2022 IEEE Canadian Conference on Electrical and Computer Engineering (CCECE 2022)

Halifax, Nova Scotia, Canada
18 – 20 September 2022

IEEE

IEEE Catalog Number: CFP22758-POD
ISBN: 978-1-6654-8433-6

****** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP22758-POD
ISBN (Print-On-Demand):	978-1-6654-8433-6
ISBN (Online):	978-1-6654-8432-9
ISSN:	0840-7789

Additional Copies of This Publication Are Available From:

Curran Associates, Inc
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: (845) 758-0400
Fax: (845) 758-2633
E-mail: curran@proceedings.com
Web: www.proceedings.com

CURRAN ASSOCIATES INC.
proceedings.com

Sunday, September 18

Sunday, September 18 8:00 - 19:00 (America/Halifax)

R1: Registration

Room: foyer

Sunday, September 18 9:00 - 12:00 (America/Halifax)

T1: Tutorial 1 - Meta Learning in Real-World: Basics and Applications

Dr. Di Wu
Room: Harbour Suites A

Deep learning has achieved impressive success in different real-world applications. However, most deep learning algorithms would require a large amount of training data. Meta-learning, also known as learning, to learn, has shown the capability of learning fast with a limited number of samples. In this tutorial, we aim to present the recent progress of meta-learning algorithms and real-world applications of meta-learning. Specifically, we will introduce three lines of meta-learning methods, i.e., gradient-based methods, metrics-based methods, and memory-based methods. Furthermore, we will also present the application of meta-learning in real-world systems such as smart grids and transportation systems. Finally, we will discuss the challenges and potential research directions.

T2: Tutorial 2 - Introduction to Codes and Standards

Nehad El-Sherif
Room: Harbour Suites B

Codes and Standards are indispensable because of the essential role they play in our lives. They touch every aspect of our lives by ensuring safety, quality and reliability of products and services. Additionally, codes and standards guarantee compatibility between different markets to facilitate international trade. According to Raymond G. Kammer, the past director of the US National Institute of Standards and Technology (NIST), about 80% of global merchandise trade is affected by standards and by regulations that embody standards. Therefore, it is important to understand the standards development process, the different types of standards, and how to become actively involved in the development process.

This tutorial provides attendees having little or no background of codes and standards with the information required to develop a basic understanding of the topic. It also serves as a refresher for experienced attendees. The 5W's method will be used to engage attendees and historical examples to emphasize the importance of complying with codes and standards. Innovation and its relation to standards will be discussed. Finally, a real-life design example will be shared with attendees to demonstrate how codes and standards are applied in practice.

Sunday, September 18 13:30 - 16:30 (America/Halifax)

T3: Tutorial 3 - Vertically Integrated Ocean Data

Steve DeLory
Room: Harbour Suites A

The world's oceans are part of the larger biome in which we live, yet only about 5-10% of the Earth's seabed has been mapped. We know that we must know more about the oceans which we live beside, gather our food from, and play in.

There is a significant process to collect information about the seabed, process the information into a usable format, and present that information in an understandable and useful way. This workshop will introduce participants to this process, using a hands-on approach.

The goal of the workshop is to walk participants through the process of collecting, processing, hosting, and using ocean data. Although there is a myriad of ocean data types that look at the water column, the seabed, and the ground beneath the seabed, we will focus on seabed mapping using sidescan sonar data. Sidescan sonar presents a very usable and intuitive ‘map' of the seabed that is visually comprehensible, comparatively easy to process, and useful to many users.

T4: Tutorial 4 - Continual Curriculum Improvement Workshop

Steve Wilton (UBC), Tim Davidson (McMaster U), Yunwei Ryan Li (U of Alberta), Jean-Francois Bousquet (Dalhousie U) Hosted by the Canadian Heads of Electrical and Computer Engineering (CHECE)
Room: Harbour Suites B

This workshop is intended to present and discuss current challenges and opportunities in modern Electrical and Computer Engineering Programs. Panelists will present recent projects that are intended to improve the undergraduate curriculum in engineering. Subjects include: • how to use the experience we gained during pandemic to deliver our material; • the delivery of a hands-on course to integrate prior knowledge; • how to use Graduate Attributes to assess and improve our curriculum; • efficiently mounting a Computer Engineering program; • managing increasingly large cohorts in our curriculum;

Sunday, September 18 19:00 - 21:00 (America/Halifax)

Reception: Conference Reception

Room: Commonwealth B

Monday, September 19

Monday, September 19 7:30 - 18:00 (America/Halifax)

R2: Registration

Monday, September 19 8:00 - 17:00 (America/Halifax)

E1: Exhibits and Posters

Room: Commonwealth B

Monday, September 19 8:45 - 9:00 (America/Halifax)

OC: Opening Ceremony

Chris Whitt, Jason Gu, Deputy Mayor Pam Lovelace
Room: Atlantic Ballroom

Monday, September 19 9:00 - 9:45 (America/Halifax)

K1: Keynote Speaker 1

Signe Redfield
Room: Atlantic Ballroom

Monday, September 19 9:45 - 10:15 (America/Halifax)

B1: Morning Break

Room: foyer

Monday, September 19 10:15 - 11:50 (America/Halifax)

Panel 1: Industry Panel

Room: Atlantic Ballroom
Chair: Nehad El-Sherif (MNKYBR Technologies Inc., Canada)

Monday, September 19 10:15 - 11:55 (America/Halifax)

TS1: Technical Session 1 - Communications, Electronics - Radar

Room: Lunenburg Room
Chair: Sreeraman Rajan (Carleton University, Canada)

10:15 An Enhanced (Margin-Based) Quantum Annealing Approach to Phase-Unwrap SAR Images

Khaled A H Kelany (University of Victoria, Egypt); Nikitas Dimopoulos (University of Victoria, Canada); Clemens P. J. Adolphs (University of British Columbia, Canada); Amirali Baniasadi (University of Victoria, Canada)

The focus of this work is to explore the use of quantum annealing solvers for the problem of phase unwrapping of synthetic aperture radar (SAR) images. Our approach involves formulating the problem as a quadratic unconstrained binary optimization (QUBO) problem, which can be solved on a quantum annealer. Given that present embodiments of quantum annealers remain limited in the number of qubits they possess, we decompose the problem into a set of subproblems that can be solved individually. These individual solutions are close to optimal up to an integer constant. In a second phase, these integer constants are determined as a solution to yet another QUBO problem. In this work, we present a margin-based extension of the approach discussed above. We also present its performance under a variety of QUBO solvers including D-Wave's 2000Q_6.

pp. 1-5

10:35 3D Printed X-Band Orthomode Transducer and Conical Waveguide Horn Antenna

Ian J Goode (Canada); Carlos Saavedra (Queen's University, Spain)

A 3D printed X-Band orthomode transducer (OMT) is presented that is fabricated using polylactic acid (PLA) and metallized using conductive paint. The OMT employs continuous transitions to combine two orthogonally polarized WR-90 waveguides into a single circular waveguide. This OMT consists of equal length paths with high isolation that are characterized by measuring the circular polarization (CP) performance with a 3D printed conical horn antenna as well as linear far field measurements to characterize the OMT. It is fed with a 90° hybrid coupler to give both left-hand and right-hand CP. The OMT fed horn has an axial ratio of less than 3 dB for both handedness of CP, an input reflection less than -10 dB, and a peak gain flatness of less than 1 dB from 8.7 GHz

to-10.7 GHz with a peak gain of 19.7 dBi at mid-band.

pp. 6-10

10:55 Classifying Linear Frequency Modulated Radar Signals Using Matched Filters

David Luong (Carleton University, Canada); Anne Young (Defence Research and Development Canada, Canada); Bhashyam Balaji (Defence R&D Canada, Ottawa Research Center, Canada); Sreeraman Rajan (Carleton University, Canada)

Because of the ubiquity of radars that transmit linear frequency modulated (LFM) waveforms, the problem of detecting and classifying LFM radar signals is an important one in spectrum monitoring. In previous work, we attacked this problem using an approach based on a bank of matched filters followed by a machine learning (ML) classifier. The motivation for using matched filters stems from the fact that they maximize the output signal-to-noise ratio (SNR). They are standard in radar applications and are easily implementable. ML classifiers, however, require large computing resources which are not always available. Here, we replace the ML classifier with two techniques that are less computationally heavy, one based on thresholding and the other on peak detection. We show that, although these techniques do not outperform the ML-based techniques, they still perform well for SNRs as low as -20 dB. We furthermore show that our techniques perform well when a superposition of multiple LFM signals is present.

pp. 11-15

11:15 FPGA-Based Designs of the Factorial Function

Noureddine Chabini and Rachid Beguenane (Royal Military College of Canada, Canada)

Field Programmable Gate Arrays (FPGAs) are used for the realization of real-life applications. The factorial function is used in computing approximate functions using for instance Taylor series. In this paper, we propose FPGA-based designs for the factorial function. We compare the proposed designs in terms of area and clock period and provide experimental results for Artix-7 Xilinx FPGAs using Vivado as a synthesis and implementation tool. The standard design resulted in low clock period and DSPs count but in larger counts of LUTs and flip-flops.

pp. 16-20

TS3: Technical Session 3 - Cyber-Physical Systems - Sensing & IoT

Room: Maritime Room
Chair: Kathleen A Svendsen (Dalhousie University & Lloyd's Register ATG, Canada)

10:15 Scan Context 3D Lidar Inertial Odometry via Iterated ESKF and Incremental K-Dimensional Tree

Chang Xu, Hanxiang Zhang and Jason Gu (Dalhousie University, Canada)

This paper focused on a 3D lidar inertial odometry algorithm framework that improves the LeGO-LOAM by constructing a new back-end optimization algorithm. In comparison with the LeGO-LOAM, the feature extraction and image projection processes are still the same. Two-step Levenberg Marquardt was replaced with an iterated ESKF method in the lidar odometry to produce a better initial pose for the robots, and the k-d tree method in the lidar mapping is replaced with the ikd-Tree method to ensure high performance mapping process in real time. In the loop closure, a

scan context search method is added to better correct the algorithm's final trajectory. We compare the improved algorithm with LeGO-LOAM and the two other methods, LIO-SAM and A-LOAM, using three datasets gathered from the Mulran dataset with different large-scale outdoor scenes. We show that the improved algorithm achieves similar or better accuracy in real-time than the other three algorithms.

pp. 21-27

10:35 Early Results and Description of an Underwater Electric-Field Sensing and Communication Experiment in Bedford Basin

Stephane Blouin (DRDC, Canada); Carmen Lucas (Defence R&D Canada, Canada)

Even though human-induced electrical-and-magnetic field cannot compete with underwater propagation ranges achieved by acoustic waves, it offers definite and unique advantages making it worth exploring from a sensing and communication point of view. To this end, this publication presents an experimental setup and early efforts meant to further advance this research field. Configurations tested at sea in Bedford Basin (N.S.) included different geometries and separation distances between transmit and receive dipole antennas. A preliminary analysis reveals that measured data agrees generally well with the outputs of electro-magnetic models for water-to-water propagation paths. Moreover, seabed-to-seabed propagation losses seem to be much smaller than those experienced through seawater. This publication also provides an overview of future work elements.

pp. 28-32

10:55 Dense Reconstruction from Visual SLAM with Probabilistic Multi-Sequence Merging

Hanxiang Zhang, Chang Xu and Jason Gu (Dalhousie University, Canada)

This paper presents a comprehensive visual SLAM system that extends the application of ORB-SLAM3. Using it as a template, a supplementary and optional function of 3D dense reconstruction is implemented for both RGB-D and stereo cameras. With conventional datasets, TUM, EuRoC, and KITTI as benchmarks, we confirm the validity of proposed system in both indoor and outdoor scenarios. Besides, the concept of Octree is integrated into our system to generate Octomap. A compact mapping can be achieved as such, verified by the fact that the size of each dense point cloud map is reduced to approximately one-fifth after the conversion. Furthermore, a multi-sequence merging method is included in our proposed system, formulating with a probabilistic-based optimizing algorithm and map accessing functions from the original system. Multi-sequence experiments evince that the tracking accuracy profits from the exploitation of a priori knowledge gathered through the preceding sequences.

pp. 33-40

11:15 Virtual Sensor Middleware: Managing IoT Data for the Fog-Cloud Platform

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

This paper introduces the Virtual Sensor Middleware (VSM), which facilitates distributed sensor data processing on multiple fog nodes. VSM uses a Virtual Sensor as the core component of the middleware. The virtual sensor concept is redesigned to support functionality beyond sensor/device virtualization, such as deploying a set of virtual sensors to represent an IoT application and

distributed sensor data processing across multiple fog nodes. Furthermore, the virtual sensor deals with the heterogeneous nature of IoT devices and the various communication protocols using different adapters to communicate with the IoT devices and the underlying protocol. VSM uses the publish-subscribe design pattern to allow virtual sensors to receive data from other virtual sensors for seamless sensor data consumption without tight integration among virtual sensors, which reduces application development efforts. Furthermore, VSM enhances the design of virtual sensors with additional components that support sharing of data in dynamic environments where data receivers may change over time, data aggregation is required, and dealing with missing data is essential for the applications.

pp. 41-48

11:35 Coordinated Outage Approach for IoT Physical-Layer Security Against Eavesdropping
Abdallah Farraj (NovoSek, Canada)

Security of the resource-constrained Internet of Things (IoT) remains a challenging task for vendors and system operators. Information confidentiality cannot be overlooked as more IoT devices find applications in critical industrial processes and control operations where protection of privacy and intellectual property is paramount. This article presents a physical layer-based approach to achieve levels of information confidentiality for IoT devices over wireless channels. An algorithmic transmission strategy is proposed in this work to achieve simultaneous levels of signal quality and confidentiality measures by collaborating between IoT devices threatened by an eavesdropper. Utilizing a spectrum-sharing model, the IoT devices cause levels of signal outage on the eavesdropper, limiting its ability to decode the signal of the IoT device of interest. The analytical and numerical results illustrate the feasibility of the proposed IoT transmission strategy and the ability to achieve target signal quality and security levels...N/A

TS4: Technical Session 4 - Microgrids and Renewables - Renewables Forecasting and Management

Room: Northumberland Room
Chair: Hamed Aly (Dalhousie University, Canada)

10:15 Machine Learning-Based Condition Monitoring of Solar Photovoltaic Systems: A Review
Shahabodin Afrasiabi, Sarah Allahmoradi, Mohammad Salimi, Xiaodong Liang and Chi Yung Chung (University of Saskatchewan, Canada)

