IEEE HONET 2023

20th International Conference on

'Smart Communities: Improving Quality of Life Using AI, Robotics and IoT

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Welcome Note: On behalf of the 20th IEEE Int'l Conference HONET'2023 Organizing Committee, we're thrilled to welcome you all from various parts of the globe at the Florida Atlantic University (FAU), Boca Raton, FL USA. The HONET Organizing teams from the host institution FAU College of Engineering, Dept Electrical Engineering & Computer Science, Florida Atlantic University Boca Raton, Florida, as well as from other Universities from various states and HONET Global team from Worldwide institutions.

Despite the lingering effects and challenges from Covid-19 pandemic and its variants, global conflicts and resulting economic and travelling problems, HONET 2023 organizing team has worked day and night to bring out a robust program. We are firmly determined and committed working together to carry out the mission of global cooperation in research, education and communications for forging alliance to continue emerging the smart communities and alliances. We extend our warm welcome to the international delegates and contributors who are participating in person or virtually from different continents and time zones i.e., from USA, Pakistan, Australia, India, Taiwan, Iraq, Japan, Ireland, Saudi Arabia, New Zealand, United Kingdom, Bangladesh, Gabon and others. The sequence of countries names represents proportion contributions from highest to lowest.

HONET series of conferences and symposia are recognized as the confluence and convergence of the researchers and delegates contributing in Research and Education pertaining to Enabling Technologies e.g., various Information & Communications Technologies (ICT), Robotics and Internet of Things (IoT), Smart Microgrids and Energy-harvesting and Storage, Photonics, Cyber-Security and AI (artificial intelligence). Moreover, Photonics technologies, HONET's legacy areas (Communications and Enabling & Emerging Technologies, e-Applications and Nanophotonics) and intelligent technologies are included to support smart communities' – one of the HONET's global objectives.

This year's HONET 3-day program comprises of nine high-impact technical-sessions with fifty-one high-quality papers in the various thematic areas. Program also comprises of four key-note presentations and six-invited papers in variety of thematic areas. Moreover, two-symposiums on hot topics; i.e., i. AI-Enabled Cyber-Security (AI4CS), ii. Emerging Technologies and Entrepreneurial Themes in Higher Education, this will also include a 'Panel Session', and iii. Online Simulations and Remote Access Visualization Tools for Engineering Sciences & Technology Curricula.

The program comprising of four keynote presentations (two in main Conference and two in Symposiums), six invited presentations covering the broad range and theme of the IEEE International Conference. The impact of the event is intended to be broad spanning the realms of academe, technology, industry, educational outreach with energy and security topics. Details are included in the appended program.

We believe that the chosen venue FAU, Boca Raton, FL, US (this year's host) as well as limited online access guarantees successful technical conference despite the tense global challenges in traveling. Although some of our delegates and participants will miss the welcoming of the hosts at FAU, Boca Raton, FL, USA with hospitality and in-person December celebrations but certain conditions such as visa and expensive travelling period are beyond our control. We hope and wish that in future, both our international and regional participants will be able join in person to enjoy meeting the international colleagues and visiting new the places on our beautiful planet. As noted above, the Technical Program is rich and wide-range including four keynotes, and almost a dozen invited presentations, and more than 55 high caliber contributed research papers, in Artificial-Intelligence, Computer and Communication Networks, Cloud Computing, Energy & Power and Enabling Technologies. Of course, two symposiums and a workshop augment the technical program.

The real success of a conference depends ultimately on the participants (both presenters and attendees). This year the participants represent 13+ nations and several states of the US besides Florida, the host. Moreover, behind the scenes there are several people who have worked with us in planning and organizing both the technical program and logistic arrangements. The financial underwritings as usual are largely from the hosts (FAU-Florida) and IEEE Palm Beach Section and continuing support assurance for HONET from the Center for Optoelectronics & Optical Communications at UNC Charlotte and the IEEE North Carolina Council.

In particular, we express our sincere thanks to Dr. Hari Kalva, Prof. & Chair EE & CS at FAU and Chair IEEE Palm Beach Section, FL, Dr. KwangSoo Yang and the Team at the Florida Atlantic University, Boca Raton, FL, serving on various committees. Also, we would like to acknowledge the continuous support from Dr. Glenn Boreman, Chair of Physics & Optical Science and Director 'Optics Center' UNC Charlotte, USA, Dr. Jim Conrad, UG Program Dir & Assoc. Chair ECE, UNC Charlotte, NC, Engr. Charles Lord IEEE NC, USA and Dr. S. M. H. Zaidi, Prof and Pro-Rector GIKI University, Pakistan.

We thankfully acknowledge the guidance from the HONET-ICT advisory board; and support of 'Optics Center-UNC Charlotte', IEEE North Carolina Council and IEEE Palm Beach Section, FL, for their technical/financial co-sponsorships. We appreciate the hard work by Dr. Syed Ali Haider (SUNY at Fredonia) for serving in multiple roles as TPC and Publication to Publicity Co-Chair and managing all the submissions and reviews on EDAS and Technical Program and subsequent IEEE Xplore proceedings. We express our sincere thanks to Dr. Junaid A. Zubairi, SUNY, Fredonia; Dr. Harshal A. Sanghvi, College of Business FAU, and Dr. Abasifreke Ebong ECE, UNC Charlotte for their active roles and committees. Among the technical program support notable names include, Dr. Muazzam Ali Khattak (QAU), Dr. Salahuddin Qazi, Prof. Emeritus SUNY Utica and Dr. Zafar Taqvi IEEE Houston area and Univ of Houston Clear Lake, TX.

A large group of reviewers (https://honet.uncc.edu/committees.html) from global community deserves appreciation for their volunteer work done with utmost care, devotion and in a timely manner. We all are confident that HONET'2023 will build upon the strengths and experiences of past events and will continue growing in its strength, quality, and prestige. It will remain a symbol of global contributions in scientific- and engineering-research, emerging technologies, global education, and economic development. In the end, we would like to acknowledge the hard work and support of our HONET core-team. We also recognize the leading global role of UNC Charlotte and various other international co-organizers and future hosts. We thankfully acknowledge HONET sponsors and contributors, namely FAU, UNC Charlotte, FIU, University of Doha, IEEE Palm Beach Section, IEEE North Carolina Council for 20th Int'l Conference.

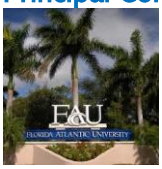
Sincerely,

M~YasinRaja for

Dr. M. Yasin Akhtar Raja
Dr. Mohammad Ilyas
Dr. Imadeldin Mahgoub
Dr. Syed Ali Haider

(IEEE-HONET'2023 Chairs)

Principal Contributor



Partner Contributor

FIU Engineering & Computing
FLORIDA INTERNATIONAL UNIVERSITY

Day 1
Monday, December 04, 2023

8:00—9:00	Welcome and Registration	
Location →	Room EE 106 (Auditorium)	
9:00—9:30	Opening Ceremony Opening remarks and introduction	
9:30—10:00	**Invited Talk 1:** Next Gen Video for Humans and Machines **Hari Kalva, Ph.D.,** *Interim Chair and Professor* *Department of Electrical Engineering and Computer Science, Florida Atlantic University*	
10:00—10:30	**Keynote:** The Development of Non-Toxic and Earth-Abundant ZnO-based Materials and Devices for Photonics and Energy Applications **Ian Ferguson, Ph.D.** *Fellow IEEE, IOP and SPIE* *Dean, Southern Polytechnic College of Engineering and Engineering Technology, Kennesaw State University*	
10:30—11:00	**Invited Talk 2:** Tackling Road Congestion through Machine Learning, Hierarchical Graphs, and Just-in-Time Congestion Response **Megan L Johnson, Ph.D.,** *Department of Mathematics, SUNY Fredonia, NY, USA*	
11:00—11:30	Break	
Location →	Room EE 213	Room EE 207
11:30—12:00 12:00—12:30 12:30—1:00 1:00—1:30	**TS I** Artificial Intelligence, Internet of Things, and AI & IoT for Smart Cities *Papers: TS1-1 to TS1-6*	**TS 6** Computer Networks and Network Security *Papers: TS6-1 to TS6-6*
1:30—2:30	Lunch Break	
Location →	Room EE 213	Room EE 207
2:30—3:00 3:00—3:30 3:30—4:00 4:00—4:30	**TS 2** Artificial Intelligence, Internet of Things, and AI & IoT for Smart Cities *Papers: TS2-1 to TS2-6*	**TS 8** Robotics *Papers: TS8-1 to TS8-6*
4:30—5:00 6:00—8:30		

