by local regional funds and industrial companies, and he is currently involved in various EU H2020 projects. He has been Visiting Expert Researcher in Brazil at UDESC State University of Santa Catarina. He is a Senior Member of IEEE and a Member of ACM. Within IEEE ComSoc, Prof. Foschini is a voting member of the EMEA Board, and he is also volunteering as EMEA Awards Committee/Young Researcher Award Program Chair and as secretary of the IEEE CSIM TC.

He has published over 200 conference and journal papers in these areas, receiving best paper award recognitions from various IEEE ComSoc technically sponsored conferences, such as ICC'21, ICC'18, ISCC'19, and CAMAD'19, and highly-cited paper mentions in IEEE journals. From the point of view of his publication record (Google Scholar - September 2021: h-index=32; i10-index=89; citations=5029), he has co-authored more than 64 international journal/magazine articles (in publication venues that are considered the excellent ones in his research field, such as IEEE COMST, ACM CSUR, Proceedings of the IEEE, IEEE TNSM, IEEE TC, IEEE TETC, IEEE TCC, IEEE TPDS, IEEE JSAC, IEEE ComMag, and IEEE WCM), guest-edited 5 special issues in international journals/magazines, co-authored 5 chapters in international books, and 130+ additional works published in other international venues

(conferences, workshops etc.) such as CCGrid, ISWC, Globecom, ICC, and ISCC. He has served as General Co-Chair and as TCP Co-Chair for several IEEE conferences, and as reviewer for several IEEE, Elsevier, and Wiley journal venues; he is also member of the Editorial Boards of IEEE Networking Letters, IGI IJHCR and IJARAS, and Hindawi IJDSN and WCMC. For a longer CV, please refer to:

http://www.lia.deis.unibo.it/Staff/LucaFoschini/pdfDocs/shortCV_English.pdf

Friday, September 17 12:00 - 12:30

B10: Break

Friday, September 17 12:30 - 14:00

IS1: IoT Connect Invited Speaker

Olof Liberg - Ericcson; Matthew Krieger - Cobra Electronics; Aiman Erbad - Hamad Bin Khalifa University
Chair: Ahmed Refaey (Manhattan College, USA & Western University, Canada)

Speaker: Olof Liberg - Head of 5G standards -'Cellular IoT - From 5G to 5G Advanced'

Olof Liberg is a researcher and program manager at Ericsson's department for Standards & Technologies. Olof joined Ericsson in 2008 and has specialized in the design and standardization of cellular radio access technologies. He is currently leading Ericsson's 3GPP radio access network standardization team. Olof holds a bachelor's degree in Business and Economics and a master's degree in Engineering Physics, both from Uppsala University. He has, over the years, actively participated to the work in several standardization bodies such as 3GPP, ETSI and the MulteFire Alliance. He was the chairman of 3GPP TSG GERAN and its Working Group 1, during the 3GPP study on new radio access technologies for Internet of Things leading up to the specification of NB-IoT. Olof is the leading author of the first and second edition of the book Cellular Internet of Things (Elsevier), has co-authored 10 IEEE articles and contributed to 50 US patents.

Speaker: Matthew Krieger - IoT Security - Even More Complex Than It Seems (2021 update)

Abstract: IoT security is a complex topic with broad scope. Beyond basic physical device security and protection of communications from prying eyes are considerations around device authentication, ensuring message integrity, ongoing patch management, standardizing protocols, securing the massive surface area of the rapidly growing footprint of IoT sensors, secure-from-the-start development practices, the mismatch between IT and industrial networks and more. This talk will explore the definition of security in the context of IoT, cover threats to the IoT devices and networks, touch on the current state of IoT security from a regulatory perspective and explore options for securing the IoT ecosystem.