Due to independency from physical models and low cost of implementation, machine learning-based condition monitoring methods for solar photovoltaic (PV) systems have recently gained attentions from academia and industry. In this paper, a literature review is conducted on machine learning applications in condition monitoring of PV systems. Different types of faults in PV systems and the general categorization of PV condition monitoring are firstly introduced. Machine learning-based PV condition monitoring are discussed in three groups, shallow, hybrid, and deep networks. The future research direction in this area is also provided in the paper.

pp. 49-54

10:35 Very Short-Term PV Power Prediction Using Machine Learning Models
Masoud Javadi (University of Saskatchawen, Canada); Soheil Naderi, Xiaodong Liang, Yuzhong Gong and Chi Yung Chung (University of Saskatchewan, Canada)

Due to the intermittency of solar photovoltaic (PV) power and fast fluctuations in the PV output power, very short-term PV power prediction is of paramount importance for efficient control of resources and units such as loads and energy storage systems and market regulation. As PV power is volatile and highly nonlinear, data-driven machine learning models are developed to predict PV power for a very short-term horizon. In this study, 10 previous samples (i.e., 50 minutes of data) are used as features to predict PV power for the current time and 5 next time periods (i.e., 25 minutes). Four machine learning techniques including linear regression (LR), random forest regression (RFR), artificial neural network (ANN), and long short term memory (LSTM) are utilized in this study. Metrics including R2, mean absolute error (MAE), and root mean square error (RMSE) have been used to evaluate the performance of developed machine learning models. The simulation results on a one-year dataset with a sampling resolution of five minutes indicate that the prediction accuracy of the proposed tuned machine learning methods is high and acceptable. The optimized RFR is found to be the best method in terms of computational performance and accuracy.

pp. 55-59

10:55 Optimal Power Management for the Integrated Multiple Energy Carrier System

Luyang Hou (Beijing University of Posts and Telecommunications, China); Chun Wang (Concordia University, Canada)

The integration of renewable energy sources, green hydrogen, and zero-emission vehicle plays a critical role in achieving net-zero emission goals of an integrated multiple energy carrier system. This paper addresses an optimal energy management problem in an integrated energy system that consists of photovoltaic panels, an office building, electric vehicles, bidirectional charging stations, an electrolyzer as well as a hydrogen refueling station with a storage system. The implementation of vehicle-to-grid and power-to-gas can discharge the energy of electric vehicle's battery back to the energy system and absorb excess renewable generation through water electrolysis in order to achieve a supply-demand balance and smooth the fluctuation caused by renewable energies. A mixed-integer linear program is developed to coordinate the charging or discharging activities, water electrolysis with renewable generation with an objective of minimizing the system operating costs. We implement our coordinated optimization strategy with a real-world case study to evaluate its performance. The computational results demonstrate that the hydrogen storage displays the greatest potentials to support peak shaving, and vehicle-to-grid can work with renewable generation to stabilize the power profile.

pp. 60-65

11:15 Investigating the Impact of Increasing Renewable Energy Penetration Levels on the Accuracy of Net Load Forecasting

Gamal Aburiyana (Dalhousie, Canada); Hamed Aly and Timothy Little (Dalhousie University, Canada)

Electricity from renewable resources is growing rapidly and contributing increasingly to the global generated electricity. Renewable energy is known to be sustainable and emissions free. On the other hand, some renewable resources such as wind and solar are intermittent. High penetration levels of such resources will certainly give the net load a fluctuating nature. This would make it difficult for the system operator to maintain the balance between the load demand and the generated power. Taking this into consideration, accurate net load forecasting is crucial. At the same time, the continuously increase in wind and photovoltaic (PV) penetration levels poses a question about the

net load behavior and whether its forecasting accuracy would be impacted. This work aims to investigate the effect of the increasing penetration levels of PV and wind power individually and together on the accuracy of net load forecasting for a specific power system and load demand amount.

pp. 66-71

11:35 Nonparametric Maximum Likelihood Probabilistic Photovoltaic Power Generation Forecasting Based on Spatial-Temporal Deep Learning

Shahabodin Afrasiabi, Sarah Allahmoradi, Mohammad Salimi, Xiaodong Liang and Chi Yung Chung (University of Saskatchewan, Canada)

One major challenge in the development of solar photovoltaic (PV) systems is their inherent intermittency due to high dependability on meteorological and weather conditions. To address this challenge, providing full statistics information for the look-ahead times can be a potential solution. This paper establishes a two-stage probabilistic framework to predict full statistics information for PV power in the look-ahead times. In the first stage, a combined deep neural network is designed to capture full spatial features by a convolutional neural network (CNN), while temporal features are realized using a gated recurrent unit (GRU). In the second stage, a probability density estimation (PDF) is developed using nonparametric smooth band limit maximum likelihood (NSBML) PDF estimator to extract full information about the predicted PV power generation. The numerical results on a PV power generation dataset with a 5-min time resolution demonstrate the effectiveness and superiority of the proposed framework by comparing with several state-of-the-art models and one PDF estimator (kernel density estimator (KDE)).

pp. 72-77

Monday, September 19 11:55 - 13:15 (America/Halifax)

L1: Lunch

Room: Atlantic Ballroom

Monday, September 19 13:15 - 14:55 (America/Halifax)

Panel 2: Equity Diversity and Inclusion Panel

Equity, Diversity and Inclusion in Industry and Academia: An Ideal Worth Investing in
Moderator: Amir Aghdam Panelists: Karen Rudie, Dejan S. Milojicic, Ramalatha Marimuthu, Andrew Alleyne, Bozenna Pasik-Duncan, Tanja Tajmel
Room: Atlantic Ballroom
Chair: Amir Aghdam (Concordia University, Canada)

In this panel, some of the less-discussed aspects of EDI will be addressed by experts from academia and industry. The benefits of having diverse groups of professionals engaged in various projects will be discussed, and practical ideas on what every one of us can do in this direction will be detailed. The audience will also have the opportunity to ask their questions in the second half of the panel.

This panel has been organized jointly by IEEE Canada and IEEE Systems Council.

TS6: Technical Session 6 - AI and Machine Learning Applications 1

Room: Bedford
Chair: Edward Gregson (Dalhousie University, Canada)

13:15 Label-Free Monitoring of Self-Supervised Learning Progress

Isaac Xu, Scott Lowe and Thomas Trappenberg (Dalhousie University, Canada)

Self-supervised learning (SSL) is an effective method for exploiting unlabelled data to learn a high-level embedding space that can be used for various downstream tasks. However, existing methods to monitor the quality of the encoder - either during training for one model or to compare several trained models - still rely on access to annotated data. When SSL methodologies are applied to new data domains, a sufficiently large labelled dataset may not always be available. In this study, we propose several evaluation metrics which can be applied on the embeddings of unlabelled data and investigate their viability by comparing them to linear probe accuracy (a common metric which utilizes an annotated dataset). In particular, we apply k-means clustering and measure the clustering quality with the silhouette score and clustering agreement. We also measure the entropy of the embedding distribution. We find that while the clusters did correspond better to the ground truth annotations as training of the network progressed, label-free clustering metrics correlated with the linear probe accuracy only when training with SSL methods SimCLR and MoCo-v2, but not with SimSiam. Additionally, although entropy did not always have strong correlations with LP accuracy, this appears to be due to instability arising from early training, with the metric stabilizing and becoming more reliable at later stages of learning. Furthermore, while entropy generally decreases as learning progresses, this trend reverses for SimSiam. More research is required to establish the cause for this unexpected behaviour. Lastly, we find that while clustering based approaches are likely only viable for same-architecture comparisons, entropy may be architecture-independent.

pp. 78-84

13:35 AI-Based Classification to Facilitate Preservation of British Columbia Endangered Birds Species

Jennie Wu, Xavier El Chantiry and Tiras Gimpel (British Columbia Institute of Technology, Canada); Michal Aibin (British Columbia Institute of Technology, Canada & Northeastern University, USA)

This study used artificial intelligence to identify endangered birds in British Columbia, Canada, to help preserve their habitats. Over many years of industrialization by humankind, it has become significantly more challenging for animals to live in a shrinking natural habitat. We used our AI to assist in protecting these animals by quickly recognizing whether or not they are contained within an image of a forest. In doing so, users can take many photographs of the interior of a forest and attempt to recognize if an endangered species lives in the area.

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. 85-88

13:55 UAV Based Smart Bird Control Using Convolutional Neural Networks

Ahmed Badr Mahmood, John Runciman and Stefano Gregori (University of Guelph, Canada); John Warbick (OMAFRA, Canada); Hariprakash Baskar (University of Guelph, Canada); Mahmood Badr (University of British Columbia, Canada)

In North America, a large percent of crops are affected by wildlife. Many farmers face crop loss, particularly of tender fruits and vegetables, due to birds. Birds love crops like cherries, blueberries, grapes, apples, and sweet corn. Certain birds approach the farmland by air while others enter the area walking on the ground. The current deterrent methods have various limitations. For example, an ultrasonic loudspeaker is a successful method, however it has a relatively short range. Unmanned aerial vehicles (UAVs) are more flexible, but they are not effective with some birds. In this paper, a new approach is introduced by integrating the two techniques and directing them using a convolutional neural network (CNN). Equipping the UAV with an ultrasonic speaker extends the range reached by the ultrasounds. The deterrent frequency is selected automatically according to the type of bird determined by CNN recognition. The CNN was implemented over the cloud using Microsoft Azure. The CNN was applied to the original dataset that was obtained from Kaggle. This dataset was modified by adding images that were taken in the field and data augmentation was applied. The results showed that CNN can recognize the bird species with accuracy over 98%. The proposed approach is promising because it has a lower cost, greater effectiveness, and a reduced nuisance to the public compared to conventional systems.

pp. 89-94

14:15 Deep Learning Application to Handwritten Arabic Words Recognition

Nori M Alzrrog and Jean-Francois Bousquet (Dalhousie University, Canada); Idris El-Feghi (University of Misurata, Libya)

Automatic handwriting recognition is the process of converting online and offline letters or words as a graphical form into its text format and still a challenging problem. Unfortunately, Automatic Arabic handwriting words recognition using deep learning neural networks is still in the early stages in terms of research. There are no general, complete, and reliable Arabic Handwritten words database that can be used as a reference for all researchers who want to extend the work on automatic Arabic handwriting word recognition. Also, many historic Arabic manuscripts have deteriorated because of the inappropriate storage and most of them have not been digitized due to the lack of reliable database that can be used to recognize the words of Arabic manuscripts. Deep Convolutional Neural Networks (DCNNs) can be used to solve the problems of automatic Arabic handwriting words recognition. In this work, we present a new DCNN model and a new dataset of Handwritten Arabic words representing the seven days of the week named Arabic Handwritten Weekdays Dataset (AHWD). Our dataset contains 21357 words prepared by less or more 1000 participants equally distributed between the seven classes. So, it can be used for training and testing on a reliable DCNN model that will be able, after training to generalize on an unseen dataset. The model works by training a Deep Convolution Neural Network (DCNN) model on a balanced-

randomly-selected dataset using different DCNN structure and improve the results by adding drop-out, image regularization, proper learning rate to avoid overfitting of the data. Finally, we have performed a blind test on the hidden test set and the performance was reported using a confusion matrix and learning curves as a validation tool for the model. Results show that our model's performance is promising, achieving accuracy rate of 0.9939 with error rate of 0.0461 using AHWD dataset, and accuracy rate of 0.9971 with error rate of 0.0171 using IFN/ENIT dataset.

pp. 95-100

TS5: Technical Session 5 - Communications, Electronics - Energy & Powering

Room: Lunenburg Room
Chair: Ali Bassam (Hydrosurv & Dalhousie University, Canada)

13:15 Return on Investment Evaluation and Optimal Sizing of Behind-The-Meter Battery Energy Storage Systems in Large Commercial Buildings in Ontario

Thiago Ramos Fernandes and Bala Venkatesh (Ryerson University, Canada)

In Ontario, Canada, electricity in large commercial buildings is charged depending on energy consumption, peak demand, and global adjustment (GA). Installing a behind-the-meter battery energy storage system (BESS) can reduce energy bills for these consumers by: 1) shifting consumption from the high to the low energy price; 2) reducing the peak demand; and 3) mitigating or eliminating the GA charge. In this context, this paper presents a method to estimate the return on investment (ROI) and determine the optimal size of BESS in large commercial buildings in Ontario. The paper's main contribution is a solid linear model that simulates the BESS optimal operation, complying with the technical characteristics of the BESS, considering Ontario electricity rates and pricing to maximize the ROI from energy arbitrage, peak shaving, and GA busting. Precise formulations for computing the energy bills of large consumers are developed, allowing realistic estimates for the ROI and sizes of BESS. Tests considering two customer classes demonstrate the differences between these classes and the factors that influence the economic returns of BESS for each.

Presenter bio: Thiago R. Fernandes received the Ph.D. degree in electrical engineering from the University of Campinas, Campinas, Brazil, in 2021. He is currently a postdoctoral researcher at the Centre for Urban Energy, Ryerson University, Toronto, Canada. His research interests include power system analysis and energy storage systems.
pp. 101-106

13:35 Energy Analysis in Single Cluster WSNs with Power Control and In-Network Data Compression

Dajiang Li and Jacek Ilow (Dalhousie University, Canada)

Analytical expressions for the energy associated with data collection in Wireless Sensor Networks (WSNs) is an important tool when operating integrated sensing and transmitting devices constrained by limited battery life-time. This paper develops a new method of finding the energy dissipated by sensors due to (i) variable times associated with the transmission of in-network compressed data and (ii) transmit power adjusted to overcome deterministic attenuation of signals with distance in various radio propagation environments. Specifically, semi-analytic expressions are derived for energy associated with data aggregation and communication when sensor nodes send data to a single cluster head (sink) located at the origin and assuming that sensors are distributed

within the cluster according to a two dimensional (2-D) Poisson point process. The compressed representations of the sensed phenomenon at various nodes in the system exploit spatial correlation among sensor measurements and, similarly as transmit powers, are dependent on the distances between nodes and the sink. The starting point for the analysis is the observation that node distances to the sink form a gamma distribution. By using this model, the dissipated energy is derived by finding the fractional moments of the gamma distribution.

pp. 107-111

13:55 Quadrature Phasing in Dickson-Pelliconi and Heap Charge Pumps with Improved Performance

Zdravko Gotovac and Stefano Gregori (University of Guelph, Canada)

This paper discusses a quadrature phasing technique that betters the performance of charge pumps. Quadrature phasing is a simple implementation of the multiphasing approach, which improves both the static performance, with a lower output resistance, and the dynamic performance, with a faster rise time. Models of the output resistance and rise time were developed for the Dickson-Pelliconi and heap charge pumps with arbitrary number of stages. Then simulation results demonstrated the benefits of quadrature phasing, which lead to increased efficiency of all the circuits that are powered by, and incorporate charge pumps as the means of power supply, without requiring additional space or more demanding clocking requirements.