Day 2
Tuesday, December 05, 2023

8:00—9:00		
Location →	Room EE 106 (Auditorium)	
9:00—9:30	**Keynote:** Machine Learning Applications in Optimal Power System Decision Analyses **Mohammad Shahidehpour, Ph.D.** *Fellow IEEE,* *Bodine Chair Professor and Directo, Galvin Center for Electricity Innovation, Illinois Institute of Technology*	
9:30—10:00	**Invited Talk 3:** Developing an Autonomous All-Terrain Vehicle - Control and Perception **James M. Conrad, Ph.D.**, *Associate Chair* *Dept. of Electrical and Computer Engineering, UNC Charlotte*	
10:00—10:30	**Invited Talk 4:** Increasing internet bandwidth for IoT with silicon photonics enabled by GeSn alloys **Jay Mathews, Ph.D.** *Department of Physics and Optical Science* *University of North Carolina at Charlotte* *Charlotte, NC, USA*	
10:30—11:00	**Symposium** on Emerging Technologies and Entrepreneurial Themes in Higher Education *Speakers & Panel Discussion* Continued at 2:30pm Room EE 106 (Auditorium)	
11:00—11:30	Break	
Location →	Room EE 213	Room EE 207
11:30—12:00	**TS 3** Artificial Intelligence, Internet of Things, and AI & IoT for Smart Cities *Papers: TS3-1 to TS3-6*	**TS 7** Energy and Power Technologies /Photonics *Papers: TS7-1 to TS7-6*
12:00—12:30		
12:30—1:00		
1:00—1:30		
1:30—2:30	Lunch Break	
Location →	Room EE 106 (Auditorium)	
2:30—3:00	continued… **Symposium** on Emerging Technologies and Entrepreneurial Themes in Higher Education *Speakers & Panel Session*	
3:00—3:30		
3:30—4:00		
4:00—4:30		
4:30—5:00		
6:00—8:30	Conference Banquet – FAU Club, Second Floor, Engineering East building	

Day 3
Wednesday, December 06, 2023

8:00—9:00		
Location →	Room EE 106 (Auditorium)	
9:00—9:30	**Invited Talk 5:** Impedance Modification of Infrared Antennas **Glenn D. Boreman, Ph.D.** *Chair, Dept. of Physics & Optical Science, Director, Center for Optoelectronic & Optical Comm. University of North Carolina at Charlotte*	
9:30—10:00		
10:00—10:30		
10:30—11:00	**AI4CS / TS 9** **Symposium** on AI-Enabled Cybersecurity (AI4CS) *Papers: TS9-1 to TS9-3*	
11:00—11:30	Break	
Location →	Room EE 213	Room EE 207
11:30—12:00	**TS 4** Artificial Intelligence, Internet of Things, and AI & IoT for Smart Cities *Papers: TS4-1 to TS4-6*	**Workshop** on Online Simulations and Remote Access Visualization Tools for Engineering Sciences & Technology Curricula *Speakers*
12:00—12:30		
12:30—1:00		
1:00—1:30		
1:30—2:30	Lunch Break	
Location →	Room EE 213	
2:30—3:00	**TS 5** Artificial Intelligence, Internet of Things, and AI & IoT for Smart Cities *Papers: TS5-1 to TS5-6*	
3:00—3:30		
3:30—4:00		
4:00—4:30		
4:30—5:00	Closing Ceremony – Room EE 106 (Auditorium)	
6:00—8:30		

TS1-1 **Road Scene Text Detection and Recognition Using Machine Learning**

Syed Hassaan Ali Shah (COMSATS University Islamabad, Wah Campus & Riphah International University, Islamabad, Pakistan); Jamal Hussain Shah (Assistant Professor, Pakistan)

For high-level semantic information extraction, text is the most powerful source. Understanding natural scene text is a hot topic in the field of computer vision. It means that natural scenes encapsulated a variety of specific information in the form of text, which may be applied in a variety of applications of real world. This study will look at all areas of scene text comprehension while adding fresh machine learning algorithms in a semi-pipelined or fully pipelined methodology. The primary target of this study is to produced and implement integrated algorithms that automatically perform image processing and computer vision techniques in order to understand, correct, and overcome all text-related challenges under a single umbrella, resulting in an all-in-one end-product. In the first phase of this research work an object detection model i.e. YOLOv5 is applied on ASAYAR dataset to localize the road scene text images in the form of bounding boxes. This model has worked more effectively and produced accuracy level up to 99% on text images. In the second phase preprocessing techniques are applied and quality of image dataset is enhanced by using K-Means color segmentation. The enhanced images are then passed through Maximally Stable Extremal Region (MSER), which is a feature region detector for text based images. After detection of text regions, Optical Character Recognition (OCR) is applied for the final text recognition.

TS1-2 [C,R] **Balancing the Load: Drones as Key Players in Solar Small Cell Network Performance**

Daksh R Dave (BITS Pilani, India); Dhruv D Khut and Sahil S Nawale (Sardar Patel Institute of Technology, India); Pushkar Aggrawal (BITS Pilani, India); Disha Rastogi (Ajay Kumar Garg College of Engineering, India); Kailas Devadkar (University of Mumbai, India)

Addressing the critical energy constraints in 5G and beyond, this study introduces an innovative load transfer method using drone-carried airborne base stations (BSs) for stable and secure power reallocation within a green microgrid network. This method effectively manages energy deficit by transferring aerial BSs from high to low-energy cells, depending on user density and the availability of aerial BSs, optimizing power distribution in advanced cellular networks. The complexity of the proposed system is significantly lower as compared to existing power cable transmission systems currently employed in powering the BSs. Furthermore, our proposed algorithm has been shown to reduce BS power outages while requiring a minimum number of drone exchanges. We have conducted a thorough review on real-world dataset to prove the efficacy of our proposed approach to support BS during high load demand times.

TS1-3 **A Blockchain Based Lightweight Secure Authentication and Trust Assessment Framework For IoT Devices in FOg Computing**

Nida Bajwa (Comsats University, Pakistan); Muazzam A. Khan (Quaid-i-Azam University, Islamabad, Pakistan); Adeel Anjum (Quaid-I-Azam University Islamabad, Pakistan)

The IoT devices are used in everyday life and are connected to build a network. An extensive amount of data is being shared among these devices. However, these devices are resource-constrained and cannot perform their computations. Because of their resource constrained nature security and privacy of IoT devices have become a major concern. As a result, the concept of fog computing, which performs computation on behalf of IoT devices, was introduced. The fog computing paradigm provides a distributed resource environment close to the smart IoT devices. In this paper, we used Blockchain Technology and Iterative Filtering (IF) Algorithm to ensure data privacy as well as prevent collusion attacks. An authentication protocol based on Elliptic Curve Cryptography (ECC) is used that provides efficient security during communication between devices. In addition, an angular distance-based secure cluster of IoT devices is establish using a secure and reliable trust mechanism where each IoT device should authenticate itself before joining the cluster, and this cluster allows devices to communicate securely and without interruption. The results of the experiments show that our proposed framework is effective against collusion attacks. Moreover, our proposed framework has greater efficiency in terms of time complexity and energy consumption.

TS1-4 **Enhancing IoT Attacks Detection Through Ensemble-Based Multiclass Attacks Classification**

Yazeed Hathal Alotaibi, Sr (Florida Atlantic University Boca Raton, FL, USA); Mohammad Ilyas (Florida Atlantic University, USA)

Interconnected nodes communicate, exchange, and transfer data through multiple network protocols to form the Internet of Things (IoT). Study shows that these protocols' ease of exploitation makes them vulnerable to cyberattacks on data transmission. In this study, we anticipate to improve IDS detection efficiency and add to the literature. A multiclass classification of IoT traffic attacks to enhances IDS efficiency. Multi-class supervised ML methods and ensemble classifiers are used. TON-IoT network traffic was used for model training. Five trained ML-Multiclass supervised models-Random Forest, Decision Tree, XGBoost, Extra Tree, and K-Nearest Neighbor-are the most accurate. Voting and stacking ensembles use these five classifiers. The evaluation measures were used to compare the ensemble techniques' classification effectiveness. Ensemble classifiers outperformed multiclass models. Ensemble learning systems that use varied learning processes with different capacities improved this. Combining these methodologies improved classification reliability and reduced classification mistakes. Experimental data indicates that the proposed framework can enhance Intrusion Detection System efficiency with 0.98923 accuracy.

TS1-5 **Portable disaster monitoring and escape guidance system**

Cheng-Huei Yang and Tsung-Che Wu (National Pingtung University of Science and Technology, General Research Center, Taiwan); Yi-Ru Lai (National Pingtung University of Science and Technology, Taiwan)

This paper attempts a novel system for disaster prevention/relief and escape in response to extreme weather threats. During extreme weather situations, previous disaster prevention equipment have been unable to effectively prevent disaster, and meet the needs of the people and relief personnel. Through integrating information and communication hardware, and software technology, this work develops a portable disaster-monitoring device to speed up disaster information integration and notification. Additionally, by developing a mobile phone disaster monitoring application (APP), people can use their mobile phones to report disasters and receive real-time disaster information, providing them enough information to determine their actions. This means by integrating the people's power and the government's efforts (disaster-prevention equipment development), we can maximize the benefits of civil defense/disaster relief and escape.