Biography: Matthew Krieger is a technologist and executive with experience in IT, manufacturing and publishing. He is President of Cober, Inc. and previously held senior IT leadership positions at Time, Inc. and the Reader's Digest Association. Matthew is Founder of Whysper, an audio aggregation platform allowing the consumption of text content as high quality text-to-speech. Matthew is Chairman of the Board of the Reader's Digest Partners for Sight Foundation, a non-profit focusing on the needs of

the blind and visually impaired community. Matthew is also on the advisory board of Cyber-Seniors, is Chair of the Southern Connecticut State University Computer Science Technical Advisory Council, is Chief Technology Officer of the SCORE Fairfield County Connecticut chapter. Matt is a frequent presenter on topics of business and technology and the intersection of each.

Speaker: Aiman Erbad - Associate Professor at the 2Division of Information and Computing Technology, College of Science and Engineering, Hamad Bin Khalifa University - Reinforcement Learning for Efficient and Privacy Preserving Distributed Inference in Smart City IoT Systems

Aiman Erbad is an Associate Professor at the 2Division of Information and Computing Technology, College of Science and Engineering, Hamad Bin Khalifa University, Qatar. Dr. Erbad obtained a PhD in Computer Science from the University of British Columbia (Canada), and a Master of Computer Science in Embedded Systems and Robotics from the University of Essex (UK). Dr. Erbad received the Platinum award from H.H. The Emir Sheikh Tamim bin Hamad Al Thani at the Education Excellence Day 2013 (PhD category). Dr. Erbad research interests span cloud computing, multimedia systems and networking, and his research is published in reputed international conferences and journals.

Friday, September 17 14:00 - 16:00

Tech13: Technical Sessions

Chair: Ali Mahmoud (University of Louisville, USA)

14:00 Evaluating an IoT Under-Mattress Sensor Mat for Detecting Anomalies in Sleep Parameters: A Pilot Study

Ibrahim Sadek (University of Sherbrooke & Helwan University, Canada); Bessam Abdulrazak (Université de Sherbrooke, Canada); Mounir Mokhtari (Institut Mines-Télécom, France)

Sleep is equally important as a healthy diet, and exercising and not getting adequate sleep can lead to being less physically active during the day. Still, sleep is underrated by many people. Measuring sleep at home using conventional methods is not practical, given the complexity of equipment, so several user-friendly sleep monitoring devices are continually being developed. This paper aims to evaluate the effectiveness of an IoT under-mattress sensor mat for identifying anomalies in sleep parameters under a real-life scenario out of the lab. The sensor mat embodies a microbend fiber optic sensor that is sensitive enough to capture the mechanical activities caused by the heart. Five older adults participated in the study, and raw sensor data were gathered over several weeks. Limits of agreement and boxplots were employed to identify anomalies in three sleep parameters, i.e., wake-up time, bedtime, and time in bed. Also, a sleep history metric was applied to captures an aggregate measure of sleep behavior. Albeit using a single-channel sensor, sleep anomalies were detected and verified by the participants' caregivers.

pp. 450-454

14:15 A CNN-ELM-Based Method for Ballistocardiogram Classification in a Clinical Environment

Sahar Tahir (University of Sherbrooke, Canada); Ibrahim Sadek (University of Sherbrooke & Helwan University, Canada); Bessam Abdulrazak (Université de Sherbrooke, Canada)

The ballistocardiogram (BCG) represents rich signals that have been adopted in various clinical applications. Still, vital signs detection via BCG is a troublesome task because the BCG waveform morphology depends on the measurement device. Additionally, BCG can be different between and within-subjects, hence in this paper, we applied a deep learning-based approach, namely convolutional neural network (CNN) and extreme learning machine (ELM), to discriminate

between BCG and non-BCG signals. BCG signals were acquired with an IoT-based microbend fiber optic sensor mat from ten patients diagnosed with obstructive sleep apnea and underwent drug-induced sleep endoscopy. Three methods, including undersampling, oversampling, and generative adversarial networks (GANs), were used to balance the number of BCG vs. non-BCG signals. Furthermore, the system performance was assessed using 10-fold cross-validation. Overall, the best results were achieved using the CNN-ELM with GANs as a data balancing method. The average accuracy, precision, recall F-score were 94%, 90%, 98%, and 94%, respectively.
pp. 455-459