Presenter bio: STEFANO GREGORI received the Laurea and Doctorate degrees in electrical and computer engineering from the University of Pavia, Pavia, Italy. He was with the School of Engineering and Computer Science, University of Texas, Dallas, TX, USA, and he is now a professor of computer engineering at the School of Engineering of the University of Guelph, Guelph, ON, Canada, where he is the founder and director of the Microelectronics Laboratory. His research focuses on the design, analysis, and characterization of integrated circuits with analog and digital applications. He is a registered Professional Engineer in the Province of Ontario.
pp. 112-117

TS7: Technical Session 7 - Cyber-Physical Systems - Robotics and Automation

Room: Maritime Room
Chair: Kathleen A Svendsen (Dalhousie University & Lloyd's Register ATG, Canada)

13:15 Towards Consistent Visual-Inertial Navigation for Unmanned Aerial Vehicles Using Depth Information

Mahmoud A. K. Gomaa and Oscar De Silva (Memorial University of Newfoundland, Canada); Awantha Jayasiri (National Research Council Canada, Canada); George Mann (Memorial University of Newfoundland, Canada)

This paper proposes a new filtering-based depth enhanced visual inertial navigation system (DE-VINS) for quadrotor unmanned aerial vehicles (UAV). This filter addresses the drifting and degraded performance of a class of conventional monocular VINS filters at hovering conditions. A theoretical nonlinear observability analysis is performed to verify the filter design. The performance of the proposed DE-VINS is numerically evaluated using a Matlab simulator and then compared against the conventional VINS filter proposed in literature. The results show improved performance of the DE-VINS in terms of estimation accuracy and consistency at zero-velocity flight conditions.

pp. 118-123

13:35 Assistive Robots for Long COVID and ME/CFS Support: Challenges and Opportunities

Signe Redfield (Patient-Led Research Collaborative & Patient Led Research Collaborative, Canada); Mae Seto (Dalhousie University, Canada); Nicholas D'Amore (Robotistry, USA)

Many people infected with COVID-19 have found that they still experience health effects months and even years afterwards, with the pandemic representing one of the largest mass-disabling events in modern history, affecting people from all demographics. It is proposed here that modern robotics methods have the potential to substantially improve the quality of life for long COVID patients and to help them recover more quickly. This paper describes what long COVID is and what its symptoms are, presents requirements for robotic capabilities to assist patients, and considers patient feedback on the possible challenges associated with developing and implementing such a solution.

pp. 124-129

13:55 Autonomous Recovery of Underway AUV on the Water Surface in Heavy Seas

Jordan Ross (Dalhousie University, Canada); Jamie Sangster (Leeway Marine, Canada); Mae Seto (Dalhousie University, Canada)

This paper proposes a robotic recovery approach to recover an AUV at sea on the aft deck of an USV. A high-fidelity simulation of an USV recovering a surface AUV with a robotic manipulator was created as a testbed to develop and test the control systems and algorithms used for the manipulator end-effector to track an AUV. The manipulator was able to sufficiently track the AUV in head, beam and bow seas for sea states 3 and 5. Head seas, as expected, showed the best tracking performance, and is the usual for recovery.

pp. 130-135

14:15 LMI Based Stability Analysis of State Convergence Architecture for Bilateral Teleoperation Systems

Muhammad Asad and Jason Gu (Dalhousie University, Canada); Valentina E. Balas (Aurel Vlaicu University of Arad, Romania); Umar Farooq (University of The Punjab, Pakistan); Khurram Qureshi (KFUPM, Saudi Arabia)

In this paper, the stability of state convergence architecture for bilateral teleoperation is studied using linear matrix inequalities (LMI). To this end, stabilizing gains for the master and slave systems as well as master-to-slave gain are found as a solution to certain LMI conditions while the force-feedforward gain is found by matching technique. In order to validate the proposed method, the closed-loop teleoperation is run in MATLAB/Simulink environment. Simulation results reveal the stability of the bilateral teleoperation system.

pp. 136-140

14:35 Automated Generation and Integration of AUTOSAR RTE Configurations

Shawn Smith (Ford of Canada, Canada); Mohammed Khalid (University of Windsor, Canada)

Automotive Open System Architecture (AUTOSAR) is a system-level standard that is used worldwide by automotive companies and their suppliers to develop the standardized software development framework for automobiles. A Runtime Environment (RTE) is essential for any

AUTOSAR software architecture. The information to configure the Runtime Environment (RTE), for any embedded Electronic Control Unit (ECU) design, is given in an AUTOSAR Extensible Markup Language (ARXML) file. Currently, these ARXML files are interpreted by the developer to manually create each configuration. That is a huge bottleneck in the design flow of software because of the drawbacks such as the cost and time spent having to manually write code. Also, manual code entry is not scalable for larger projects. Every time manual code is created it needs to be tested and verified to ensure ISO 26262 compliance. Creating an ISO 26262 compliant, RTE code generator is essential in the process of automating integration of AUTOSAR methodology in the design of ECUs. This paper describes the design of a Computer-Aided Design (CAD) tool that automatically interprets the given AUTOSAR XML files and then generates the corresponding optimized C code (*.h and* .c files). The CAD tool is optimized for run time and memory usage and is ready to use for generating any portion of the RTE automatically, while being AUTOSAR compliant.

Presenter bio: Dr. Mohammed A. S. Khalid received the Ph.D. degree in Computer Engineering from the University of Toronto in 1999. He has over 25 years of experience in teaching, research and development in academia and industry. Before joining the University of Windsor in August 2003, he worked for 4 years as a Senior Member of Technical Staff in the Verification Acceleration R & D Group (formerly Quickturn), of Cadence Design Systems, based in San Jose, California. His research and development interests are in architecture and CAD for field programmable chips and systems, reconfigurable computing and embedded system design. He has published several papers in these areas and holds a U.S. Patent in the area of architecture of reconfigurable systems.
pp. 141-144

TS8: Technical Session 8 - Microgrids and Renewables - Renewables Power Quality and Microgrid

Room: Northumberland Room
Chair: Hamed Aly (Dalhousie University, Canada)

13:15 A Comparative Study on Solar-Based Multilevel Inverters as A Substitute for Existing OLTCs

Abolfazl Babaei (University of Manitoba, Canada); Waldemar Ziomek (PTI Transformers LP, Canada); Aniruddha Gole (University of Manitoba, Canada)

In this paper, a comparative study is proposed on a converter-based OLTC (COLTC) when it is used as a substitute for an electromechanical tap changer used in power transformers to vary the output voltage. Different structures of converters have been studied and compared in the converter-based OLTC, and the transient voltages and the maximum regulation to the desired voltage in the load side have been taken into account. All inverters are supplied by a photovoltaic system or any DC system and are in series with a grid voltage on the output side. A simulation has been performed in the PLECS software to compare the results of the converters while they are used in COLTC. The results prove that the diode-clamped multilevel inverter is a better choice in the application of the converter-based OLTC, as it has lower transient voltage, and also the voltage regulation in the load side is performed much better than the other multilevel structures.

Presenter bio: Abolfazl Babaei (Graduate Student Member, IEEE) received the master's degree from the Iran University of Science and Technology (IUST), Tehran, in 2014. He is currently pursuing the Ph.D. degree with the University of Manitoba, Winnipeg, MB, Canada. Also, now, he is the R&D member at PTI Transformers LP, Winnipeg, Canada. His research activities include

HVDC, HVAC, power electronics, renewable energies, multilevel inverters, power system transient simulation, reliability studies, and tap changing transformers.
pp. 145-150

13:35 Real-Time Wavelet-Based Data Compression in Light of IEC61850 Communication Protocol

Rizwan Ayub and Walid Morsi (Ontario Tech University (UOIT), Canada)

This study addresses the problem of data compression in the context of IEC61850 communication protocol used in smart grids. The study presents a new approach based on wavelet compression that uses the predictor importance to identify the wavelet detail level that holds the salient features of the disturbance signal and then applies a hybrid threshold that includes both hard and soft thresholds to the wavelet details. The effectiveness of the proposed approach has been tested and evaluated and the results have shown that the proposed approach was very effective in increasing the compression ratio leading to reduction in the file sizes. Furthermore, the results of testing the proposed approach using a real-time digital simulator in the context of IEC61850 showed that the implementation of the proposed approach not only led to a significant reduction in the number of messages but also leads to a reduction in their sizes while maintaining a high-quality signal reconstruction following the compression process.

pp. 151-158

13:55 Smart Grid Data Compression of Power Quality Events Using Wavelet Transform

Kripa Jose and Walid Morsi (Ontario Tech University (UOIT), Canada)

Smart grids typically incorporate a communication networking layer onto the electric power grid to exchange the data and the information between the intelligent electronic devices and the supervisory control and data acquisition (SCADA). The smart grid monitoring and control requires the acquisition and the transmission of a large volume of data over such communication networks. This process sets new requirements for the existing data communication networks within the smart grid regarding the network transmission capacity and the data storage. Data compression is an effective mean to compress the power quality (PQ) data and hence saving the cost of data storage while meeting the communication network transmission capacity limits. The previous work on PQ data compression uses wavelets multiresolution signal decomposition into various decomposition levels. Thresholding is then applied on each wavelet decomposition level to capture the features needed for signal reconstruction. The goodness of compression is significantly affected by the choice of the wavelet basic function as well as the choice of the number of decomposition levels. This paper looks into identifying the most suitable wavelet basic function and the suitable number of wavelet decomposition level to achieve high compression of PQ disturbances. The study considered 80 wavelets and 4 categories of PQ disturbances such as sag, swell, interruption and notches. The results have been presented and the conclusions were drawn.

pp. 159-164

14:15 A Proposed Adaptive Filter for Harmonics Mitigation Based on Adaptive Neuro Fuzzy Inference System Model for Hybrid Wind Solar Energy System

Fawaz Al Hadi, Hamed Aly and Timothy Little (Dalhousie University, Canada)

This paper is developing an approach to analyze the behavior of renewable energy systems and with the help of analysis, design a filter to reduce the effect of harmonics and improve the efficiency of

distributed power systems consisting of hybrid renewable resources namely Wind and Solar. A powerful harmonic prediction model is proposed in this work to help in adapting the filter parameters to mitigate the harmonics injection due to renewable energy resources integration into the main grid. The outcomes from this study and forecasted model serve as inputs to select from a combination of filters to effectively mitigate harmonics from system. The proposed energy source consists of two wind models using Permanent Magnet Synchronous Generator (PMSG) driven via wind turbine and a solar photovoltaic (PV). This hybrid model demonstrates that the electric power generated is not stable because of the wind speed and solar irradiation fluctuation. After establishing the hybrid model and generating the electric power output via simulation, a forecasting model was developed using the simulated data and other relevant parameters as inputs for training to predict the hour ahead and day ahead forecast. In this work the Adaptive Neuro Fuzzy Inference System (ANFIS) is used for forecasting purpose and based on that forecasting model the filter parameters could be adapted. Results prove the effectiveness of the proposed models.

pp. 165-169

Monday, September 19 14:55 - 15:20 (America/Halifax)

B2: Afternoon Break

Monday, September 19 15:20 - 17:00 (America/Halifax)

Special Session: iMERIT Special Session

Room: Atlantic Ballroom
Chair: Jason Gu (Dalhousie University, Canada)

iMERIT (Interdisciplinary Marine Engineering Research and Industrial Training) is a seven-year, $1.65 million NSERC CREATE grant based at Dalhousie University, the University of New Brunswick, the University of Prince Edward Island and Memorial University of Newfoundland and Labrador.

The iMERIT grant program brings together researchers, innovators and professionals from academia, industry, professional organizations and government agencies to carry out research and training in marine technology, to address challenges of ocean exploration and to facilitate trainees' smooth transition from university education into industrial career.

Since 2019, a total of 36 students are part of or have completed the program.

TS10: Technical Session 10 - AI and Machine Learning Applications - Applications to Power and Networking

Room: Bedford
Chair: Edward Gregson (Dalhousie University, Canada)

15:20 Deep Neural Network Modeling for Accurate Electric Motor Temperature Prediction
Siavash Hosseini, Amirmohammad Shahbandegan and Thangarajah Akilan (Lakehead University, Canada)

Electric motors are becoming widely used in many different applications, such as electric cars, and

turbines. Measuring the temperature of internal components of an electric motor is vital to maintain its safe operation. However, measuring the temperature of the permanent magnet and stator directly comes at the expense of higher cost and additional hardware. To overcome this issue, machine learning techniques can be employed to model the mentioned parameters without the need of specialized sensors and design ideas for housing them inside the motors. Classical methods, like lumped-parameter thermal networks (LPTNs), are capable of calculating the temperature of internal elements of the motors. But, these methods require expertise and may lack acceptable accuracy. In this study, two deep neural networks (DNNs) were modeled using convolutional neural network (CNN) and long short-term memory (LSTM) units to predict the temperature of four target values of permanent magnet synchronous motors (PMSMs): stator tooth, stator yoke, stator winding, and permanent magnet. For attribute conditioning exponentially weighted moving average (EWMA) and exponentially weighted moving standard deviation (EWMS) were applied. A thorough ablation analysis shows that the CNN-based model predicts the targets better than the LSTM model with average mean squared error (MSE) of 2.64. It is also found that the proposed CNN-based model achieves a 13% mean average performance improvement compared to the existing state-of-the-art solution.

pp. 170-175

15:40 Early Fault Detection of Medium Voltage Covered Conductors with Deep Learning Method

Morteza Shamsoddini, Tongkun Lan, Hamid Teimourzadeh, S. Mahdi Mazhari, Chi Yung Chung and Seok-Bum Ko (University of Saskatchewan, Canada)

Partial discharge (PD) is the initial stage of a complete failure in some power systems' components, such as electrical machines, cables, covered conductors, etc. If left without repair, these phenomena can eventually lead to substantial power outages and damages. The advanced approaches for PD detection rely on statistical feature extraction and conventional machine learning methods; however, the performance of these methods will decrease in the presence of noise. This study investigates a solution for PD fault detection in Medium Voltage Covered Conductor Overhead lines (MVCCO) using a deep learning method based on the Long Term Short Memory (LSTM) and Attention layers. A k-fold stratified cross-validation method is used for training and validation. Also, the impacts of some hyperparameters on the deep learning model and the classification result are investigated. The proposed method is applied to a large open-source dataset of signals with PD fault provided by VSB's ENET center. The obtained results are compared with some traditional machine learning methods, which proved the superiority of the proposed method over the conventional techniques in terms of detecting a faulty signal.