TS1-6 **CYBRIA - Pioneering Federated Learning for Privacy-Aware Cybersecurity with Brilliance**

Anurag Thantharate (University of Missouri Kansas City & Samsung Electronics, USA); Pratik Thantharate (SUNY Binghamton & IEEE USA, USA)

Centralized machine learning approaches for cybersecurity raise significant privacy and security concerns due to raw data aggregation from distributed sources. This paper presents Cybria, a federated learning framework for collaborative cyber threat detection without compromising confidential data. The decentralized approach trains models on local data distributed across clients and shares only intermediate model updates to generate an integrated global model. We develop a federated learning architecture tailored for privacy-preserving intrusion detection. Comparative evaluations on the Bot-IoT dataset demonstrate that Cybria's federated model achieves 89.6% accuracy compared to 81.4% for a centralized deep neural network. The ~10% improvement highlights the benefits of collective learning from decentralized data for cyber defense applications. However, real-world deployment faces challenges like statistical heterogeneity, systemic bias, and data poisoning attacks. Advances in secure aggregation, differential privacy, and adversarial defenses are crucial to robust large-scale adoption. With thoughtful human-centric design, federated intelligence paves the path for an ecosystem approach to security where organizations collectively build threat awareness without centralizing data.

TS2-1 **Finger Knuckle Print Classification Using Pretrained Vision Models**

Ahmed Altaher (Florida Atlantic University, USA); Mustafa Khalid Mezaal (Al-Shaab University, Iraq); Muhammad Tanveer Jan, Munid Alanazi, Mostapha Alsaidi, Zahra Salekshahrezaee, Ali Altaher and Hanqi Zhuang (Florida Atlantic University, USA)

Privacy and security are significant issues in the field of biometric traits in today's world. This research report presents a comprehensive study that utilizes seven different deep learning models to classify Finger Knuckle Prints (FKP). The main aim of this study is to examine the efficacy of fine-tuning pretrained vision models in adapting to the specific dataset being analyzed. The models employed in this study include AlexNet, DensNet, EfficientNet, GoogleNet, Shallow Convolutional Neural Networks (SCNNs), ResNet50, and VisionTransformer. The models underwent training and testing procedures utilizing a comprehensive dataset obtained from 165 volunteers by Hong Kong Polytechnic University (Poly U). This dataset consisted of about 7,920 photos depicting the FKP gestures. A series of experiments were done to investigate the impact of alterations to the architectural design parameters of the models on the achievement of optimal recognition accuracy. The findings from our investigation indicate that the SCNNs and AlexNet had remarkably high accuracy rates of 98.3% and 96.224%, outperformed all other models. The accuracy rates reached by different models are as follows: EfficientNet achieved an accuracy rate of 98.176%, AlexNet achieved 96.224%, GoogleNet attained 95.601%, ResNet50 achieved 92.598%, DenseNet achieved 81.224%, and VisionTransformer gave the lowest accuracy of 79.513%.

TS2-2 [R] **Smartphone Based Food Classification: Applications, Challenges, and Future Prospects for Diabetics**

Afnan A Crystal, Maria Valero and Valentina Nino (Kennesaw State University, USA)

Diabetes has become a global health concern, posing risk to millions of individuals. Managing dietary consumption is crucial for the overall health of diabetic patients. Traditional methods of monitoring food intake can be tedious and unreliable. However, computer vision-based solutions, such as image-based food recognition systems (FIRS) using mobile cameras, offer automated and efficient ways to track food intake. This systematic review examines mobile computer vision approaches for food classification, volume estimation, and calorific measurement. Besides, the study discusses the potential integration of Glycemic Index estimation to FIRS to benefit diabetic patients. Future directions and issues related to FIRS are also explored.

TS2-3 **A Novel Solution To Transportation Safety**

Jorge Diaz Rodriguez, Steven Steele, Ammy A Ovando, Gopi Debnath and Muhammad Hassan Tanveer (Kennesaw State University, USA); Razvan Cristian Voicu (Georgia Institute of Technology & Kennesaw State University, USA)

As the idea of autonomous cars become more popular a large amount of semi-autonomous cars have been sold, and the imperfections of the technology has become more apparent due to crashes caused by them. Car accidents can leave motor vehicle drivers impaired and unable to call for assistance, due to this the concept of the Intelligence Autonomous Monitoring (IAM) began. The IAM is a intelligent monitoring device developed using a raspberry pi 4B, an Intel Real Sense D-455, and the Convolutional Neural Network Yolov7 which was trained using car crash images. Convolution Neural Networks have

become a great tool for object detection and have been used to detect a plethora of things including but not limited to cars and people. This review can help future researchers to further improve the performance of the device in detection and prevention.

TS2-4 **Turn Constrained Shortest Path**

Amogh Allani and KwangSoo Yang (Florida Atlantic University, USA)

Given a transportation network, a source node s, a destination node t, and the number of maximum possible turnings b, the Turn-Constrained Shortest Path (TCSP) problem is to find the route that minimizes the travel distance and meets the turn-constraint. The TCSP problem is important for societal applications such as shipping and logistics, emergency route planning, and traffic management services. The TCSP problem is computationally challenging because of the large size of the transportation network and the constraint that the route meets the turn-constraint. Previous work has focused on the shortest path with turning time costs. However, these approaches cannot minimize the travel distance with the turn-constraint. We propose novel approaches for TCSP to meet the turn-constraint while minimizing the travel distance for the vehicle route. Experiments and a case study using real-world datasets demonstrated that the proposed algorithms can minimize the travel distance and meet the turn-constraint; furthermore, it has comparable solution quality to the unconstrained shortest path and significantly reduces the computational cost.

TS2-5 **Multi-Dataset Human Activity Recognition: Leveraging Fusion for Enhanced Performance**

Munid Alanazi, Ali Altaher, Ahmed Altaher and Mohammad Ilyas (Florida Atlantic University, USA); Bader Alsharif (Florida Atlantic University & Technical and Vocational Training Corporation (TVTC), Riyadh, USA)

This paper explores the domain of Human Activity Recognition (HAR) utilizing sensor-based data and machine learning models. Deeply, the paper research two data fusion methods with the goal of building efficient model for activity recognition problem. two dataset have combined for the purpose of classification. We address a common challenge in HAR research. such as, Using different smartphone models and sensor configurations. To tackle this challenge, we conducts experiments on two datasets, KU-HAR and UCI HAR, and employs data fusion techniques at both feature and decision levels. Four popular machine learning classifiers-Decision Trees, Random Forest, Gradient Boosting, and XGBoost-are evaluated using these fusion methods. The results show promising performance in classifying fundamental human activities. XGBoost demonstrated the highest accuracy, surpassing all other models with approxi-mately 96.83%. In comparison to XGBoost's accuracy, Gradient Boosting achieved an accuracy of about 95.71%, demonstrating strong performance. Random Forest, while slightly behind, still delivered an acceptable accuracy of around 94.28%, making it a viable choice for Human Activity Recognition tasks. decision tree has the lowest performance with 85.69% In terms of decision-level fusion accuracy, Stacking outperformed the other methods with an accuracy of approximately 96.70%. Majority Voting also demonstrated strong performance, closely following with an accuracy of about 95.96%. However, Bagging fell behind the rest, achieving an accuracy of approximately 93.65%

TS2-6 **Dimensionality Reduction for Smart Meter Data using Variational Autoencoders**

Aviral Kandel and Dimitrios Charalampidis (University of New Orleans, USA)

The growth of smart grid technology has led to the generation of exceptionally high-dimensional energy datasets, owing to the increased frequency of measurements. Moreover, utilizing a year-long dataset is imperative, as relying solely on monthly or quarterly data may lead into wrong conclusions due to variations in seasonal dynamics and customer behavior. In order for this vast amount of information to be usable, it must be summarized into a low-dimensional representation. In this paper, we propose a Long Short Term Memory-based Variational Autoencoder (LSTM-VAE) to generate an encoded representation of the original complex multivariate data. By utilizing this method, a 8760-dimensional dataset can be condensed into a 10-dimensional dataset, which can be subsequently further reduced by Principal Component Analysis (PCA) to a 2D representation for visualization purposes. In addition to visually inspecting the 2D representation of the data, the effectiveness of this method is assessed by a subsequent clustering algorithm using the Adjusted Rand Index (ARI). Both visual inspection and the ARI index demonstrate that the proposed method outperforms other dimensionality reduction techniques by a substantial margin.