14:30 Voting Control in Multiple Entry PBFT Blockchain Systems for IoT

Jelena Mišić and Vojislav B. Mišić (Ryerson University, Canada); Xiaolin Chang (Beijing Jiaotong University, China); Priyanka Sarode (Ryerson University, Canada)

In this work we design and model a policy which incentivizes nodes to vote in a multiple entry PBFT protocol. Each time a node votes on a block proposal, a token is generated for that node. Nodes that do not vote are penalized by denying them the right to submit proposals until they have collected a sufficient number of tokens. We present a queuing M/G/1 model of token control mechanism and integrated queuing model of the node with access regulated with token mechanism. Performance results confirm the efficiency of proposed scheme.
pp. 460-465

14:45 Anomaly Detection on Smart Meters Using Hierarchical Self Organizing Maps

Muhammadjon Toshpulatov and Nur Zincir-Heywood (Dalhousie University, Canada)

With the growing environmental and technological demands in the energy market, changes in the electrical systems are inevitable. To accommodate these demands advanced metering infrastructures and smart meters are employed. In this paper, we explore a data driven unsupervised learning approach for anomaly detection on smart meters. To this end, we employ and evaluate a hierarchical self organizing map on real world smart meter data. Our results show that different types of anomalies could be detected with an F1-score of over 90%.
pp. 466-471

15:00 B5G: Intelligent Coexistence Model for Edge Network

Sara Zimmo (The University of Western Ontario, Canada); Ahmed Refaey (Manhattan College, USA & Western University, Canada); Abdallah Shami (Western University, Canada)

While researchers are focusing on the fifth-generation (5G) cellular network, the network operators and standard bodies are discussing specifications for beyond fifth-generation (B5G) and 6G. Attributes of B5G include edge intelligence which involves artificial intelligence or machine learning (ML) in the architecture. Network edge servers, or base stations (BS), use edge computing to make time-critical decisions, especially in IoT devices while the data are being transmitted into the cloud. As the dynamic spectrum sharing continues in B5G, BSs implements the coexistence between Wi-Fi and cellular network. These exciting advances require energy efficiency to be considered as network operators pay the majority of the expenses to energy consumption. In this paper, different prediction models on traffic behaviour are computed to determine the lowest root mean square error. The best prediction model is used in the wake-up policy to consider the communication and computing times of the BS needed to return in service. Furthermore, a wake-up policy for the BS is introduced to maintain Quality of Service (QoS) while minimizing energy consumption. Particularly, a wake-up time threshold is set so that if the duration of the traffic prediction time does not cross this threshold, the decision will not be in favour to put it into sleep mode. This ensures that the QoS of the user is not compromised, as this threshold removes the unnecessary wasted time for BS to go to sleep and wake-up.

pp. 472-476

15:15 Measuring Noise Pollution by Utilizing Bluetooth Low Energy Beacons

Evan Fallis and Petros Spachos (University of Guelph, Canada)

A major problem in several modern cities is noise pollution. Noise pollution is any disturbing or unwanted noise that interferes or even harms humans. It has several sources such as public events and vehicular traffic. Being able to characterize areas based on acoustic noise level is useful not only for proving danger in terms of damage to the human ear but also for general discomfort from living near a constantly noisy environment. Internet of Things (IoT) devices can help to collect, process, and characterize acoustic noise, while they offer advantages such as small size and low cost. This work uses small-size Bluetooth Low Energy (BLE) beacons to collect audio data in different parts of a city. The data are forwarded to a server station for further characterization and processing. Initial results show the promising performance of the proposed system, in terms of energy consumption and audio data characterization.

pp. 477-481

Friday, September 17 16:00 - 16:30

CC: Closing Ceremony

Chairs: Ahmed Refaey (Manhattan College, USA & Western University, Canada), Xianbin Wang (Western University, Canada)