pp. 176-181

16:00 Superiority of the Neural Network Dynamic Regression Models for Ontario Electricity Demand Forecasting

Sulalitha Bowala Mudiyanselage and Mohammadreza Makhan (University of Manitoba, Canada); You Liang (Toronto Metropolitan University, Canada); Aerambamoorthy Thavaneswaran and Srimantarao S. Appadoo (University of Manitoba, Canada)

Electricity demand forecasting is an essential step in balancing the electricity grid. A balanced electricity grid helps make efficient decisions in production planning and scheduling. The study of uncertainty in electricity demand requires more advanced hybrid forecasting approaches, which combine statistical methods and machine learning techniques. In electricity demand forecasting, the

features such as temperature and day-type are suggested as the most influential features in the literature. The novelty of this paper is to use Canadian electricity demand data and explore the effect of temperature and day-type on electricity demand using hybrid models. The hybrid neural network dynamic regression (NNDR) model is used to obtain the point forecasts/predictions for Ontario electricity demand data. The experimental results show the superiority of the proposed NNDR model over the commonly used dynamic regression models with the Seasonal Autoregressive Integrated Moving Average (DRSARIMA) errors model and the Prophet model. Moreover, long-term point forecasts and innovations are used to obtain two classes of prediction intervals (PIs) using data-driven probabilistic innovation distribution and bootstrapping for NNDR, DRSARIMA and Prophet models.

pp. 182-187

16:20 AI-Based Traffic Forecasting in 5G Network

Maryam Mohseni, Soodeh Nikan and Abdallah Shami (Western University, Canada)

Forecasting of the telecommunication traffic is the foundation for enabling intelligent management features as cellular technologies evolve toward fifth-generation (5G) technology. In this work, a deep-learning based analysis of a traffic dataset was conducted. For this purpose, several neural network-based models are utilized. The paper explores the forecasting performance of the fully connected sequential network (FCSN). Specifically, one-dimensional convolutional neural network (1D-CNN), single shot learning LSTM (SS-LSTM), and autoregressive LSTM (AR-LSTM) models have been evaluated. In addition, the baseline model was developed to assess the performance of the aforementioned models. The results reveal that FCSN and 1D-CNN have comparable performance. However, 1D-CNN is a smaller network with less number of parameters. One of the other benefits of the proposed 1D-CNN is having less complexity and faster execution time for predicting the next 24-hour traffic.

pp. 188-192

16:40 Time Series Anomaly Detection via Reinforcement Learning-Based Model Selection

Jiuqi Elise Zhang, DI WU and Benoit Boulet (McGill University, Canada)

Time series anomaly detection has been recognized as of critical importance for the reliable and efficient operation of real-world systems. Many anomaly detection methods have been developed based on various assumptions on anomaly characteristics. However, due to the complex nature of real-world data, different anomalies within a time series usually have diverse profiles supporting different anomaly assumptions. This makes it difficult to find a single anomaly detector that can consistently outperform other models. In this work, to harness the benefits of different base models, we propose a reinforcement learning-based model selection framework. Specifically, we first learn a pool of different anomaly detection models, and then utilize reinforcement learning to dynamically select a candidate model from these base models. Experiments on real-world data have demonstrated that the proposed strategy can indeed outplay all baseline models in terms of overall performance.

pp. 193-199

TS9: Technical Session 9 - Communications, Electronics - Electronics

Room: Lunenburg Room
Chair: Ali Bassam (Hydrosurv & Dalhousie University, Canada)

15:20 A 5.56GHz Single Core Digitally-Controlled Oscillator with Direct Fine Tuning Steps of 2.85 kHz

Shakeeb Abdullah, John Rogers and Rony E. Amaya (Carleton University, Canada)

This work presents a single core DCO (digitally-controlled oscillator) that can step through fine tuning step sizes of as low as 2.85 kHz at frequency of 5.56 GHz without the need of using either dithering, dual -gm pair, inductive switching, expensive FinFET, silicon-on-insulator (SOI), or frequency division (pushing the sub-micron technology of regular 40 nm CMOS to another level). This small resolution is achieved by using fixed MOM caps (highest Q available capacitors in 40 nm TSMC kit). The DCO had 4 banksets on the drain with 16 banks each and 1 bankset on the source with 20 banks. The DCO spanned frequency of 5.41 GHz (all banks closed) to 6.75 GHz (all banks open) with a tuning range of 22.04%. The phase noise (PN) performance of the DCO was -114 dBc/Hz (@ 1MHz offset) at frequency of 6.75 GHz, and had FoM of -181 dBc/Hz @ 1 MHz offset; DCO power consumption was 10 mW.

pp. 200-204

15:40 Using TFM Analysis and Memory Map Calibration for Designing Linear and Monotonic LC DCOs

Shakeeb Abdullah (Carleton University & NRC, Canada); John Rogers and Rony E. Amaya (Carleton University, Canada)

This papers shows a proof-of-concept and experimental design on how to design a linear and monotonic LC DCO using a combination of Topographical Field Map (TFM) analysis (or TFMA) and a one time Programmable Memory Map (PMM) calibration (or PMMC) scheme. Linearity and monotonicity is important in (all-digital) phase-locked loops (AD-PLLs) since it helps predict the locking mechanism and system analysis better - leading to more robust timers and synchronizers; which can further be used in the implementation and improvement of better health care equipment, smart devices, and cloud hardware. For improving the linearity and monotonicity of the DCO in this paper, TFMA is first used to design the DCO in its linear region, then PMMC is used to make the DCO monotonic. The calibration process is only done once to map DCO linearity. Instead of direct access, an external stimuli is given to the memory map, which then controls the DCO. The measured DCO using the proof-of-concept calibration system had a linearity R^2 of 0.997, a DNL of 0.65 LSB over its entire control-bit spectrum, and a DNL of 0.11 LSB over its fine tuning spectrum.

pp. 205-212

16:00 Performance Limits of Gated Delay Line Time Integrator

Fei Yuan (Toronto Metropolitan University)

Delta-sigma time-to-digital converters (TDCs) are known for their ability to deliver a resolution beyond the limits of chosen technology. To realize an all-digital delta-sigma TDC so as to fully benefit from the merits of technology scaling, all-digital time integrators (ADTIs) are needed. The performance of gated delay line ADTIs is fundamentally limited by the timing errors arising from

the imperfections of gated delay stages including nonlinearities, thermal noise, flicker noise, supply voltage noise, skew errors, and metastability. This paper presents an analytical investigation of the impact of these imperfections on the performance of gated delay line ADTIs, backed with simulation results.

Presenter bio: Fei Yuan He received B.Eng. degree in Electrical Engineering from Shandong University, Jinan, China in 1985, M.A.Sc. degree in Chemical Engineering, and Ph.D. degree in Electrical Engineering from University of Waterloo, Waterloo, Ontario, Canada in 1995 and 1999, respectively. During 1985-1989, he was a lecturer in the Department of Electrical Engineering, Changzhou Institute of Technology, Jiangsu, China. He was a Visiting Professor at Humber College of Applied Arts and Technology, Toronto, ON, Canada, and Lambton College of Applied Arts and Technology, Sarnia, ON, Canada in 1989 where he worked on Honeywell total distributed control systems. He was with Paton Controls Limited, Sarnia, ON, Canada as a Controls Engineer during 1989 - 1994. He joined the Department of Electrical and Computer Engineering, Ryerson University, Toronto, Canada as an Assistant Professor in 1999 and was promoted to Associate Professor with early tenure in 2003 and Full Professor in 2008. Dr. Yuan served as the Associate Chair for Undergraduate Programs and Faculty Affairs of the Department of Electrical and Computer Engineering in 2002-2006, the Chair of Department of Electrical and Computer Engineering in 2010-2015, the Director of Quality Assurance, Faculty of Engineering and Architectural Science, Ryerson University in 2015-2021. Dr. Yuan is the author of Injection-Locking in Mixed-Mode Signal Processing (Springer, 2019), the editor of Low-Power Circuits for Emerging Applications in Communications, Computing and Sensing (CRC Press, 2018), the editor and a lead co-author of CMOS Time-Mode Circuits : Principles and Applications (CRC Press, 2015), the author of CMOS Circuits for Passive Wireless Microsystems (Springer, 2010), CMOS Active Inductors and Transformers : Principle, Implementation, and Applications (Springer, 2008), CMOS Current-Mode Circuits for Data Communications (Springer, 2006) and the lead co-author of Computer Methods for Analysis of Mixed-Mode Switching Circuits (Kluwer Academic, 2004). He is also the author / coauthor of 10 book chapters and some 250 research papers in refereed international journals and conference proceedings. Dr. Yuan is a co-recipient of the Best Student Paper Award at 2021 IEEE International Symposium on Circuits and Systems, and a co-recipient of 2nd Place Award in 2007 national microelectronic design competition (TEXPO'2007). Dr. Yuan was awarded Dean's Teaching Award in 2017, Ryerson Research Chair award in 2005, Dean's Research Award in 2004, Doctoral Scholarship from Natural Science and Engineering Research Council of Canada in 1997 and 1998, Teaching Excellence Award from Changzhou Institute of Technology in 1988, and Science and Technology Innovation Award from Changzhou Municipal government in 1988. Dr. Yuan is a Fellow of the Institute of Engineering and Technology (IET), a senior member of the Institute of Electrical and Electronics Engineers (IEEE), and a registered professional engineer in the province of Ontario, Canada.
pp. 213-218

16:20 Design of High-Bandwidth, High-DC Gain Single-Stage Amplifier for High-Speed ADCs
Ximing Fu (University of Electronics & Dalhousie University, Canada); Yushi Zhou (Lakehead University, Canada); Kamal El-Sankary (Dalhousie University, Canada)

Many modern, high-speed, high-performance applications require analog-to-digital converters (ADCs) that operate in high frequency. This paper presents the design and simulation of a high gain bandwidth (GBW), high gain, high-power-bandwidth efficiency fully differential single-stage operational amplifier (Opamp) implemented in 65nm CMOS technology. The Opamp was designed suitable for high-speed pipeline ADC building blocks such as the sample-and-hold (S/H) stage, a

multiplying digital-to-analog converter (MDAC). The proposed topology uses a single-stage folded-cascode with Nauta transconductor assisted gain boosting to simultaneously achieve independent DC gain and GBW boosting. The PVT variations from the inverter-based Nauta transconductor are compensated using a process compensated biasing architecture to stabilize the regulated cascode loop gain and GBW under different process corners. The simulated Opamp achieves a DC gain of 75 dB, unity-gain bandwidth of 1.5 GHz under 4pF load, and a phase margin of 80 degrees. The settling time is 5.5 ns, and the Opamp consumes power of 6 mW with a supply voltage of 1.2 V.

pp. 219-223

16:40 Linear Time-Varying Causal Systems Transformed

Shervin Erfani and Majid Ahmadi (University of Windsor, Canada)

In this note we concentrate on the frequency-domain representation of linear time-varying systems (LTVS). Application of bilateral two-dimensional Laplace transform (2DLT) to LTV systems is invigorated. Specifically, transformation of the class of single-input single-output LTV causal systems is considered using the introduced 2D-to-1D reduction techniques.

pp. 224-228

TS11: Technical Session 11 - Cyber-Physical Systems - Electric Grid

Room: Maritime Room
Chair: Jordan Ross (Dalhousie University, Canada)

15:20 Site Suitability Assessment of Public EV Charging Stations in Urban Environment

Anagha Patil, Arpita Giriyappanavar, Binod Vaidya and Hussein T. Mouftah (University of Ottawa, Canada)

In the recent years, shifting from internal combustion engine (ICE) vehicles to electric vehicles (EV) can be seen. Even though EV deployment is the most viable solution to reduce Green House Gas (GHG), there are several challenges. One of the ongoing challenges is the misalignment of charging supply and demand. With the increasing EV adoption, the public EV charging network is deemed to be inadequate in Ottawa. In this paper, we put forward a methodology for locating suitable sites for EV charging stations in Ottawa, that combines Geographic Information System (GIS) technique and Multi-Criteria Decision Making (MCDM) method. We have also created web application for determining location-based site suitability of EV charging station in Ottawa. Outcomes show that our web App can effectively provide appropriate suitability rating for any given location within Ottawa region.

pp. 229-234

15:40 Impact of the Open Charge Point Protocol Between the Electric Vehicle and the Fast Charging Station on the Cybersecurity of the Smart Grid

Kandarp Gandhi and Walid Morsi (Ontario Tech University (UOIT), Canada)

Cyber-physical security is becoming an important issue within the smart grid. The growth in sales of the electric vehicles (EVs) dictates the need for high-power fast charging stations (HP-FCS). The operation and control of such HP-FCS requires the integration of information and communication

technologies (ICT), which makes such critical infrastructure prone to cyber-attacks and hence compromising the charging of the EVs in particular when operating in vehicle-to-grid mode. In Canada, the Open Charge Point Protocol (OCPP) is considered one of the most popular protocols used in HP-FCS. This charging protocol does not include built-in security measures against cyber-attacks and hence it may represent an access point to the unauthorized users. In this paper, potential threats against HP-FCS that uses the OCPP are demonstrated through the cyber-attacks applied to microgrid equipped with distributed renewable energy resources. Furthermore, the paper demonstrates how to implement a cyber-attack on such a microgrid when operating in an islanded mode while investigating the impact of such cyber-physical attacks on its components

pp. 235-240

16:00 Agglomerative Hierarchical Clustering with Dynamic Time Warping for Household Load Curve Clustering

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

Energy companies often implement various demand response (DR) programs to better match electricity demand and supply by offering the consumers incentives to reduce their demand during critical periods. Classifying clients according to their consumption patterns enables targeting specific groups of consumers for DR. Traditional clustering algorithms use standard distance measurement to find the distance between two points. The results produced by clustering algorithms such as K-means, K-medoids, and Gaussian Mixture Models depend on the clustering parameters or initial clusters. In contrast, our methodology uses a shape-based approach that combines Agglomerative Hierarchical Clustering (AHC) with Dynamic Time Warping (DTW) to classify residential households' daily load curves based on their consumption patterns. While DTW seeks the optimal alignment between two load curves, AHC provides a realistic initial clusters center. In this paper, we compare the results with other clustering algorithms such as K-means, K-medoids, and GMM using different distance measures, and we show that AHC using DTW outperformed other clustering algorithms and needed fewer clusters.

pp. 241-247

16:20 Cyber-Physical Blockchain Based Secure Platforms for Data and Energy Trading in Multi-Level Electricity Markets