TS3-1 **Pioneering Climate Forecasting in Tennessee with LSTM-ANN Machine Learning Model**

Amin Amiri, Yu Liang and Mbakisya Onyango (University of Tennessee at Chattanooga, USA)

Climate forecasting within the unique context of Tennessee presents a complex and pressing challenge in the face of global climate change. In response, this study embarks on a pioneering exploration of advanced techniques designed to elevate the precision and reliability of climate prediction methodologies. At the heart of our research lies a revolutionary fusion of two cutting-edge technologies: Long Short-Term Memory (LSTM) networks and Artificial Neural Networks (ANN). This synergistic partnership forms the core of a sophisticated predictive modeling framework, meticulously fine-tuned to accommodate the nuanced and region-specific climatic intricacies that characterize Tennessee's climate patterns. Our commitment to advancing climate forecasting is exemplified through the successful application of our proposed model. With a deep dive into historical climate data from 1980 to 2022, our research reveals the model's remarkable capacity to generate accurate forecasts consistently. This achievement underscores the model's robustness and adaptability in capturing and deciphering long-term climatic trends. In an era where the consequences of climate change loom large, our findings hold profound

implications. They signify a transformative leap forward in the quest for precise and actionable climate predictions. By bridging the chasm between cutting-edge scientific innovation and practical climate solutions, our research is invaluable to the global mission of mitigating climate change's far-reaching impacts and securing a sustainable future for all.

TS3-2 **In-vehicle Sensing and Data Analysis for Older Drivers with Mild Cognitive Impairment**

Sonia Moshfeghi, Muhammad Tanveer Jan, Joshua Conniff, Seyedeh Gol Ara Ghoreishi, Jinwoo Jang, Borko Furht, KwangSoo Yang, Monica Rosselli, David Newman, Ruth Tappen and Dana Smith (Florida Atlantic University, USA)

Driving is a complex daily activity indicating age- and disease-related cognitive declines. Therefore, deficits in driving performance compared with ones without mild cognitive impairment (MCI) can reflect changes in cognitive functioning. There is increasing evidence that unobtrusive monitoring of older adults' driving performance in a daily-life setting may allow us to detect subtle early changes in cognition. The objectives of this paper include designing low-cost in-vehicle sensing hardware capable of obtaining high-precision positioning and telematics data, identifying important indicators for early changes in cognition, and detecting early-warning signs of cognitive impairment in a truly normal, day-to-day driving condition with machine learning approaches. Our statistical analysis comparing drivers with MCI to those without reveals that those with MCI exhibit smoother and safer driving patterns. This suggests that drivers with MCI are cognizant of their condition and tend to avoid erratic driving behaviors. Furthermore, our Random Forest models identified the number of night trips, number of trips, and education as the most influential factors in our data evaluation.

TS3-3 **Anomalous Behavior Detection in Trajectory Data of Older Drivers**

Seyedeh Gol Ara Ghoreishi, Sonia Moshfeghi, Muhammad Tanveer Jan, Joshua Conniff, KwangSoo Yang, Jinwoo Jang, Borko Furht, Ruth Tappen, David Newman, Monica Rosselli and Jiannan Zhai (Florida Atlantic University, USA)

Given a road network and a set of trajectory data, the anomalous behavior detection (ABD) problem is to identify drivers that show significant directional deviations, hard-brakings, and accelerations in their trips. The ABD problem is important in many societal applications, including Mild Cognitive Impairment (MCI) detection and safe route recommendations for older drivers. The ABD problem is computationally challenging due to the large size of temporally-detailed trajectories dataset. In this paper, we propose an Edge-Attributed Matrix that can represent the key properties of temporally-detailed trajectory datasets and identify abnormal driving behaviors. Experiments using real-world datasets demonstrated that our approach efficiently identifies abnormal driving behaviors.

TS3-4 **Detecting Falls through Convolutional Neural Networks using Infrared Sensor and Accelerometer**

Zeyu Liu (Valley Christian High School, USA)

Over 20 million seniors in the US live alone, at risk of falling without being able to notify anyone of their distress. Falls among the elderly pose significant health risks, and early detection is crucial for minimizing their impact. Current methods for fall detection utilize camera-based systems and accelerometers to track body position and movement. However, these methods suffer from high false-positive rates and lack of user privacy. In our work, we remedy these issues by combining infrared sensors and accelerometers with advanced machine-learning algorithms for fall detection. Our work shows that through our unique integration of multiple sensors' data, a convolutional neural network (CNN) is able to accurately detect falls while maintaining high precision and recall rates. This research aims to guide future advancements in the field, assisting researchers, engineers, and healthcare professionals in developing innovative solutions to improve the quality of life for the elderly and reduce healthcare burdens.

TS3-5 **FPGA-QHAR: Throughput-Optimized for Quantized Two-Stream Human Action Recognition on The Edge**

Azzam Alhussain (University of Central Florida, USA & Jubail Industrial College, Saudi Arabia); Mingjie Lin (University of Central Florida, USA)

Accelerating Human Action Recognition (HAR) efficiently for real-time surveillance and robotic systems on edge chips remains a challenging research field, given its high computational and memory requirements. This paper proposed an integrated end-to-end HAR scalable HW/SW accelerator co-design based on an enhanced 8-bit quantized Two-Stream SimpleNet-PyTorch CNN architecture. Our network accelerator was trained on UCF101 and UCF24 datasets and implemented on edge SoC-FPGA. Our development uses partially streaming dataflow architecture to achieve higher throughput versus network design and resource utilization trade-off. We also fused all convolutional, batch-norm, and ReLU operations into a single homogeneous layer and utilized the Lucas-Kanade motion flow method to enable a high parallelism accelerator design and optimized on-chip engine computing. Furthermore, our proposed methodology achieved nearly 81% prediction accuracy with an approximately 24 FPS real-time inference throughput at 187MHz on ZCU104, which is 1.7x - 1.9x higher than the prior research. Lastly, the designed framework was benchmarked against several hardware chips for higher throughput and performance measurements and is now available as an open-source project on GitHub for training and implementation on edge platforms.

TS3-6 **Dynamic Visualization Platform for Travel-Related Data Integration to Support Sustainability-Based Decision-Making for Smart Cities**

Yufei Xu (Georgia Institute of Technology, Gabon); Gulam Kibria and Chaojie Wang (Georgia Institute of Technology, USA); Einat Tenenboim (Georgia Tech, USA); Viswa Sri Rupa Anne (Georgia Institute of Technology, USA); Zhiwei Chen (Drexel University, USA); Srinivas Peeta (Georgia Institute of Technology, USA)

Smart cities seek to leverage data from advanced information, communication, and sensor technologies (ICSTs) for achieving their transportation-related sustainability goals. However, the multi-source, multi-timescale nature of these disparate data sets introduces many challenges to community decision-makers,
hindering the use of these technologies in an efficient, effective, and holistic manner. Here, using statistical and machine learning methods, we present a visualization platform developed for the City of Peachtree Corners, GA, comprising nine integrated data sets. This platform can capture dynamic interactions between data from different sources and has the potential to support decision-makers in developing different solution options for contemporary transportation-related problems in a smart city environment.

TS4-1 **Machine Learning Technology to Recognize American Sign Language Alphabet**

Bader Alsharif (Florida Atlantic University & Technical and Vocational Training Corporation (TVTC), Riyadh, USA); Munid Alanazi and Mohammad Ilyas (Florida Atlantic University, USA)

Recent technological advancements have facilitated the development of a variety of tools and software designed to enhance the quality of life for individuals with hearing impairments. In this research paper, a comprehensive investigation was conducted utilizing three distinct machine learning models to interpret hand gestures representing the American Sign Language (ASL) alphabet. The study employed the Random Forest, Support Vector Machine (SVM), and K-Nearest Neighbors (KNN) models, all trained and tested using a dataset comprising 87,000 images of ASL alphabet hand gestures converted into grayscale pixels.

Multiple experiments were performed, involving adjustments to the models' architectural parameters to achieve the highest possible recognition accuracy. The experimental results were exceptional; the Random Forest model achieved an outstanding accuracy rate of 99.55%, the highest among all models. The SVM model achieved an accuracy rate of 99.29%, while the KNN model reached an accuracy rate of 98.69%

TS4-2 **Next-Generation License Plate Detection and Recognition System using YOLOv8**

Arslan Amin (National University of Sciences and Technology (NUST), Pakistan); Rafia Mumtaz (National University of Sciences and Technology, Pakistan); Muhammad Jawad Bashir (National University of Science and Technology (NUST), Pakistan); Syed Mohammad Hassan Zaidi (Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Pakistan)

In the evolving landscape of traffic management and vehicle surveillance, efficient license plate detection and recognition are indispensable. Historically, many methodologies have tackled this challenge, but consistent real-time accuracy, especially in diverse environments, remains elusive. This study examines the performance of YOLOv8 variants on License Plate Recognition (LPR) and Character Recognition tasks, crucial for advancing Intelligent Transportation Systems. Two distinct datasets were employed for training and evaluation, yielding notable findings. The YOLOv8 Nano variant demonstrated a precision of 0.964 and mAP50 of 0.918 on the LPR task, while the YOLOv8 Small variant exhibited a precision of 0.92 and mAP50 of 0.91 on the Character Recognition task. A custom method for character sequencing was introduced, effectively sequencing the detected characters based on their x-axis positions. An optimized pipeline, utilizing YOLOv8 Nano for LPR and YOLOv8 Small for Character Recognition, is proposed. This configuration not only maintains computational efficiency but also ensures high accuracy, establishing a robust foundation for future real-world deployments on edge devices within Intelligent Transportation Systems. This effort marks a significant stride towards the development of smarter and more efficient urban infrastructures.

TS4-3 **A Proposal to a Dynamic Traffic Detection System in Saudi Arabia: A Sun-Powered Drones Approach**

Yousra S Almathami (King Saud University, Saudi Arabia)

Traffic violations, particularly near exit roads, are a significant issue in Saudi Arabia, often resulting in congestion and inefficiencies as drivers cut off others queued in line. Current strategies to combat this issue, such as static cameras at exits, fail to capture violations occurring outside their field of view, which often contribute to traffic blockage across multiple lanes. This paper proposes a new idea that uses solar-powered drone- based in addition to the static cameras that is activated when traffic build-up reaches a defined threshold. Instead of being limited to a fixed location, these drones can traverse defined or dynamic routes, capturing violations beyond the static camera's scope. The recorded footages from these drones are processed using YOLOv8 for object detection and the built in Deep Sort algorithm for violator tracking and identification. By comparing IDs with the footages from the static cameras, a flag will be raised to law enforcement with the car details. Violators identified in both footages would be subjected to fines. This proposal presents a potential solution to drastically reduce traffic violations and improve road safety and efficiency in Saudi Arabia

TS4-4 **Deep Learning Technology to Recognize American Sign Language Alphabet Using Mulit-Focus Image Fusion Technique**

Bader Alsharif (Florida Atlantic University & Technical and Vocational Training Corporation (TVTC), Riyadh, USA); Munid Alanazi, Ali Altaher, Ahmed Altaher and Mohammad Ilyas (Florida Atlantic University, USA)

In our study, we implemented an innovative approach that harnessed the proven capabilities of ResNet, which achieved an exceptional accuracy rate of 99.98% in classifying American Sign Language (ASL) alphabets. This approach involved utilizing ResNet to extract features from multiple input images, subsequently amalgamating these features and feeding them into the Vision Transformer (ViT) model for further processing. The underlying strategy of knowledge transfer exemplifies the principles of transfer learning and multi-image-focused fusion.

As a result of our efforts, we observed a significant enhancement in the ViT model's accuracy, which surged from 88.59% to an impressive 97.09%. This accomplishment underscores the potential of our proposed system in advancing ASL alphabet classification tasks, with particular relevance to individuals with hearing impairments. Our study not only emphasizes the significance of innovative fusion techniques in deep learning but also presents a promising solution for enhancing the accuracy and reliability of ViT in image processing applications. By exploring the intersections of various neural network architectures, our work paves the way for more inclusive and effective technologies, fostering seamless engagement for individuals with diverse abilities.

TS4-5 **EMD and VMD in pre-movement EEG signal analysis: A hybrid mode selection to classify upper limb complex movements using statistical features**

Beenish Khalid (National University of Science and Technology, Pakistan); Ali Hassan (National University of Sciences and Technology, Pakistan); Ehsan Ullah Munir (COMSATS Institute of Information Technology, Wah Cantt, Pakistan); Imran Khan Niazi (New Zealand College of Chiropractic, New Zealand)

Electroencephalogram (EEG) signals, inherently non-stationary and non-linear, present significant challenges in their processing and interpretation. This paper presents a hybrid mode selection approach using two advanced decomposition methods: Empirical Mode Decomposition (EMD) and Variational Mode Decomposition (VMD), to analyze these signals, targeting their application in the classification of upper limb complex movements for enhanced prosthetic limb control and rehabilitation therapy assessment.

Using optimized statistical features extracted from selected modes, Intrinsic mode functions (IMFs) via EMD and modes via VMD, we seek to better distinguish neural activities in pre-movement EEG signal. Our methodology involves the following two strategies: straightforward extraction of statistical features from modes yielded by EMD and VMD; a genetic algorithm (GA) feature selection technique to select the most optimal set from these statistical features. These derived features train machine learning (ML) classifiers to differentiate limb movements. The results, derived from proprietary dataset from Aalborg University, Denmark, comprising five distinct upper limb movements, demonstrate the effectiveness of our hybrid approach. The usage of EMD and VMD significantly enhanced the discriminatory power of the extracted features, leading to improved classification performance. Furthermore, our hybrid approach yielded classification accuracies of 93.1\% and 95.6\% with EMD and VMD respectively when the K-NN classifier was deployed with a 10-fold cross-validation. K-NN classifier outperformed traditional ML classifiers in terms of computational time, highlighting its potential as lightweight yet robust algorithm for classification of complex movements. The primary goal is to present and validate a hybrid mode (IMFs/modes) selection approach through EMD and VMD to analyze EEG signals associated with upper limb complex movements.

TS4-6 **Charlotte Area Traffic Light Dataset**

Shengkai Xu, Mohammad N Hasan, Robert E Thomas and Aidan Lopez (UNC Charlotte, USA); Sam Shue (University of North Carolina at Charlotte, USA)

We present a new traffic light object detection dataset of over 4,000 images labeled from dashcam video in Charlotte, NC. The dataset captures challenging weather and lighting, with daytime, nighttime, and rainy conditions. 7 annotation classes allow benchmarking of detection models like YOLOv5. Performance degrades at night and in rain versus daytime conditions. This geographically targeted dataset exposes region-specific factors impacting traffic light perception. It serves as a benchmark tailored to Charlotte to improve robustness across settings.

TS5-1 **Echoes in Silence: A Technological Leap for Pakistan Sign Language Translation and Recognition**

Tayyaba Riaz (Quaid i Azam University, Pakistan); Adeel Anjum (Quaid-I-Azam University Islamabad, Pakistan); Adnan Anjum (IBM, Pakistan); Muazzam A. Khan (Quaid-i-Azam University, Islamabad, Pakistan)

In an endeavor to bridge communication barriers for the Pakistani deaf community, this project presents a robust system capable of translating Pakistani Sign Language (PSL) to text and vice versa. The architecture leverages cutting-edge technologies: the textual and voice inputs are processed using Natural Language Processing (NLP) techniques, with voice-to-text translation facilitated by the WebSpeechToolkit. For the Sign-to-Text (S2T) module, images and videos undergo rigorous preprocessing using OpenCV, followed by hand landmark detec- tion via MediaPipe, ensuring the precise capture of PSL gestures. TensorFlow's neural networks are instrumental in recognizing these gestures, translating them into textual counterparts. The project's unique feature is its flexibility in breaking down non- existent sentences into words and, if

needed, further into alpha- bets. Despite its innovative approach, the system acknowledges limitations in its training data, encompassing a dataset of English words, numbers, Urdu alphabets, and English alphabets, yet still achieving an impressive accuracy of approximately 95%. Hosted on a user-friendly Django website interface, this system introduces two primary modules: one for translating text to PSL signs and another for the inverse. With its amalgamation of technologies and user-centric design, this project holds promise as a pivotal tool for enhancing the accessibility and interaction of the deaf community in Pakistan.

TS5-2 **Abnormal Driving Detection using GPS Data**

Charles Boateng, KwangSoo Yang, Seyedeh Gol Ara Ghoreishi, Jinwoo Jang, Muhammad Tanveer Jan, Joshua Conniff, Sonia Moshfeghi, Ruth Tappen, Jiannan Zhai and Monica Rosselli (Florida Atlantic University, USA)

Given a GPS dataset comprising driving records captured at one-second intervals, this research addresses the challenge of Abnormal Driving Detection (ADD). The study introduces an integrated approach that leverages data preprocessing, dimensionality reduction, and clustering techniques. Speed Over Ground (SOG), Course Over Ground (COG), longitude (lon), and latitude (lat) data are aggregated into minute-level segments. We use Singular Value Decomposition (SVD) to reduce dimensionality, enabling K-means clustering to identify distinctive driving patterns. Results showcase the methodology's effectiveness in
distinguishing normal from abnormal driving behaviors, offering promising insights for driver safety, insurance risk assessment, and personalized interventions.