Hossein Chabok (Laval University, Canada); Ali Moeini (Hydro-Québec/IREQ, Canada); Innocent Kamwa (University Laval, Canada)

Despite all potential advantages of incorporating intelligence into power systems and electricity market, there is growing opposition towards the idea of smart grids following the threat of cyber-attacks that could cause serious issues in different parts of the power system if not properly addressed. In this regard, this paper focuses on introducing two novel effective conceptual secure platforms based on blockchain technology (BT) for multi-level electricity markets (MLEMs) that can be complied with the current electricity market conceptions. The proposed structures are evaluated in terms of consensus and time analyses and it is demonstrated that these strategies are scalable and compatible with the electricity market's framework.

pp. 248-255

16:40 An ML-Based Strategy to Identify Insulation Degradation in High Voltage Capacitive

Bushings

Karine Midori Nacano (Pontifical Catholic University of Parana (PUCPR), Brazil); Marcelo Eduardo Pellenz (PPGIa - Pontifical Catholic University of Parana (PUCPR), Brazil); Edgard Jamhour, Voldi Zambenedetti and Ivan Chueiri (Pontifical Catholic University of Parana (PUCPR), Brazil); Marcos V H Rambo (COPEL Geracao e Transmissao S.A., Brazil); Daniel Benetti (Arueira Instalações Elétricas Ltda, Brazil)

Real-time monitoring of the electric power system has become essential for the efficient operation of the Smart Grid. In this scenario, the power transformer is the core equipment of a substation, and the proper operation of this equipment is of great importance for the power supply. The component responsible for terminal insulation in the power transformer is the bushing. As the bushing's lifetime depends on many factors, including the power demands, the manufacturing method, and the received stresses, online monitoring systems of these components are increasingly being used. An efficient and reliable monitoring system for identifying bushing's problems can reduce maintenance costs. It is possible to reduce the number of shutdowns for inspections and offline tests, and the risks of accidents caused by transformer explosions. Online monitoring systems for capacitive bushings are susceptible to acquisition circuit inaccuracies, noises, and interferences. In addition, bushing behavior can change due to temperature and humidity conditions. These operational parameters can cause fluctuations in online monitoring measurements and represent a challenge for correctly identifying bushing anomalies or degradations. This paper evaluates different machine learning (ML) approaches to identify anomalies in capacitive bushings. We propose the proper selection of features and the most efficient ML strategy to detect anomalies. We based the study on measured data from power transformers under normal and anomalous operation conditions.

pp. 256-262

Monday, September 19 17:00 - 18:25 (America/Halifax)

Panel 3: YP Mentorship Panel

Room: Harbour Suites
Chair: Mae Seto (Dalhousie University, Canada)

Monday, September 19 18:30 - 19:00 (America/Halifax)

D1: IEEE Awards Gala Reception

Room: Atlantic Ballroom

Monday, September 19 19:00 - 21:30 (America/Halifax)

D2: IEEE Awards Gala

Tuesday, September 20

Tuesday, September 20 7:45 - 17:30 (America/Halifax)

R3: Registration

Tuesday, September 20 8:00 - 17:00 (America/Halifax)

E2: Exhibits and Posters

Room: Commonwealth B

Tuesday, September 20 8:45 - 9:00 (America/Halifax)

OR: Opening Remarks

Chris Whitt, Jason Gu
Room: Atlantic Ballroom

Tuesday, September 20 9:00 - 9:45 (America/Halifax)

K2: Keynote Speaker 2

Sree Rajan
Room: Atlantic Ballroom

Tuesday, September 20 9:45 - 10:15 (America/Halifax)

B3: Morning Break

Tuesday, September 20 10:15 - 11:55 (America/Halifax)

TS16: Technical Session 16 - Emerging Health Care Technologies - Heart Disease Detection and Modeling of Covid-19

Room: Bedford
Chair: Lei Zhang (University of Regina, Canada)
10:15 Feature Selection and Machine Learning Model Development for Heart Failure Prediction
Rayyan Akhand (University of Ottawa, Canada); Marzia Zaman (Cistel Technology Inc., Canada)

Hearth failure can be prevented if the physician and/or patient can predict the failure risk ahead of

time and take preventive measures. Machine learning based predictive modeling can be used as a tool for this purpose. Systematic methodology identifying key features to develop a robust machine learning based model is discussed in this paper. We showed with a public dataset with labeled data, an accuracy of 85.26% is achievable using Random Forest classifier model. Also, it was revealed that the among all the clinical features, follow up time is also critical in achieving high performant predictive models....N/A

10:35 Modeling and Predicting COVID-19 Infections: The Effect of Incomplete Testing and Recovery Data in the Early Days of the Pandemic

Mike Eklund (University of Ontario Institute of Technology, Canada)

This paper presents an analysis of the impact of inconsistent data on the modeling and prediction of outcomes during the early stages of COVID-19 pandemic. The analysis is based on susceptible, infected, recovered (SIR) modeling of the pandemic during the first four months of the COVID-19 outbreak using publicly available data and comparison of modeling assumptions to overcome missing or possibly inaccurate reported data regarding testing results and outcomes related to the recovery of patients infected with COVID-19. The Johns Hopkins data set is primarily used with supplemental data from the Canadian context to illustrate the impact on regional modeling and prediction. As of April 18, 2020 there were regional examples of the outbreak at different stages: increasing cases, peaking and decreasing cases, as well as many that were at or near the transition from one interval to the next.

pp. 263-267

10:55 Heart Disease Detection Using Back-Propagation Artificial Neural Network

Jagmohan Kaur (IKG Punjab Technical University, India); Baljit Singh Khehra (BAM Khalsa College, Garhshankar, Hoshiarpur, Punjab, India); Amarinder Singh (Baba Banda Singh Bahadur Engineering College, India)

Heart disease is a leading health problem in the world, thereby, raising the need for its detection at the earliest stage. The limitations of conventional approaches have motivated the inspire IT professionals and research scholars to execute a promising, simple, inexpensive and easy medical diagnosis system. The present paper proposes a back-propagation artificial neural network (BPANN) based machine learning (ML) technique to enhance the accuracy for the detection of heart disease. The experimental results performed in MATLAB revealed that the proposed system outperforms single-layer and typical ANN. The aim of the study is to design the model with suitable combination of layers and neurons to enhance the success rate. Comparison with other data-analytic parameters and cross-validation method highlights the promising solution for the detection of heart disease.

pp. 268-273

11:15 Early Detection of Heart Disease Using Advances of Machine Learning for Large-Scale Patient Datasets

Syed Ammad Ali Shah, Ayat Hama Saleh, Masha Ebrahimian and Rasha Kashef (Ryerson University, Canada)

Heart disease is one of the significant causes of death all over the world. The Healthcare industry produces a large amount of data; thus, heart disease prediction is becoming a challenging task in

IoT-based healthcare systems. Machine learning plays a vital role in predicting the disease accurately. Many studies have been conducted in this area; however, they do not use large-size datasets to explore the real power of machine learning techniques in predicting heart disease. In this paper, we used four large-scale multi-dimensionality heart disease datasets collected from different sources. We applied various traditional machine learning techniques, namely Decision Tree (DT), Naïve Bayes (NB), K-Nearest Neighbor (KNN), Random Forest (RF), and Support Vector Machine (SVM), to predict heart disease. The results obtained by these traditional techniques are compared with a Multiple Layer Perceptron (MLP) and an Ensemble Majority voting model for the classification of heart disease.

pp. 274-280

11:35 A Bio-Inspired Neural Network for Modelling COVID-19 Transmission in Canada
Lei Zhang (University of Regina, Canada)

The 2019 novel coronavirus (COVID-19) has turned the world into turmoil and variant of the virus keeps emerging and creating new surges in cases. Mathematical modelling of infectious diseases can reveal how diseases spread, forecast the future course of an outbreak, and in practice, guide the management of public health care to effectively control the disease. This paper presents a nonlinear dynamic model to forecast the potential upsurge of COVID-19 transmission cases. The developed model can be used to forecast the trends of COVID-19 case rates, prepare the health system for the projected number of patients, and evaluate the effectiveness of public health measures such as travel restrictions, social distancing and quarantine.

pp. 281-287

TS13: Technical Session 13 - Oceans

Room: Lunenburg Room
Chair: Brandy Armstrong (University of Southern Mississippi, USA)

10:15 Deep Learning for Marine Bioacoustics and Fish Classification Using Underwater Sounds
Jean-François Laplante and Moulay A. Akhloufi (University of Moncton, Canada); Cédric Gervaise (CHORUS Institute, France)

The migration of species is an important factor in the analysis of ecological systems. Changes in migratory patterns of a species or a specific group in an ecosystem often follow changes in the environment - many animals are sensitive to small changes that may not initially be thought of as significant for the health of an ecosystem. The presence of many species can be detected by the sounds they produce, and as such, environmental conservation efforts have much to gain from the automation of the analysis of Bioacoustics. Deep Learning shows promise for this type of task. This work evaluates the performance of different deep learning methods when performing the task of detecting the presence of brown meagre sounds in spectrograms with different window lengths and achieves an F1-score of 0.94 for brown meagre vocalization detection.

Presenter bio: Moulay Akhloufi received his Ph.D.in in Electrical Engineering from Laval University (Canada), a M.Sc. in Electrical Engineering from Ecole Polytechnique of Montreal (Canada), and MBA from Laval University (Canada). He was a Research Associate with the Perception and Robotics laboratory of Ecole Polytechnique of Montreal, an Imaging Software specialist with Matrox Imaging, and a Director of Research and Development of the Robotics and

Vision Center in Quebec (Canada). He was Professor in computer engineering in the Electronic Engineering department of University Santa Maria (Chile). Since 2016, he is Professor in the department of Computer Science of University of Moncton (Canada) and a Head of the Perception, Robotics and Intelligent Machines. His area of interest are in computer vision, robotics, and machine learning.
pp. 288-293

10:35 Collaborative AUV Localization and Tracking of an Underway Ship with Adaptive Pinging and a Planner for Trilateration

Erin L Wetter and Mae Seto (Dalhousie University, Canada)

The efficacy of 3 collaborative autonomous underwater vehicles (AUV) to track a dark ship is studied in a scenario where the ship has entered a marine protected area through a choke point. This is performed in simulations. The objective is to quantify the advantage of mobile transducers over traditional moored long baseline (LBL) transponders. An underwater environment with a constant sound velocity profile captures the one-way travel time inter-AUV communications as well as the two-way travel time for AUVs ranging the ship. The novel contributions include an assessment of the ship localisation error given the self-localisation error of the three AUVs and their range measurement uncertainty. Another contribution is an adaptive ping strategy, which potentially gives more accurate ship localisation by scheduling the pings to arrive simultaneously at the ship. The third contribution is a collaborative AUV mission planner which strives to increase the range that the 3 AUVs can trilaterate the ship over. The results show that the adaptive ping strategy and the collaborative AUV mission planner are effective in reducing ship localisation error. With these encouraging results, future work includes a refined environment model that integrates BELLHOP and considers environmental and range dependent communications.

pp. 294-299

10:55 Multi-Modal Signal Analysis for Underwater Acoustic Sound Processing

Faraz Talebpour, Saeed Mozaffari and Shahpour Alirezaee, Mr (University of Windsor, Canada); Mehrdad Saif (University of Windsor & Faculty of Engineering, Canada)

Acoustic sound source localization in a shallow water environment is an impactful area of research for environmental and marine-life monitoring. Most available sound source localization techniques require multiple hydrophones, which can be costly, complicated, and hard to maintain. In this paper, we utilized the modal dispersions of a signal to derive a single hydrophone-based localization method for a noisy, shallow water environment. Moreover, we investigated the effects of underwater ambient noise on the accuracy of the proposed method. Our proposed method can select multi- modals for localization to increase accuracy in low SNR environments. We evaluated our proposed method in various SNRs. Finally, we compared our results with previous works, which showed improvement.

pp. 300-305

11:15 An Approach to Choose Observation Systems to Observe Ocean Phenomena

Eonjoo Kim and Mae Seto (Dalhousie University, Canada)

The ocean covers more than 2/3 of Earth's surface, but 90\% of the ocean is still unexplored or overlooked. Efficient ocean observation system is fundamental for understanding the climate changes, monitoring marine pollution and exploring the ocean resources. Motivated by this, the

ocean observation system is broken down into ocean phenomena, sensors and observation platforms and described using the temporal, spatial scales. An approach to evaluate the efficacy of the observation system to measure the ocean phenomena is introduced by superimposing the temporal and spatial scales of both phenomena and platforms. The platforms performance are analysed using criteria as well as observation strengths and limitations.

pp. 306-313

TS15: Technical Session 15 - Cyber-Physical Systems - IoT - 2

Room: Maritime Room
Chair: Mae Seto (Dalhousie University, Canada)

10:15 Development of an IoT Monitoring System for Bridge Bearing Movement Using a MEMS Accelerometer-Based Inclination Sensing

Heshan Fernando, Isabel Heykoop, Joshua Woods and Neil Hoult (Queen's University, Canada)

This paper details the system design, including hardware design and IoT architecture, for monitoring bridge bearing movement using MEMS accelerometer-based inclination sensing. The system has the potential to lower the cost and improve the monitoring of bridge bearings for degradation and failure. A prototype system is developed for deployment on the Waaban Crossing-a 1.2 km two-lane bridge that is currently under construction in Kingston, Ontario, Canada. An IoT system is designed to measure the movement of ten bearings on a single pier, and transmit the data wirelessly to an IoT Hub for monitoring and visualization. Methods for measurement and thermal calibration are presented with preliminary results.