TS5-3 **A Novel Autoencoder-LSTM algorithm for Anomaly Detection**

Hamid Akbarian, Imad Mahgoub and Andre Williams (Florida Atlantic University, USA)

As the field of Artificial Intelligence (AI) continues to expand, AI-driven anomaly detection
algorithms become paramount for operators to issue corrective actions, preventing disasters and reducing unnecessary costs. Historically, AI utilized deterministic rule-based techniques for anomaly detection.
Today advances in AI have enabled more sophisticated algorithms. This paper proposes a novel Autoencoder Long Short-Term Memory (AE-LSTM) algorithm to improve anomaly detection. We evaluate and compare the efficacy of AE-LSTM against the benchmark Deep Neural Network Long Short-Term Memory (DNNLSTM) algorithm. Evaluation metrics include false positives (FP), false negatives (FN), algorithm execution/run time, and F1-score. Autoencoder (AE) base architecture has been chosen to leverage its dimension reduction capabilities for relevant feature extraction. Our proposed scheme results show a considerable improvement from DNN-LSTM for anomaly detection.

TS5-4 **EEG-Based Emotion Recognition Using DWT and Artificial Neural Network: A Case Study on Autism Spectrum Disorder**

Israa Laith (Al-Nahrain University, Iraq); Osama A. Awad (Nahrain University & Information Engineering College, Iraq); Ali Sadeq Jalal (Al-Nahrain University & College of Information Engineering, Iraq)

Autism Spectrum Disorder (ASD) impacts brain development, leading to social communication challenges and interaction. Research is increasingly exploring the use of Artificial Intelligence (AI) to diagnose ASD, interpret their emotions, and search for effective change interventions. This study investigates computer-aided ASD emotion recognition using electroencephalography (EEG) signals. The proposed method implements a four-level Discrete Wavelet Transform (DWT) for feature extraction and an Artificial Neural Network (ANN) to classify three dimensions of emotions: valence, arousal, and dominance. The model achieved 83% accuracy for valence and 96% for both arousal and dominance. These findings hold potential for developing an adaptable closed-loop ASD intervention system. In conclusion, EEG-based emotion recognition using DWT and ANN appears promising for identifying emotional challenges in autism. However, further research is required, considering limitations like sample size and static stimuli.

TS5-5 **Optimizing Smart City Water Distribution Systems using Deep Reinforcement Learning**

Mostafa Zaman (VIrginia Commonwealth University, USA); Ashraf Tantawy (De Montfort University, United Kingdom (Great Britain)); Sherif Abdelwahed (Virginia Commonwealth University, USA)

Inefficient scheduling in water distribution systems can lead to energy waste, costly overflows, and a system that cannot keep up with demand. Simultaneous real-time management of system components such as pumps and valves to optimize operation in response to demand variations is a challenging task. Recent advances in deep reinforcement learning provides an opportunity to overcome the state explosion problem using function approximation to generalize from a limited interaction with the environment. In this work, we train a Long Short-Term Memory (LSTM) based Reinforcement Learning (RL) agent to optimize the energy usage of a smart water distribution system while maintaining a safe operating envelope. We compare the performance of the RL agent to two agents based on human experience in the domain; a baseline controller that is based on simple operational logic, and a fuzzy logic controller that captures imprecise human requirements. We show that the RL agent outperforms the other agents in terms of energy usage and operational safety, indicating its potential benefits for large-scale smart city systems. Future research work will focus on prioritized large-scale system scheduling to cope with smart city emergency situations.

TS5-6 **A Design Solution to Enable a Vehicle for Controlled Autonomous Self-Driving Operations**

Invited *Joseph M Phillips (University of North Carolina at Charlotte, USA); Grayson Bass (University of North Carolina at Charlotte); Sam Shue and James M. Conrad (University of North Carolina at Charlotte, USA)*

The autonomous vehicle industry is growing rapidly due to the quick advancements in technology. As society tran-sitions into the era of autonomous vehicles, there will be many vehicles left behind that do not possess autonomous or self-driving capabilities. To understand the electrical and mechanical design of an existing manufactured vehicle, one may need to reverse engineer the manufacturers design. This is very complicated, time consuming, and may not yield useful results. Rather than reverse engineer a manufacturers vehicle design, a work-around solution could be applied and adjusted to work with that vehicle. This work focuses on a solution where the objective is to integrate a rotary shaft encoder system through multiple layers of hardware and software abstraction. The encoder hardware integration will provide the necessary data feedback that will allow the conversion of a conventional human-driven vehicle to an autonomous controlled vehicle.

TS6-1 **A Collaborative Trajectory-Oriented Viewport Prediction for On-Demand and Live 360° VR Video Streaming**

Abid Yaqoob (Insight Centre for Data Analytics, Dublin City University, Ireland); Gabriel-Miro Muntean (Dublin City University, Ireland)

Viewport prediction is critical in delivering high-quality 360° virtual reality (VR) videos to a large audience across diverse networks. Traditional computationally expensive viewport prediction mechanisms that rely on static content analysis and individual viewing preferences have proven inadequate in adapting to dynamic content and user preferences. This paper introduces TOPVR, a novel trajectory-oriented viewport prediction approach for both on-demand and live 360° VR video streaming. TOPVR overcomes the challenges of diverse user preferences by leveraging the collaborative behavior of viewers and smartly capturing the relationship between different trajectories. It incorporates a user management system that identifies potential users with similar preferences and the closest trajectory changes to the current user over time. Additionally, a collaborative viewport prediction method estimates the future viewing positions for each user based on recent viewing information and the similar trajectories and trend changes of other users watching the same content. We evaluate the performance of TOPVR using a real-world head movement dataset recorded using on-demand and live streaming experiments. Our experimental results demonstrate that TOPVR, with its viewer management system and collaborative trajectory prediction mechanisms, outperforms existing benchmark algorithms in terms of higher prediction performance.

TS6-2 **Evaluation of 3GPP Release 16 Indoor Positioning in Private Standalone 5G Networks**

Samira Homayouni (R&D, Austria); Mario Paier (Hutchison Drei Austria, Austria); Osman Bodur and Martin Pecherstorfer (TU Wien, Austria); Gregor Stangelmayer (Hutchison Drei Austria, Austria); Clemens Hohensulz (TU Wien, Austria); Thomas Schweeger (ZTE, Austria); Johannes Rehak (Hutchison Drei Austria, Austria)

This paper presents the results of a comprehensive study that evaluates the 3GPP Release 16 specifications for indoor positioning for the first time in a private standalone 5G network. Through a detailed examination of design, practical implementation and deployment strategies via operational demonstrations, it assesses how well these specifications meet regulatory, commercial, and industrial needs. Empirical evaluation is conducted in real-world measurement scenarios, with a particular focus on an industrial environment featuring a smart factory. The findings demonstrate positioning accuracy ranging from less than a meter to a few meters, depending on specific scenarios and assumptions.

TS6-3 **ERA: Efficient Request Assignment for Servers in Data Center Networks with SDN**

You-Chiun Wang (National Sun Yat-Sen University, Taiwan); Jun-Fu Zhang (National Sun Yat-sen University, Taiwan)

Software-defined networking (SDN) can facilitate network management by using a controller to monitor the network and instruct switches. It receives attention to manage a data center network (DCN) with multiple servers using SDN. In the paper, we propose an efficient request assignment (ERA) scheme to allocate requests sent from clients to the servers in an SDN-based DCN. For each request, ERA first finds candidate servers with sufficient resources and grades them. The calculation of grades considers the load degree, processing delay, and resource utilization of each server. Based on its grade, ERA picks a suitable server to handle the request, which can achieve load balance among servers and
save time responding to requests. Through simulations, we show that the ERA scheme can efficiently improve the connection rate, response time, and resource utilization of servers.

TS6-4 **Echo chamber analysis: Matrix Geometric Method for Aggregated model of GI/G/s in discrete time**

Takako Hoshiyama (The University of Tokyo & Research Center, Japan)

This study focuses on the discrete-time general-distribution aggregation network queueing system, which was the subject of our previous study with using the Matrix Geometric Method (MGM), and discusses the micro characterization methods and results of the processing nodes of the model. The MGM in our previous studies were found difficult to validate in some areas owing to the lack of resources in the computing environment during the validation phase. Therefore, in this paper, we use the random matrix theory to perform a spectral analysis to investigate the nature of fluctuations in the eigenvalues and discuss their properties. We assume an undirected graph type and an effective graph type network. For each link type, the behavior of the maximum eigenvalue as the number of agents increases is investigated and its dynamics is clarified. We also

present a system modeling methodology to connect the same analysis method to the aggregation network queueing system, and discuss the validity of the methodology.