Presenter bio: Heshan Fernando is a Postdoctoral Fellow at Ingenuity Labs, Queen’s University, Kingston, Canada. He is interested in the research and development of intelligent and robotic systems for industrial applications–robotic machines and autonomous systems that can learn and adapt to operate reliably in dynamic and complex environments. Heshan is currently working on the development of robotic systems and AI methods for rail infrastructure monitoring. His previous research projects have involved the study and development of control and learning strategies for robotic excavation and intelligent sensing and condition monitoring methods automated assembly machines. Heshan received the B.Eng (Honours, 2011) degree in Mechanical Engineering with a Mechatronics and Embedded Systems option from the University of Victoria, and both M.A.Sc. (2012) and Ph.D. (2021) degrees in Mechanical Engineering from Queen’s University. From 2016 to 2017, Heshan was a visiting researcher at the Centre for Applied Autonomous Sensor Systems (AASS) at Örebro Universitet and the Rocktec Automation Division of Epiroc AB–both located in Örebro, Sweden.
pp. 314-318

10:35 Finger Tracking for Human Computer Interface Using Multiple Sensor Data Fusion

ZhengYang Wang (Dalhousie University, Canada)

As human-computer interface advances from two to three dimensions, new input devices are required to allow low-cost learning and increased human involvement in virtual reality contexts. In this study, we offer a small, finger-worn, wireless motion-tracking platform that can be reprogrammed for a number of functions to enhance mobile computing. First, it functions as a wireless mouse in the air without requiring a surface for a mouse or trackpad, making it appropriate for augmented-reality or virtual-reality systems. Second, it supports single-finger motion tracking in

its entirety. A more complex version is able to mix information from more units on multiple fingers to create a greater variety of options. The prototype of our ring will have an ultra-compact wireless sensing platform with an on-board triaxial accelerometer, triaxial magnetometer, triaxial gyroscope, and a short-range wireless Bluetooth transmitter with a ToF sensor for finger flexion detection. Quantitative and qualitative evaluations of the accuracy and usefulness of the IMU sensor breakout board have been conducted. The results demonstrate that the IMU sensor finger tracking system is intuitive for mouse-like tasks.

pp. 319-323

10:55 Cooperative Transmission Strategy for IoT Physical-Layer Security Against Interference Attacks

Abdallah Farraj (NovoSek, Canada)

Information security of the resource-constrained Internet of Things (IoT) remains a challenge for system operators. This article presents a physical layer-based security strategy to reach target levels of information availability for IoT devices targeted by adversaries. Utilizing a spectrum-sharing communication framework, this work proposes a cooperative transmission strategy to collaborate between select IoT devices in limiting signal outages for an IoT device undergoing active interference attacks and thus achieving information availability. The analytical and numerical results illustrate the feasibility of the proposed IoT transmission strategy and the ability to achieve target security levels during interference attacks....N/A

11:15 An Energy Harvesting Receiver Utilizing Microstrip Filter Technology for IoT Devices in 5G Network

Maryam Eshaghi and Rashid Rashidzadeh (University of Windsor, Canada)

Energy scavenging from radiofrequency waves is getting more attention to energize low-power IoT sensors as the fifth-generation (5G) of wireless technology becomes mainstream. To efficiently extract energy from electromagnetic waves, the receiver antenna has to be properly matched with a rectifier to provide a steady dc output. A common solution is to design a matched bandpass filter with lumped LC components. However, in high frequencies using a conventional LC filter is not practical due to parasitic effects. In this paper, a 3rd order Chebyshev bandpass filter and a 5th order Elliptic function microstrip low-pass filter have been designed using Advance Design System (ADS). RO4003C material with a dielectric constant of 3.55 and height of 0.508 mm is utilized for the substrate. The Chebyshev filter shows perfect matching at 12-17 GHz. The Elliptic filter shapes the output of the rectifier, and the energy harvester provides 25 mW output with input power of -10 dBm and overall efficiency of 86%.

pp. 324-327

11:35 Toward a Coalgebraic Model of Control Programs

Timothy Teatro and Mike Eklund (University of Ontario Institute of Technology, Canada); Ruth Milman (UOIT, Canada)

The paper provides a model of a mathematical model of a control systems program. This model, in the abstract setting of category theory, also suggests an architecture for engineering. A polynomial functor is used to specify a Moore machine and through the fixpoint of this functor we obtain a transducer from a stream of input values to a stream of control values. Implementation using

Reactive Extensions (RX) is sketched in a language independent manner.

pp. 328-335

TS14: Technical Session 14 - Education Session

Room: Northumberland Room
Chair: Nehad El-Sherif (MNKYBR Technologies Inc., Canada)

10:15 STAR-ML: A Rapid Screening Tool for Assessing Reporting of Machine Learning in Research

Md Asif Khan (McMaster University, Canada); Ryan Koh and Samah Hassan (KITE - University Health Network, Canada); Theodore Liu and Victoria Tucci (McMaster University, Canada); Dinesh Kumbhare (KITE - University Health Network, Canada); Thomas E. Doyle (McMaster University, Canada)

Literature review provides researchers with an overview of the field and when presented as a systematic assessment, it summarizes state-of-the-art information and identifies knowledge gaps. While there are many tools for assessing quality and risk-of-bias within studies, there is currently no generalized tool for evaluating the transparency, reproducibility, and correctness of machine learning (ML) reporting in the literature. This study proposes a new tool (Screening Tool for Assessing Reporting of Machine Learning; STAR-ML) that can be used to screen articles for a systematic or scoping review focusing on the reporting of the ML algorithm. This paper describes the development of the tool to assess the quality of ML research reporting and how it can be applied to improve the literature review methodology. The tool was tested and updated using three independent raters on 15 studies. The inter-rater reliability and the time used to review an article were evaluated. The current version of STAR-ML has a very high inter-rater reliability of 0.923, and the average time to screen an article was 4.73 minutes. This new tool will allow for filtering ML-related papers that can be included in a systematic or scoping review by ensuring transparent, reproducible, and correct screening of research for inclusion in the review article.

pp. 336-341

10:35 From Technical Writing Course Assignments to Publications: A Process Review

Azfar Adib, Wei-Ping Zhu and M. Omair Ahmad (Concordia University, Canada)

Technical writing is a vital skill in engineering domain. It needs proper nurturing among engineering students, particularly in undergraduate level. Publishing students' writings can be an effective way to enhance engagement and learnings of students in undergraduate technical writing courses. With that objective, in this review we proposed a process-based approach of transforming some technical writing course assignments to a magazine publications. The proposed approach was applied during a 3-credit technical writing and communications course offered for second year undergraduate engineering students at an English-medium university in Canada. Outcomes of this process have been analyzed by interviewing and surveying the participants (student writers and magazine editors). This paper provides an overview of the process and perceptions of the participants.

Presenter bio: Azfar Adib is a Senior Member in IEEE. He is currently a PhD student in the Department of Electrical and Computer Engineering at Concordia University in Canada. He also works for the university as a leadership instructor for graduate students, along with usual roles of

teaching & research assistant. Azfar obtained his B.Sc. (Hons) degree in Electrical and Electronic Engineering from Bangladesh University of Engineering and Technology in 2009. He received his MBA degree from Institute of Business Administration , Dhaka University in 2013. Azfar worked for over 8.5 years (during 2010-2019) in Grameenphone Ltd, leading telecommunication service provider in Bangladesh. He served there in different functional and managerial roles. He played a key role in development -launching- evangelization of new technological solution. Notable ones among these are- 3G services (2013), mobile content optimization (2014), safe internet (2016), off-loaded hardware donation (2016), industry-academia collaboration (2017), M2M services (2017), IoT services (2019). These were considered as key milestones in digitalization of Bangladesh and the country's continuous progress in achieving overall SDG targets. Azfar's professional contribution got well acknowledged in the corresponding organization, country and region. Azfar is an active writer, community activist and speaker. He has written over 50 articles, published in different local, regional and global platforms . He has regular performed public speaking in different places. His writings and talks are focused on various themes like : encouraging higher participation of currently underrepresented segments in science (e.g., women, underprivileged people) , sustainable development through ethical applications and best possible utilization of technology. Azfar has a long track record of volunteering. He was the founder of "IoT for Bangladesh", the first ever newsletter in Bangladesh promoting internet-of-things through different endeavors. He acted as the Office Secretary of Bangladesh MBA Association, the oldest forum of Bangladesh business graduates. Currently he is volunteering in different endeavors in Montreal; which includes "Sustainability Concordia", "Stop Exploitation Hub". "Fraser Hickson Children's Library". Azfar has regularly been involved with research, analytical and strategic endeavors. He made an IEEE conference publication based on his undergraduate thesis, and a journal publication based on his MBA final project. He has several upcoming publications based on his on-going PhD research . Azfar contributed in the formulation of "National Strategy for Artificial Intelligence in Bangladesh (2019-2024)". Azfar has been the lead organizer of different events in educational, professional and social arena; which are mostly focused to inspire people (particularly youth) for various constructive purposes. Azfar acted as mentor and judge in different scientific innovation contests. As a leadership instructor for graduate students in Concordia University, he has been facilitating different leadership workshops for over 2 years. Azfar has a long record of engagement with IEEE. It started almost 17 years ago during his undergraduate life. He was the 'Industrial Activity Coordinator' of IEEE Bangladesh Section during 2018 & 2019. In 2021, he got elevated to Senior Member. Currently he is the 'Student Activities Chair' in IEEE Montreal Section. In all these roles, Azfar has contributed in numerous endeavors in IEEE.
pp. 342-347

10:55 Investigation of Energy Efficiency of Fishing Vessels in the Adriatic Sea by Fuel Consumption Measurements and Catch Analysis: Design and Operation of Data Collection System

Marija Koričan (University of Zagreb, Croatia)

Ship emissions are a significant environmental issue, directly connected to fuel consumption and highly investigated in the last decade. Fuel consumption of a vessel presents a key factor in the research of ship energy efficiency, environmental impact, optimization and economic performance. Fuel consumption is mainly evaluated by available mathematical models, and the estimated value is used in further calculations, thus the results conceal an error. Evaluating the average fuel consumption also disables the possibility to analyze the fuel usage in different operating modes. Further, both technical and operational optimization aim at reducing fuel consumption. To achieve a quality improvement of a ship's system, the input data on consumption needs to have minimal

errors. This paper presents different methods of fuel monitoring and evaluation as well as development of a modern fuel measurement system for fishing vessels. A short overview of fuel consumption models is given and the focus is shifted to fuel monitoring devices. Fuel monitoring devices are an effective method for determining the exact consumption and investigating the energy efficiency of vessels. The application of flow meters and fuel level sensors in the Croatian fishing fleet is presented and an example of measurements collected by the devices is included.

pp. 348-353

11:15 IoT Enabled Grid Storage System

Sean D Budhooram (Ontario Tech University, Canada); David W Jong (Ontariotech University, Canada); Anna Safonov, YiXin Li and Vijay K. Sood (Ontario Tech University, Canada)

This paper summarizes the work performed towards the design and development of an Internet of Things (IoT) enabled grid power storage device. Our proposed prototype integrates high-usage cycle Lithium Iron Phosphate (LiFePO4) cells with an Arduino microcontroller to enable storage of grid power during off-peak hours and discharge during peak hours. This technology is fundamental to balancing the grid power supply and demand variations and reducing the global dependence on environmentally polluting fossil fuels. Our lab prototype device uses a battery pack with a capacity of about 500 Wh using salvaged LiFePO4 cells in a 4-series by 5-parallel configuration. The pack has a peak instantaneous discharge capability of 1500 Amperes at 12 Volts. This design is modular and flexible, with the possibility of alternative cell arrangements to meet different needs.

Presenter bio: Vijay Sood obtained his Ph.D. from the University of Bradford, England in 1977. Previously, he worked as a Researcher at IREQ (the Research Institute of Hydro-Québec) in Montreal. In 2007, he joined UOIT, Oshawa as an Associate Professor in the Electrical Engineering Department. His research interests are in the monitoring, control and protection of power systems. He has published over 100 articles and written two books on HVDC and FACTS transmission systems. He teachs courses in Power Electronics, Electrical Machines and Power Systems. He is a Professional Engineer in Ontario, a Fellow of the IEEE, the Engineering Institute of Canada and the Canadian Academy of Engineering.
pp. 354-359

Tuesday, September 20 11:55 - 13:15 (America/Halifax)

L2: Lunch

McNaughton Medalist Keynote
David Plant
Room: Atlantic Ballroom

Tuesday, September 20 13:15 - 14:55 (America/Halifax)

TS17: Technical Session 17 - Emerging Health Care Technologies - Health Care Devices and Systems

Room: Bedford
Chair: Eonjoo Kim (Dalhousie University, Canada)

13:15 RISC-V Based Processor Architecture for an Embedded Visible Light Spectrophotometer

Guillaume Soulard, Gabriel Lachance and Élodie Boisselier (Université Laval, Canada); Mounir Boukadoum (Université du Québec à Montréal, Canada); Amine Miled (Laval University, Canada)

The miniaturization of sensing systems often requires embedding an electronic subsystem for local or edge computing, or to interface with the sensor for pre-processing operations. The sensing part of the work presented in this paper is an optoelectronic system that measures neurotransmitters concentration based on visible spectroscopy and that is currently implemented with an external processor in a computer. This paper presents a System on a Chip (SoC) design based on the RISC-V processor and the required peripheral interfaces to replace the current system. The new design is first simulated and then implemented on Cyclone IV and Xilinx ZCU102 FPGAs to explore the usability and advantages of the approach. Both architectures were similar in terms of memory and register use, but the ZCU102-based system used 18016 logic elements, while the Cyclone IV-based one used much less, 13468 logic elements. We also observed a significant difference in frequency of operation, with Cyclone IV was running at 27.84 MHz and ZCU102 at 125 MHz clock speeds.

pp. 360-363

13:35 Evaluation of a Fabric Sheath Cooling Apparatus for Twisted Coiled Actuators

Alex Lizotte and Ana Luisa Trejos (Western University, Canada)

Wearable robotic systems have the potential to help many individuals with rehabilitation and to support activities of daily living. Unfortunately, these systems are not widespread due to their cost, limited portability, and size. Twisted Coiled Actuators (TCA), novel artificial muscles made from nylon thread, are inexpensive, lightweight, and slim. However, the natural cooling time of these thermally activated muscles is too slow to support rehabilitation or voluntary motions. This paper presents and assesses the feasibility of a novel cooling apparatus for the TCA. The cooling method involves a flexible fabric channel and a miniature air pump to cool the TCA with forced convection. The channel is lightweight, flexible, and can easily be sewn onto other materials to allow easy fabrication of wearable devices. ANSYS Fluent simulations were performed to determine the relationship between the input air velocity and the cooling time constant of the system. The results indicate that the miniature air pumps currently available are not powerful enough to cool the TCA at the required frequencies. There was a 13.2% difference between the cooling time constant predicted by the model and the time constant found experimentally for an input of 1 m/s.

pp. 364-369

13:55 Trust Metrics for Medical Deep Learning Using Explainable-AI Ensemble for Time Series Classification

Kashif Siddiqui and Thomas E. Doyle (McMaster University, Canada)

Trustworthiness is a roadblock in mass adoption of artificial intelligence (AI) in medicine. This research developed a framework to explore the trustworthiness as it applies to AI in medicine with respect to common stakeholders in medical device development. Within this framework the element of explainability of AI models was explored by evaluating an ensemble of explainable AI (XAI) methods. In current literature a litany of XAI methods are available that provide a variety of insights into the learning and function of AI models. XAI methods provide a human readable output for the AI's learned processes. These XAI methods provide very subjective outputs with varying degrees of quality. Currently, there are no metrics or methods of objectively evaluating XAI

generated explanations against outputs from other XAI methods or to test repeatable consistency of explanations from a single XAI method. This research presents two constituent elements, similarity and stability, to explore the concept of explainability for time series medical data (ECG). Thus providing a repeatable and testable framework to evaluate XAI methods and their generated explanations. This is accomplished using subject matter expert (SME) annotated ECG signals (time-series signals) represented as images to AI models and XAI methods. The XAI methods of Vanilla Saliency, SmoothGrad, GradCAM and GradCAM++ were used to generate XAI outputs for a VGG-16 based deep learning classification model. The framework provides insights about XAI method generated explanations for the AI and how closely that learning corresponds to SME decision making. It also objectively evaluates how closely explanations generated by any XAI method resemble outputs from other XAI methods. Lastly, the framework provides insights about possible enhancements to XAI to go beyond what was identified by the SMEs in their decision making.

pp. 370-377

14:15 Advancement of Printed Electronics for Use in IoT Applications and Wireless Health Care Devices

Joseph S Hyland (Carleton University, Canada); Shakeeb Abdullah (Carleton University & NRC, Canada); Gaozhi (George) Xiao (National Research Council Canada, Canada)

This paper presents advancements and applications of printing technologies to create circuits for use in IoT integration and wireless monitoring in health care systems. Designs are shown for three distinct RF devices: a Luneburg lens, varactor, and two Butler matrices. The Luneburg lens is produced using SLA printing and conductive copper tape to operate at x-band from 8 to 12 GHz where it is measured to enhance the peak far-field gain by 2.9 dB. The varactor circuit was printed on Barium Strontium Titanate (BST) doped substrate to produce a ferroelectric effect. The first Butler Matrix was built on flexible 127 μm (5 mil) polyethylene terephthalate (PET) substrate and conductive printed silver [Ag] at a design frequency of 12.5 GHz. The beam(s) of the matrix had peak realized gain of -32 dBi due to the heavy losses in the substrate and printed conductor ($\tan\delta \approx 0.02$) and ($\sigma = 2.6\times106$ S/m). The second matrix is made on 1.27 mm (50 mil) Rogers RO3006 substrate with half oz copper cladding at a design frequency of 2.4 GHz. The beam(s) of the matrix had peak realized gain of 0.7 dBi with substrate losses of ($\tan\delta = 0.002$) and bulk conductivity of copper ($\sigma = 5.7\times107$ S/m).

pp. 378-383

TS18: Technical Session 18 - Imagery and Acoustics - Image Processing

Room: Lunenburg Room
Chair: Amy Deeb (Lloyds Register, Canada)

13:15 A Non Local Multi-Fiber Network for Action Anticipation in Videos

Nour El din Elmadany (AAST, Egypt); Lei Gao and Ling Guan (Ryerson University, Canada)

In this paper, we investigate the fascinating capacity of 3D Deep ConvNets in action anticipation. Specifically, a Non Local Multi-Fiber Network (NL-MFN) model is proposed. The proposed model is compared against several 3D Deep ConvNets for the task of early action recognition or partially observed frames on the available UCF101 dataset. Additionally, we present the results on the EPIC kitchens challenge dataset used in action anticipation task at the CVPR conference. The

experimental results demonstrated the effectiveness of the proposed NL-MFN in action anticipation.

pp. 384-388

13:35 Trend Extraction and Visualization of Motor Vehicle Occupant Fatality Rates

Kaci N Stromberger and Qi Zhang (Illinois State University, USA)

Motor-vehicle crashes contribute to a significant number of fatalities and injuries in the United States. To effectively extract the accident trend and decrease the death rate, government experts need to analyze the data of vehicle crashes to find out the major causes and come out with a comprehensive decision to reduce traffic crashes. Interactive data visualization is an important technique that allows people to get dynamic visual feedback and extract hidden information. In this project, we developed a dynamic data visualization system that employs JavaScript and Data-Driven Documents (D3) to model the number of motor vehicle occupant fatalities in the United States in 2012 and 2014. Using this model, trends and patterns are extracted from the data with multiple variables considered, including age, sex, and impaired driving. The designed model is created with a HyperText Markup Language (HTML) structure and uses Cascading Style Sheets (CSS) for styling, which is able to switch between these variables and display various data information without reloading the visualization in the web browser. The developed platform can be used as a valuable tool to support the development and assessment of highway safety programs that tend to prevent road traffic accidents.

pp. 389-394

13:55 Whale Optimization Algorithm for Color Image Segmentation Using Supra-Extensive Entropy

Baljit Singh Khehra (BAM Khalsa College, Garhshankar, Hoshiarpur, Punjab, India); Arjan Singh and Lovepreet Kaur (Punjabi University Patiala, India)

Image segmentation plays an important role for image analysis. Image thresholding technique is one of the most effective segmentation techniques. Although, bi-level thresholding is widely applied to segment non-complex color images, however, bi-level thresholding is not suitable in case of color complex images. In case of color complex images which contain multiple objects, only multi-level thresholding works efficiently. The conventional thresholding approaches give efficient results for bi-level thresholding, but the time complexity of the conventional approaches may be excessively high for color image multilevel thresholding due to search multiple threshold values for three (red-green-blue, RGB) components. Thus, color image multilevel thresholding segmentation can be considered as NP-hard combinatorial optimization problem because the time complexity of the searching procedure increases exponentially as levels of thresholding increase. Here, the major objective is to search optimal threshold values for segmenting the color image into appropriate segments. In this paper, Supra-Extensive entropy based new objective function is designed to find optimal threshold values for segmenting the color image into multiple segments. For optimizing the proposed objective function, two well-established population based optimization approaches Whale Optimization Algorithm (WOA) is explored. Such approach is called WOA-based SEEMT. The proposed approach is compared with Grey Wolf Optimizer (GWO) called GWO-based SEEMT algorithm. Experiments are performed on six color benchmark images in terms of optimal threshold values, peak signal to noise ratio (PSNR), uniformity, structure similarity (SSIM) index, mean structure similarity (MSSIM) index, number of iterations and CPU time. The experimental results

show that the there is no significant difference between the performance of WOA-SEEMT and GWO-SEEMT algorithms in terms quality parameters PSNR, uniformity, SSIM index and MSSIM index while WOA-SEEMT algorithm is much faster than GWO-SEEMT from computational point of view.

pp. 395-401

14:15 Hyperspectral Image Classification Based on Gramian Angular Fields Encoding

Yaomin Xue (Memorial University of Newfoundland, Canada); Weimin Huang (Memorial University, Canada); Cheng Yang (Huazhong University of Science and Technology, China)

Using convolutional neural networks (CNN) as a classifier has proven effective in hyperspectral image classification. However, overfitting is a common problem that CNN may face when spectral and spatial information are integrated into the input patch for modeling. Unlike previous approaches, a new feature processing method based on Gramian Angular Fields encoding is proposed in this paper. This specifically focuses on improving edge pixel accuracy for different classes by encoding the 1-D spectral feature into the 2-D Gramian matrix as the data samples that are independent to each other. Without the disturbance from neighboring noises, the spectral information can enhance the classification performance for each pixel using the proposed transformation scheme. Experiments show that the proposed method achieve higher accuracy on edge pixels than other CNN classification approaches.

pp. 402-405

TS19: Technical Session 19 - Cloud Computing 1

Room: Maritime Room
Chair: Michal Aibin (British Columbia Institute of Technology, Canada & Northeastern University, USA)

13:15 Continuous Integration and Continuous Delivery Framework for SDS

Yahuza Bello and Emanuel Figetakis (Manhattan College, USA); Ahmed Refaey (University of Guelph, Canada & Western University, Canada); Petros Spachos (University of Guelph, Canada)

Fast and efficient development of software drives the high demand for automation techniques, especially for cloud-based systems trying to implement Software Defined Systems (SDS). The emergence of Continuous Integration/Continuous Delivery (CI/CD) provides a set of steps for building, testing, and deployment of new software in an automated fashion. Consequently, many companies integrate CI/CD pipelines into their platform to automate the development and deployment of new software and applications. Software-Defined Perimeter (SDP) is a new approach to cyber security proposed by the Cloud Security Alliance (CSA) to dynamically secure network services. This is reached utilizing the need-to-know concept where authorization is only granted after strict user verification. SDP framework integrates with cloud-based systems seamlessly. However, the installation, configurations, and management of its components are still manual. This will require a lot of time and resources as the number of protected services increases. Therefore, this paper presents the implementation of the Continuous Integration/Continuous Delivery (CI/CD) pipeline for the open SDP project that automates the installation and deployment of its various components. Specifically, the Open SDP components (i.e., SDP controller and gateway) will be used as a use case to show the use of CI/CD and to secure applications hosted on the OpenShift environment. The OpenShift pipeline operator, which is based on the Tekton project

was adopted as the CI/CD pipeline for this project. The Code Ready Container (CRC) was utilized as the OpenShift cluster, which is then hosted on a server running a Windows OS. Furthermore, the challenges, as well as their solutions of the Open SDP CI/CD pipeline, are presented.

pp. 406-410

13:35 Evaluating the Performance of the Eclipse OpenJ9 JVM JIT Compiler on AArch64

Aaron G. Graham (University of New Brunswick & Centre for Advanced Studies---Atlantic, Canada); Jean-Philippe Legault, Hillary Soontiens, Julie Brown, Stephen A. MacKay, Gerhard W. Dueck and Kenneth B. Kent (University of New Brunswick, Canada); Kazuhiro Konno (IBM Cloud and Cognitive Software, Japan); Daryl Maier (IBM Canada, Canada)

The embedded computing market, which includes Internet-of-Things (IoT) and mobile computing devices, is a non-traditional computing market where computation resources are limited. Therefore, software, particularly the managed runtime, is required to be more compact and efficient than in a cloud/desktop-based environment. This paper focuses on porting the Eclipse OpenJ9 runtime, a Java Virtual Machine (JVM), built on top of Eclipse OMR, to a new environment while continuing to provide a generic run-time environment. The low-power AArch64 (ARMv8-A) platform is becoming the answer for resource constrained environments of embedded systems. We evaluate and validate the AArch64 implementation of OpenJ9's Just-in-Time (JIT) compiler against more mature architectures currently available, namely x86-64. The evaluation reveals performance discrepancies and necessary improvements, beyond those that are already known. Our work is an effort to template new architectural support and allow others to follow our model. We provide a baseline for future research on OpenJ9, OMR and the JIT on the AArch64 platform and outline some improvements as future work.

pp. 411-418

13:55 Q-Learning Based Routing in Optical Networks

Nolen Bryant, Kwok Chung, Jie Feng and Sommer Harris (Northeastern University, Canada); Kristine N Umeh (Northeastern University, USA); Michal Aibin (British Columbia Institute of Technology, Canada & Northeastern University, USA)

The rapid increase in bandwidth demand has driven the development of flexible, efficient, and scalable optical networks. One of the technologies that allows for much more flexible resource utilization is Elastic Optical Network. However, there is a need to solve the Routing, Modulation and Spectrum Assignment (RMSA) problem. In this paper, we use reinforcement learning to improve the efficiency of the routing algorithm. More specifically, we implement an off-policy Q-learning and compare it with the state-of-the-art algorithms. The results confirm that Q-learning is highly effective when optimal results need to be found in a large search space.

pp. 419-422

14:15 Adaptive Mapping Algorithm for Spectrally-Spatially Flexible Optical Networks

Warisha Bilal, Ming Hsieh, Jeremy Liu and Angela Van (British Columbia Institute of Technology, Canada); Michal Aibin (British Columbia Institute of Technology, Canada & Northeastern University, USA)

Due to the increase in data transmission worldwide, the capacity of a single-core network will soon not meet the transmission demand of higher traffic. New solutions to optical networks, such as

Spatially-Spectrally Flexible Optical Networks, are proposed and investigated to solve this problem. This paper introduces a new algorithm for the Routing, Modulation, Core and Spectrum Assignment (RMCSA) problem based on the adaptive slot mapping procedure. The main goal is to reduce the Bit Rate Blocking (BRB). We compare our approach with three others. The result shows that our algorithm reduces BRB by an average of 20-25%.

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. 423-428

TS20: Technical Session 20 - Microgrids and Renewables - Renewables Integration

Room: Northumberland Room
Chair: Hamed Aly (Dalhousie University, Canada)

13:15 Power System Resiliency Studies Under Renewable Energy Penetration: A Review
Mohammad Salimi, Yuzhong Gong, Shahabodin Afrasiabi, Xiaodong Liang and Chi Yung Chung (University of Saskatchewan, Canada)

High-impact low-probability (HILP) events can significantly threaten the resiliency of electric power grids. In the meantime, the utilization of renewable energy sources (RESs) has introduced serious challenges regarding their variability in operation and planning of power systems. This paper provides a comprehensive review of power system resiliency studies for HILP events considering the integration of high penetration of RESs into power grids. The research reviewed can be classified into three levels, transmission systems, distribution systems, and microgrids (MGs). Findings in this review indicate both negative and positive impacts of RESs on grid resiliency, and several practices for mitigating those adverse consequences are advised in the paper.

pp. 429-434

13:35 Battery Energy Storage Technology in Renewable Energy Integration: A Review
Masoud Javadi (University of Saskatchawen, Canada); Xiaodong Liang, Yuzhong Gong and Chi Yung Chung (University of Saskatchewan, Canada)

Renewable energy sources reduce greenhouse gas emissions caused by traditional fossil fuel-based power plants, and thus, they experience rapid developments recently. Despite the benefits, power fluctuation from renewables due to their intermittent nature may result in grid power oscillation, and deteriorate stability, reliability, and power quality of power grids. Integration of battery energy storage systems (BESSs) with renewable generation units, such as photovoltaic (PV) systems and wind farms, can effectively smooth out such power fluctuations. In this paper, an extensive literature review is conducted on various BESS technologies and their potential applications in

renewable energy integration. To improve the quality of service with the lowest costs, BESSs should be optimized in the planning (e.g., sizing studies) and operation stages to control the unit and its charging or discharging output powers. As the cost of BESSs is still high, optimal decision-making for improving the profitability of these devices considering technical and lifetime constraints is of paramount importance.

pp. 435-440

13:55 A Novel Flexible and Scalable Nonintrusive Load Monitoring Approach Using Wavelet Design and Machine Learning

Jessie Gillis and Walid Morsi (Ontario Tech University (UOIT), Canada)

This paper addresses the problem of non-intrusive appliance load monitoring considering the flexibility of adapting to a new load and the scalability when adopting more appliances. The proposed approach in this paper uses the concept of wavelet design to generate new wavelets to match the features in the transient signals of such loads. The detection and the classification processes are then automated through the application of the unsupervised clustering and the decision tree classifier. The proposed concept has been experimentally verified using a real-test system. The flexibility and the scalability of the proposed method have been discussed and have been exemplified through numerical results.

pp. 441-445

Tuesday, September 20 14:50 - 15:20 (America/Halifax)

B4: Afternoon Break

Tuesday, September 20 15:20 - 17:00 (America/Halifax)

TS21: Technical Session 21 - Emerging Health Care Technologies - Cyber-Physical Systems and Requirements Setting

Room: Bedford
Chair: Amy Deeb (Lloyds Register, Canada)

15:20 Ultrasound Operator Variance Classification for Agency in Artificial Intelligence Support of Cyber-Physical Systems

Calvin Zhu, Thomas E. Doyle and Michael Noseworthy (McMaster University, Canada)

Ultrasound (US) is the most widely used medical imaging modality due to its low cost, portability, real time imaging ability and use of non-ionizing radiation. However, unlike other imaging modalities such as CT or MRI, it is a heavily operator dependent, requiring trained expertise to leverage these benefits. More broadly, the natural interaction between human and computer in general cyber-physical systems would benefit from the support of artificial intelligence (AI) that has the agency to adapt its response based on operator variance. The focus of this paper will be on US operator variance as a first step in demonstrating the concept of AI agency.