TS6-5 **Possible applications of network dynamics with the distance parameters and the spectral properties of its Laplacian matrix**

Takako Hoshiyama (The University of Tokyo & Research Center, Japan); Hironori Shimoyama (Professional of Computational Science and Education, Japan)

This study considers n-dimensional network topologies of weights described with distance as a parameter, extending our previous work of the variation of the weight properties of network dynamics. Here we utilize the typical complete graph and star topologies and analyze their behavior when the weights between agents is inversely proportional to the distance between them. We also consider the cases corresponding to the inverse square law of distance, the inverse cubic law, and more. The inversely proportional law is often appeared in energy, luminosity, field, search probability, etc. We construct a Laplacian matrix that takes distances into account; evaluate the eigenvalue distributions; and analyze the eigenvectors for each system. The behaviors for the maximum eigenvalue of the systems vs the number of agents is characterized by the distance to the powers and the topology of the network. Finally, we discuss the possible applications of the model and the method to the other fields of science and engineering.

TS6-6 **Analyzing Insider Threats and Human Factors in Healthcare 5.0**

Leela Pavani Velagala and Gahangir Hossain (University of North Texas, USA)

The healthcare industry has shifted towards Healthcare 5.0, emphasizing electronic and remote services. However, this has also increased the risk of data breaches, often caused by human errors rather than technology flaws. This paper highlights the importance of addressing human-related factors to balance technological advancements and data security in healthcare. It specifically examines insider threats as a significant human factor affecting data security and discusses various types of insiders and related security threats. The paper also explores preventive strategies based on human factor analysis to enhance security measures for protecting sensitive patient information within healthcare organizations.

TS7-1 **Optimized PV System Integrated Microgrid Configuration**

Azhar Ul Haq (National University of Sciences and Technology, Islamabad, Pakistan); Saad Ahmad and Ihsan Ullah Khalil (National University of Sciences and Technology, Pakistan); Maryam Jalal (National University of Technology, Pakistan)

Microgrid is becoming a cost-effective option for un- or under-electrified areas. Mostly because they improve power system dependability and reduce transmission, distribution, and dispatch costs. A microgrid needs well- planned, scheduled, and engineered distributed generators. Thus, each distributed generator must be defined and optimized within physical restrictions. HOMER program calculates the best microgrid setup. Several microgrid scenarios are simulated using solar PV, wind power, diesel generator, advanced grids, and lithium-ion batteries as Energy Storage Devices (ESDs) in varied configurations. Helioscope and PVsyst are used for selecting the optimum tilt angle and maximum module placement. The optimum system maximizes power and economic gains. In addition, the results suggest an increase in system reliability, and a drop in the cost of power by 4.4%, which contributes to the efficacy of the proposed strategy.

TS7-2 **The prospect of cost reduction in the metallization of crystalline silicon solar cells by alternative metal contacts - Ag-coated Cu paste**

Abasifreke Ebong, Donald L. Intal and Sandra Huneycutt (University of North Carolina at Charlotte, USA); Howard Imhof (Silicon Valley Materials Technology Corp LLC., USA); Richard Stephenson (Silicon Valley Materials Technology Corp LLC, USA); Marshall Tibbetts and Dana L. Hankey (& ACI Materials, USA)

This paper reports on the progress for contacting PERC structure with atmospheric Ag-coated Cu (Ag-c-Cu) screen-printable paste. The preliminary efficiency of >19% on the commercial-size silicon wafers is very encouraging, in particular, because the cells were sintered at the same peak temperature as the standard Ag paste. The cell efficiency was controlled by the low fill factor of 73.6% due to high series resistance (Rs) of 1.59 Ω-cm2. The high Rs was due to poor printing resulting from non-optimized rheology and viscosity of the Ag-c-Cu. Because this paste was made through the cavitation method instead of the three-roll-milling, the finger widths are very narrow, which would further reduce the metal footprint and cost. This is good news for the concern about Cu diffusion into silicon at high temperatures as the Jo2 for this cell and others remain in the 10-9 A/cm2 suggesting the junction is not compromised.

TS7-3 **Dynamic Battery Type Detection Using Neural Networks**

Hector K Lopez and Ali Zilouchian (Florida Atlantic University, USA); Amir Abtahi (2649 NW 28th Terrace & Engineering Design Build, USA)

Dynamically detecting battery chemistries, including LiFePO4, Ni-MH, and Lead Acid, is explored through extensive simulations. Utilizing discharge curves as training data, three neural network architectures-Single Hidden Layer, Double Hidden Layer, and Radial Basis Transfer Function-are employed for pattern recognition across diverse discharge profiles. The objective is to enable the identification of connected battery types and optimize charging control. This research holds significance in real-time Electric Vehicle (EV) charging optimization, offering the capability to discern various battery

chemistries. Additionally, in Peer-to-Peer (P2P) energy markets, the dynamic contribution of batteries to the grid requires safe and efficient charging for interoperable systems. The findings presented in this study introduce adaptable systems, fostering innovation in sustainable energy practices.

TS7-4 **Emulation of Smart Grid Technologies and Topologies in a Small Scale Smart City Testbed**

Mostafa Zaman (VIrginia Commonwealth University, USA); Nathan A Puryear, Ahmed Malik and Sherif Abdelwahed (Virginia Commonwealth University, USA)

Smart grids and smart cities are intertwined due to their shared goal of enhancing urban dwellers' standard of living while simultaneously decreasing their carbon footprint. An integral part of a smart city's infrastructure, the smart grid lays the groundwork for effective energy management and makes it possible to include renewable energy sources. While smart grid technology can benefit a city, implementation can be challenging and costly. Researchers can utilize simulation tools and emulated physical hardware to make adopting new technologies more accessible to evaluate smart grid deployment strategies before integrating them into existing cities. This paper presents the new smart grid capabilities in a small-scale smart city testbed called OpenCyberCity and demonstrates an example control implementation for the emulated smart grid hardware.

TS7-5 **Advancements in 275 nm UV-LED Technology for Deactivation of Bacteriophages, Phi6 and MS2**

Trailokya Bhattarai (UNC Charlotte, USA); Abasifreke Ebong, M. Yasin Akhtar Raja and Mariya Munir (University of North Carolina at Charlotte, USA)

This paper presents a comprehensive investigation of the efficacy of a 275 nm UV-LEDs system in deactivating two key bacteriophages, MS2 and Phi6, employed as surrogates for non-enveloped and enveloped viruses. This research includes designing and building the 275 nm UV-disinfection system and testing its effectiveness in deactivating the bacteriophages. Our research centers on meticulous control of UV exposure parameters, including precise adjustments to UV dose, irradiance, and exposure time culminating in substantial microbial reduction. Notably, the Phi6 bacteriophage demonstrated a remarkable ~1.26 log reduction factor, corresponding to ~94.50% reduction in viability, achieved at a UV dose of 32.81 mJ/cm². Similarly, the MS2 bacteriophage exhibited a log reduction factor of 1.16 and a corresponding 93% reduction, attained at a UV dose of 26.82 mJ/cm². These outcomes underscore the considerable potential of the designed 275 nm UV-LED system as a targeted and versatile disinfection technology, bearing substantial implications for real-world applications. Moreover, the prospect of integrating solar cell technology in future research endeavors holds promise for the development of self-sustained and renewable disinfection systems.

TS7-6 **Increasing internet bandwidth for IoT with silicon photonics enabled by GeSn alloys**
Invited

Jay Mathews (University of North Carolina at Charlotte, USA)

The Internet of Things will require increasing internet bandwidth to handle the increase in data transmission from the large number of devices that will be connected. Photonic integrated circuits could be used to enhance routing speeds for fiber optic networks. By using silicon as the platform, costs can be lowered due to mass manufacturing and monolithic integration. GeSn alloys grown on Si could be used to help achieve this goal as a material for infrared light generation and detection.

TS8-1 **Crafting CanSats: A Novel Modular Design Paradigm for Scientific CanSats**

Carrington Chun, Muhammad Hassan Tanveer, Thomas Swift, Kevin Dallesasse and Uday Patel (Kennesaw State University, USA); Sumit Chakravarty (Kennesaw State, USA)

This paper introduces a novel modular design paradigm for Scientific CanSats, offering a cost-effective platform for testing space-related hardware in near-space environments with reduced developmental timelines. By harnessing Commercial Off The Shelf (COTS) products alongside open-source technologies, this framework emphasizes quick integration of diverse scientific instruments and control systems. The core architectural elements comprise: (1) a unified power and communication bus, (2) standardized mechanical attachments and interfaces, and (3) distributed computing and data management. To validate the effectiveness and adaptability of this design, undergraduate students were engaged to design modules adhering to the established standards. This approach facilitated the creation of an adaptable ecosystem of Command and Sensor Modules, enabling swift assembly and reconfiguration of CanSats with diverse scientific potentials. Remarkably, students transitioned from conceptual design to tangible modules within a semester, while CanSat assembly and reconfiguration from existing modules took five and four minutes respectively.

TS8-2 **EZ3micro - A Novel Miniaturized Pick & Place Prototype for Improved Industrial Applications**

Haden C Sangree and Mahmoud Kofiah (Kennesaw State University, USA); Razvan Cristian Voicu (Georgia Institute of Technology & Kennesaw State University, USA); Muhammad Hassan Tanveer (Kennesaw State University, USA)

This research paper focuses on the development of a miniaturized pick-and-place robotic prototype, which utilizes a magnetically levitated ACOPOS 6D shuttle developed by B&R Industrial Automation Corp. The aim is to meet the technological demands of various industries, including manufacturing, logistical, biomedical, and agricultural. The prototype boasts several cutting-edge features, such as wireless communication, batteryoperated design, low weight, high stability,

precision control, visual recognition, and advanced end effector control. The end effector can perform pick-and-place and orientation change functions, and the modular design allows for endless applications, including rapid sorting for manufacturing, agriculture, and logistics. Furthermore, the prototype offers advancements in biomedical applications by automating sample selection, transportation, and testing. Overall, this research paper presents a new technological advancement to help maintain the current growth rate of various industries.

TS8-3 **Time-based Mapping of Space Using Visual Motion Invariants**

Juan David Yepes and Daniel Raviv (Florida Atlantic University, USA)

This paper focuses on visual motion-based invariants that result in a representation of 3-D points in which the stationary environment remains invariant, ensuring shape constancy. This is achieved even as the images undergo constant change due to camera motion. Nonlinear functions of measurable optical flow, which are related to geometric 3D invariants, are utilized to create a novel representation. We refer to the resulting optical flow-based invariants as 'Time-Clearance' and the well-known 'Time-to-Contact' (TTC). Since these invariants remain constant over time, it becomes straightforward to detect moving points that do not adhere to the expected constancy. We present simulations of a camera moving relative to a 3D object, snapshots of its projected images captured by a rectilinearly moving camera, and the object as it appears unchanged in the new domain overtime. In addition, Unity-based simulations demonstrate color coded transformations of a projected 3D scene, illustrating how moving objects can be readily identified. This representation is straightforward, relying on simple optical flow functions. It requires only one camera, and there is no need to determine the magnitude of the camera's velocity vector. Furthermore, the representation is pixel-based, making it suitable for parallel processing.

TS8-4 **Detecting Moving Objects Using a Novel Optical-Flow-Based Range-Independent Invariant**

Daniel Raviv, Juan David Yepes and Ayush Gowda (Florida Atlantic University, USA)

This paper focuses on a novel approach for detecting moving objects during camera motion. We present an optical flow-based transformation that yields a consistent 2D invariant image output regardless of time instants, range of points in 3D, and the camera's speed. In other words, this transformation generates a lookup image that remains invariant despite the changing projection of the 3D scene and camera motion. In the new domain, projections of 3D points that deviate from the values of the predefined lookup image can be clearly identified as moving relative to the stationary 3D environment, making them seamlessly detectable. The method does not require prior knowledge of the camera's direction of motion or speed, nor does it necessitate 3D point range information. It is well-suited for real-time parallel processing, rendering it highly practical for implementation. We have validated the effectiveness of the new domain through simulations and experiments, demonstrating its robustness in scenarios involving rectilinear camera motion, both in simulations and with real-world data. This approach introduces new ways for moving objects detection during camera motion, and also lays the foundation for future research in the context of moving object detection during six-degrees-of-freedom camera motion.

TS8-5 **Design of a Low-Cost Wireless Charging Station Based on the Robotic Vision System**

Wen-Yu Cheng, Wen-Chung Cheng, Zhen Ni, Erik Engeberg and Xiangnan Zhong (Florida Atlantic University, USA)

Physical training of autonomous robotic systems are often limited by battery capacity since the intelligent training cycles have to be halted for battery recharge. Many researchers have focused on various solutions of power management for autonomous robots. However, these solutions are usually custom-fitted for the specific applications, and would be difficult to be generalized to other autonomous robotic systems. In this paper, we propose to develop a low-cost wireless charging system based on the on-board vision/camera sensor. This design is capable of autonomous docking for the robot chassis without further external supervision. Specifically, we use the QR codes to label the charging station and establish the robot's camera vision system to recognize the dock. The robot will drive to the station automatically. The low-cost charging station is also designed for wireless charging of the robot. We present the specific designs of charging dock, wireless connection, and battery charging experiments explicitly. This low-cost wireless charging system provides advancements toward a fully autonomous physical training infrastructure for robotic navigation experiments.

TS8-6 **Enabling ROS for Low-Cost Educational Robotics Platforms**

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Robotics has become an increasingly relevant subject for engineering students over the past decade. This subject blends together many topics, such as artificial intelligence, localization, path-planning, machine vision, and human-machine interaction. The need to manage so many different aspects, and by extension, multiple applications, all running simultaneously in the same computing system has given rise to robotics frameworks, which are software packages aimed at providing communications interfaces, standardized messages, and various debugging and simulation tools. The most popular of these robotics frameworks is ROS (Robotics Operating System). The ubiquity of ROS in research and industry motivates that university courses begin introducing ROS in curriculum. To properly teach ROS, some hardware component is required. While educational platforms exists for ROS, such as the famous "Turtlebot", these platforms tend to be very expensive, creating an expensive cost-to-entry for any course attempting to integrate ROS into their curriculum. To resolve this issue, this paper introduces a software architecture for ROS enabling inexpensive robotics kits, such as the RSLK from Texas Instruments, which are commonly used in university courses.

TS9-1 **Impact of False Data Injection Attacks on Machine Learning-based Cascading Failure Predictions**

Naeem Md Sami and Mia Naeini (University of South Florida, USA)

Machine Learning (ML) and Artificial Intelligence (AI) are garnering popularity in power system failure analysis for their ability to recognize patterns and predict situations based on historical data. The concern over cascading failures in power systems is growing, particularly with the increasing complexity and stochastic nature of modern power grids. While ML techniques have been employed to predict various aspects of cascading failures, the potential for cyber-attacks to infiltrate ML frameworks and manipulate attributes to conceal cascading failures or distort risk assessments is a pressing issue. This paper aims to investigate the impact of false data injection attacks (FDIA) on an example ML-based prediction model for cascading failures. The objective is to understand how these attacks influence ML performance and how such alterations can provide insights to detect such attacks. As anticipated, our assessment indicates that FDIA can alter baseline accuracies, resulting in erroneous predictions of cascade risk. The paper also makes recommendations for detecting and mitigating such attacks.

TS9-2 **Clustering Enabled Robust Intrusion Detection System for Big Data using Hadoop-PySpark**

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In the era of burgeoning networks and the prolifer- ation of novel devices, safeguarding computer security presents an ever-growing challenge. The increasing attack surface grants cybercriminals ample opportunities to exploit vulnerabilities within systems. While the internet fosters innovation across diverse sectors, it also exposes us to perils in the form of cyber attacks and nefarious activities. Consequently, the neces- sity to robustly identify and counteract these threats becomes paramount. Network Intrusion Detection Systems (NIDS) play a pivotal role in upholding system confidentiality, availability, and integrity by actively monitoring and responding to potential breaches. This study addresses the complex predicaments arising from managing copious data volumes and imbalanced class distributions in intrusion detection, a result of the exponential escalation of network traffic. A hybrid framework is proposed to bolster the accuracy of identifying minority classes within imbalanced datasets. This innovative framework synergistically combines K-means clustering and the Random Forest classifier, custom-crafted for big data processing through the utilization of Hadoop with PySpark. The effectiveness of the proposed model is evaluated using the NSL-KDD dataset for training and testing, encompassing accuracy assessment and processing time evaluation. The outcomes vividly manifest the remarkable performance of the proposed model, with an accuracy of 0.9987, a precision of 0.9994, a recall of 0.9991, and an F1-score of 0.9986: eclipsing that of other established models in the realm of intrusion detection.

TS9-3 **Ransomware Detection Using Federated Learning with Imbalanced Datasets**

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Ransomware is a form of malware which encrypts user data and extorts payments in return for decryption keys. This cyberthreat is one of the most serious challenges facing organizations today and has already caused immense financial harm to organizations. Hence, many researchers have been actively studying ransomware defenses. Recently, the federated learning (FL) approach has also been applied for ransomware analysis, allowing corporations to achieve scalable, effective ransomware defense without having to share their private data. However, most operational settings will exhibit a large variation in the quantity and composition of ransomware data collected across multiple sites/regions. This imbalance will inevitably degrade the effectiveness of distributed FL methods. To address this concern, a modified FL scheme is proposed using a weighted cross-entropy loss function approach to mitigate dataset imbalance. A detailed performance evaluation study is also presented for static ransomware analysis with the latest Windows-based ransomware families. The findings confirm improved ML classifier performance with a highly imbalanced dataset.

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