Recently there has been an explosion of interest in AI across the medical community and many are turning to the growing trend of deep learning (DL) models to assist in diagnosis. However, deep

learning models do not perform as well when training data is not fully representative of the problem. Due to this difference in training and deployment, model performance suffers which can lead to misdiagnosis. This issue is known as dataset shift. Two aims to address dataset shift were proposed. The first was to quantify how US operator skill and hardware affects acquired images. The second was to use this skill quantification method to screen and match data to deep learning models to improve performance.

A CAE Healthcare BLUE phantom with various mock lesions was scanned by three operators using three different US systems (Siemens S3000, Clarius L15, and Ultrasonix SonixTouch) producing 39013 images. DL models were trained on a specific set to classify the presence of a simulated tumour and tested with data from differing sets. The Xception, VGG19, and ResNet50 architectures were used to test the effects with varying frameworks. PCA for dimension reduction was applied then K-Means clustering was used to separate images generated by operator and hardware into clusters. This clustering algorithm was then used to screen incoming images during deployment to best match input to an appropriate DL model which is trained specifically to classify that type of operator or hardware.

Results showed a noticeable difference when models were given data from differing datasets with the largest accuracy drop being 81.26% to 31.26%

pp. 446-451

15:40 An Intelligent Methodology to Enhance Requirements Engineering in Multidisciplinary Projects

Ali Salmani, Alireza Imani, Majid Bahrehvar, Linda Duffett-Leger and Mohammad Moshirpour (University of Calgary, Canada)

The multidisciplinary nature of a team has been identified as one of the success criteria of both user-centric approaches and agile methods. Stakeholder involvement is considered to be essential for agile processes in order to meet project objectives and ensure results are aligned with stakeholder expectations. However, establishing a collaborative process involving designers, programmers, stakeholders, and users can be challenging; particularly during the requirements engineering stage. Agile methodologies, such as scrum, offer a powerful way of effectively managing software projects and generates a great deal of useful data through tools such as Jira and GitHub. The aim of this research is two folds: 1) analyze the project data from aforementioned sources using process mining techniques to discover deficiencies in the software development process, and 2) propose an automated effort estimation process to address the identified challenges in this study and provide decision support in the development process. This approach is applied to a case study of a virtual healthcare intervention system. The results are indicative that these enhancements helped boost the decision-making and release planning processes by providing the development team a more clear picture, which ultimately mitigated the number of change requests.

pp. 452-457

16:00 A Priori Quantification of Transfer Learning Performance on Time Series Classification for Cyber-Physical Health Systems

Ryan Clark and Thomas E. Doyle (McMaster University, Canada)

Cyber-Physical Systems fully encompass the intelligent system from signal acquisition through to

physical computing and computation -- it requires consideration of the deep entanglement between computational and physical elements. Human health and performance is increasingly being measured and analyzed using machine learning to identify complex relationships using wearable and pervasive computing. This combination defines the focused area of Cyber-Physical Health Systems. Modern deep learning algorithms, such as one dimensional convolutional neural networks, have demonstrated excellent performance in classifying time series data because of the ability to identify time invariant features. A primary challenge of deep learning for time series classification is the large amount of data required for training and many application domains, such as in medicine, have challenges obtaining sufficient data. Transfer learning is a deep learning method used to apply feature knowledge from one deep learning model to another; this is a powerful tool when both training datasets are similar and offers smaller datasets the power of more robust larger datasets. This makes it vital that the best source dataset is selected when performing transfer learning and presently there is no a priori metric defined for this purpose. Analyzing time series data from public human-activity-recognition datasets a neural network autoencoder was used to first transform the source and target datasets into a time independent feature space. To quantify the suitability of transfer learning datasets the average embedded signal from each dataset was used to calculate the distance between each datasets centroid. The metric was then used to predict the success of transfer learning from one dataset to another for the purpose of general time series classification.

pp. 458-464

TS22: Technical Session 22 - Imagery and Acoustics - Acoustics

Room: Lunenburg Room
Chair: Mae Seto (Dalhousie University, Canada)

15:20 A Discriminant Correntropy Analysis for Multi-Feature Fusion

Lei Gao and Ling Guan (Ryerson University, Canada)

In this work, a discriminant correntropy analysis (DCA) method is proposed with application to multi-feature fusion. Benefiting from the joint strength of discriminant power and correntropy descriptor, not only is the discriminant representation explored but also the localized similarity is utilized to measure the structural relationship between the given multiple features, generating a new multi-feature representation with high quality. Different from the most existing multi-feature fusion techniques, such as canonical correlation analysis (CCA) and kernel CCA (KCCA), the probability density is used to reveal the intrinsic relation of input data sources instead of correlation. Moreover, unlike the traditional entropy-based algorithm (e.g., kernel entropy component analysis (KECA) method), DCA is able to be applied to multiple variables instead of a single data source only, enabling a more powerful tool for multi-feature fusion. The performance of the proposed DCA method is verified through experiments on audio emotion recognition and face recognition tasks. The results demonstrate DCA outperforms other statistics machine learning (SML) and deep neural network (DNN) based methods.

pp. 465-470

15:40 Residual Time-Restricted Self-Attentive TDNN Speaker Embedding for Noisy and Far-Field Conditions

Zhor Benhafid (USTHB, Algeria); Sid-Ahmed Selouani (Université de Moncton, Campus de Shippagan, Canada); Mohammed Sidi yakoub (Université de Moncton Campus de Shippagan, Canada); Abderrahmane Amrouche (USTHB, Algeria)

One of the emerging challenges in automatic speaker recognition is the development of systems that are robust to noisy and far-field conditions. The current standard for x-vector speaker embedding is based on a time-delay neural network (TDNN) and is less robust than systems based on a residual network (ResNet) and other baseline systems that use signal enhancement preprocessing in presence of these conditions. In this study, we improve the performance of TDNN-based embedding by integrating a residual block with a time-restricted self-attention option (AttResBlock) into the TDNN frame level. Experiments using the Voices Obscured in Complex Environmental Settings (VOiCES) corpus are carried out to evaluate the proposed speaker embedding extractor (AttResBlock-TDNN). The experimental results show that AttResBlock-TDNN outperforms state-of-the-art systems under many adverse conditions. For instance, the proposed AttResBlock-TDNN produces relative improvements in the minDCF and EER of 11.4% and 15.5%, respectively, over the original TDNN-based encoder.

pp. 471-476

16:00 Taking Advantage of Power Limits in Momentum RLS Loudspeaker Nonlinear Parameter Estimation

Christophe Assi (Université du Québec à Trois-Rivières, Canada); Manouane Caza-Szoka, Daniel Massicotte and François Nougarou (Universite du Quebec a Trois-Rivieres, Canada)

This paper shows that choosing an input signal that respects the electrical power limits of a loudspeaker can improve the identification of the nonlinear parameters, even in simulation. This is demonstrated by simulating the estimation of three dominant nonlinear parameter curves: the force factor, inductance, and mechanical stiffness, all varying with the loudspeaker's position. A comparison between power limited and non-limited input signal performances is made for different colored and non-colored noises. The signals are tested in the context of linear estimation of the polynomial coefficient of the nonlinear parameter curves. To avoid convergence towards local minimums, a Recursive Least Squares (RLS) algorithm with momentum modification is used. However, even with this method the estimation converges often far from the real curves. Therefore, the proposed power limited signal is used. When this type of signal is used as test input signal, 96%, 100%, and 81% of the training processes, for the force factor, the inductance and the mechanical stiffness respectively, had a Normalized Maximum Distance below 1%. The interpretation of the findings is that the input signal must be strong enough so the loudspeaker has sufficient displacement to operate in its nonlinear region but should avoid extreme powers to avoid local minimums during convergence.

pp. 477-482

16:20 Super-Resolution of Audio Files Using Feed-Forward Neural Networks for Music Storage and Transfer

Sean True and Cungang Yang (Ryerson University, Canada)

In this paper, a system for reducing the file size of an audio signal, and then performing super-resolution on the resultant signal to estimate the original, is proposed and designed. This design takes influence from the principles of audio sampling, as well as super-resolution systems designed for visual media, and is split into an encoder and a decoder. The encoder successfully reduces the file size of the audio file by a significant amount. The super-resolution-based decoder can also successfully generate a matching high-frequency audio track that can be combined with the encoded lossy audio in order to estimate the original audio with a reasonable degree of audible accuracy.

While a number of improvements to the system can be made in the future, it shows great promise, as it accomplishes the goals it was designed to meet....N/A

TS23: Technical Session 23 - Cloud Computing 2

Room: Maritime Room
Chair: Michal Aibin (British Columbia Institute of Technology, Canada & Northeastern University, USA)

15:20 Non-Intrusive Load Monitoring Using Machine Learning Acceleratror Hardware for Smart Meters

Matthew A Oinonen, Oliver Gaus, Tristan Pereira and Aman Walia (Ontario Tech University, Canada); Walid Morsi (Ontario Tech University (UOIT), Canada)

Residential electricity customers consume a significant amount of energy due to the extensive use of inefficient appliances. In order to save energy and to reduce the electricity bills of the customers, load monitoring provides such customers with information to make informative cost-effective decisions. Non-Intrusive Load Monitoring (NILM) determines which appliances are on at the electrical input to a residence. Machine Learning (ML) based methods of NILM offer flexibility but at the cost of the computational complexity. This paper looks into addressing the problem of the computational bottleneck using a novel ML-based acceleration hardware. In this work, the machine learning is used to develop an NILM-based algorithm, which is then tested on a publicly available dataset labeled; the Reference Energy Disaggregation Dataset (REED). Subsequently, a physical system modelling an end-to-end smart metering solution is designed and tested. The results show a significant decrease in the time and energy to run the ML algorithms and most importantly, the successful real-time operation of NILM algorithms embedded into a smart meter. By using the newly developed ML acceleration hardware and the ML-based NILM algorithms, NILM can be embedded into next-generation Smart Meters

Presenter bio: Recent Electrical Engineering Graduate from Ontario Tech University in Oshawa Ontario. Just started a Masters in Electrical and Computer Engineering at Ontario Tech researching Smart Grid topics.
pp. 483-488

15:40 COVID Risk Aversion System: Intelligent Risk Calculation Using Location Tracking and Dynamic Area Assessment

Khalid Abdel Hafeez (Ryerson University, Canada); Daniel Silva, Peter Levine, Brett Hausdorf and Ibrahim Mohammed (Ontario tech University, Canada)

The lack of an in-depth system for determining exposure to COVID-19 has left people with a need for an autonomous method of tracking/monitoring user habits and active COVID-19 cases. The COVID Risk Aversion System (CRS) was created to track users and how often they encounter these risks around them. This project currently uses Ontario as a testbed. The CRS system consists of two main components: an in-house server and user application. Using internal and external technologies, CRS logs how often users interact with other users who have the application and the locations they visit. A server was developed to store every location that each user encounters and then categorizes a quantified risk to that specific location based on multiple factors. Risk is determined by COVID-19 cases in the area, risk values of people at given locations, and regional per capita cases of COVID-19. The server alters area risk based on decreasing or increasing cases within a specific region. Every hour, the server checks Ontario's COVID-19 statistics and updates

the database's values, and then recalculates the dynamic values for all locations stored in the system. The client-side application reports the user's location every 5 minutes and requests information on all users geographically close to that person using Vincenty's formula. Twice a day, the application updates the user's risk based on the interactions the user has had throughout the day. Users can also view a map of Ontario that displays regional risk and can check the risk of specific locations. CRS aims to be an effective method at reducing the user's exposure to COVID-19.

pp. 489-493

16:00 Performance Analysis of Vehicular Cloud Under Interruption Avoidance Strategy

Chinh Tran and Mustafa Mehmet-Ali (Concordia University, Canada)

Future vehicles are expected to generate large amounts of data which may need to be off-loaded to a proximate server for processing. This led to the introduction of vehicular clouds (VC), which proposes that computing is done at nearby vehicles. However, as the vehicles may leave and join the VC randomly, the computing services of VC are time-varying, which may cause service interruptions. This work analytically evaluates the performance of the VCs under a service strategy that overcomes the interruptions caused by resource volatility. We use order statistics to derive the probability distribution of the number of vehicle arrivals to assign all the tasks of a job, the upper and lower bounds of mean job completion time. Finally, we present the numerical results for the analysis and the simulation results to show the correctness of the analysis.

pp. 494-498

16:20 Optimal Power Allocation Based on Success Probability of SIC Detection in MWRC PNC

Hao Li (Mcgill University, Canada); Xiao-Wen Chang and Benoit Champagne (McGill University, Canada)

In this paper, we propose a novel power allocation scheme for physical-layer network coding (PNC) in uplink multi-way relay channels (MWRC). The power allocation is formulated as a constrained optimization problem under the transmitting power constraint of user terminals, aiming at maximizing the success probability of the successive interference cancellation (SIC) detection at the relay. Optimizing over such a metric maximizes the probability of correctly detecting all user signals, which is critical to the network code generation at the relay. Specifically, we first develop a generalized closed-form success probability of the SIC detection on signals with pulse-amplitude modulation (PAM) at the relay. A constraint optimization is formulated over this probability subject to the power constraints of user terminals. We implement an evolutionary particle swarm optimization (PSO) algorithm to solve the problem whose cost function is complicated and not necessarily concave. The numerical results show that the proposed power allocation method can improve the quality of network code extraction at the relay.

pp. 499-503