Sunday, November 19

Sunday, November 19 18:00 - 21:00 (Australia/Sydney)

VIP dinner

Monday, November 20

Monday, November 20 9:00 - 10:00 (Australia/Sydney)

Registration

Level 9: Executive Board Room

Monday, November 20 10:00 - 10:30 (Australia/Sydney)

Opening Speech

Level 9: executive board room
Prof. K. Dunn, PVC Research, WSU

Monday, November 20 10:30 - 11:00 (Australia/Sydney)

Tea break

Monday, November 20 11:00 - 12:30 (Australia/Sydney)

Keynote speaker #1: Covert Data Communications in Cell-Free Internet-of-Things Networks

Level 9
Prof. A. Jamalipour

Cell-free wireless communications is a new paradigm within the future 6G networks towards implementation of the Internet of intelligence with connected people and things. In a cell-free network, a large number of distributed access points are connected to a central processing unit and serve a smaller number of users over the same time-frequency resources. The system has shown great potential in improving network performance in some perspectives compared to the co-located and conventional small-cell systems. The next-generation Internet-of-Things systems could be dispersed over large areas under a cell-free network setting. This has given rise to security concerns stemming from the exposure of wireless channels and the exponential growth of connected devices. In this talk, a novel covert downlink transmission scheme is presented that jointly optimizes beamforming and artificial noise vectors to obscure critical transmissions at an eavesdropper in CF IoT Networks.

Abbas Jamalipour is the Professor of Ubiquitous Mobile Networking at The University of Sydney and the Editor-in-Chief, IEEE Transactions on Vehicular Technology. He holds a PhD in Electrical Engineering from Nagoya University, Japan; and is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), the Institute of Electrical,

Information, and Communication Engineers (IEICE), and the Institution of Engineers Australia (IEA), an ACM Professional Member, and an IEEE Distinguished Speaker. He has authored nine technical books, eleven book chapters, over 550 technical papers, and five patents, all in the field of wireless communications. Dr. Jamalipour was the President (2020-21), Executive Vice-President (2018-19), and has been an elected voting member of the Board of Governors of the IEEE Vehicular Technology Society since 2014. Previously, he served as the Editor-in-Chief IEEE Wireless Communications, Vice-President Conferences, and a member of Board of Governors of the IEEE Communications Society. He is an Editorial Board Member of the IEEE Access Journal, a member of the Advisory Board of IEEE Internet of Things Journal, and an editor for several other journals. He has been a General Chair or Technical Program Chair for several conferences, including IEEE ICC, GLOBECOM, VTC, WCNC and PIMRC. He is the recipient of several prestigious awards such as the 2019 IEEE ComSoc Distinguished Technical Achievement Award in Green Communications, the 2016 IEEE ComSoc Distinguished Technical Achievement Award in Communications Switching and Routing, the 2010 IEEE ComSoc Harold Sobol Award, the 2006 IEEE ComSoc Best Tutorial Paper Award, as well as over fifteen Best Paper Awards.

Monday, November 20 12:30 - 13:30 (Australia/Sydney)

Lunch break

Level 6

Monday, November 20 13:30 - 15:00 (Australia/Sydney)

Keynote speaker #2: Generative AI for rapid and scalable behaviour modelling in cities

Level 9

Prof. F. Salim

Understanding human behaviours is critical to improving operation efficiency, individual and organisational productivity, public health management, and quality of life in cities. The proliferation of sensors and Internet of Things leads to new opportunities and challenges for human behaviour modelling and forecasting behavioural patterns at scale. Annotating behaviours of interest is expensive and often infeasible. This demands new ways for modelling behaviours at scale, moving away from fully-supervised learning approaches. Recent Generative AI approaches and Large Language Models has become a compelling choice for modelling mobility behaviours, especially in cases when training data is limited. I will present our self-supervised learning (SSL) approaches for multimodal sensor data, with different applications as examples, including human behaviour recognition and traffic flow forecasting. I will also talk about how we handle data heterogeneity and fusion of heterogenous time-series towards robust representation. I will also present a new versatile paradigm, leveraging Large Language Models (LLMs) for time-series forecasting, including for mobility and energy domain, using natural language prompts.

Flora Salim is the inaugural Cisco Chair of Digital Transport, University of New South Wales (UNSW) Sydney. Her research is on ubiquitous computing, behaviour modelling, trustworthy and robust AI, and machine learning for multimodal sensor data. She is a member of the Australian Research Council (ARC) College of Experts, an Editor of Proceedings of the ACM on Interactive, Mobile, Wearable, Ubiquitous Technologies (IMWUT), the Associate Editor-in-Chief (AEIC) of IEEE Pervasive Computing, and an Associate Editor of ACM Transactions on Spatial Algorithms and Systems. She is a Chief Investigator of the ARC Centre of Excellence in Automated Decision Making and Society (ADM+S), and the Co-Lead of the ADM+S Machines Program, and the Transport and Mobilities Focus area.

Monday, November 20 15:00 - 15:30 (Australia/Sydney)

Tea break

Monday, November 20 15:30 - 17:00 (Australia/Sydney)

Panel discussion

Level 9

Prof. Jamalipour (USyd), Prof. Salim (UNSW), Prof. Baldock (WSU)

Monday, November 20 18:00 - 21:00 (Australia/Sydney)

VIP dinner

Invited guests

Tuesday, November 21

Tuesday, November 21 8:30 - 9:00 (Australia/Sydney)

Registration

Tuesday, November 21 9:00 - 10:30 (Australia/Sydney)

Keynote speaker #3: OTFS and Delay Doppler Communications

Level 9

Prof. Y. Hong

Yi Hong is an Associate Professor in the ECSE DEPT at Monash University. She served as a member of the Australian Research Council College of Experts (2018-20) and she was the Director of Graduate Research (2016-18) of the ECSE Department at Monash University. She is a Senior Member of IEEE, the IET Fellow, and a member of IEEE Communications Society, IEEE Information Theory Soceity, and IEEE Vehicular Technology Society. She was the Tutorial Chair of 2021 IEEE International Symposium on Information Theory, Melbourne. She was the General co-Chair of 2014 IEEE Information Theory Workshop at Hobart, Tasmania; the Technical Program Committee Chair of the 2011 Australian Communication Theory workshop, Melbourne; the Publicity Chair of 2009 IEEE Information Theory Workshop at Taromina, Sicily; and Technical Program Committee Member of various IEEE leading conferences. She is currently the Associate Editor (AE) of IEEE Transactions on Green Communications and Networking (TGCN). She served as the AE for IEEE Wireless Communications Letters (WCL) and Transactions on Emerging Telecommunications Technologies (ETT). She received the NICTA-ACoRN Early Career Researcher award at AUSCTW Adelaide 2007. She leads a group of research students and postdocs working on communications technology, wireless security, and coding techniques for wireless communications and networking as well as SSD storage.

Tuesday, November 21 10:30 - 11:00 (Australia/Sydney)

Tea break

Level 6

Tuesday, November 21 11:00 - 12:30 (Australia/Sydney)

Tutorial: Deep Learning Aided Intelligent Sensing and Identification for 6G

Level 9

Prof. Tomoaki Otsuki and Prof. Guan Gui

Abstract: With the rapid advancements in artificial intelligence (AI) and deep learning (DL), it is evident that future wireless communication systems will possess significantly enhanced intelligence and security compared to their predecessors. While traditional algorithms demonstrate commendable performance and efficiency in addressing accurately modeled problems, they often face challenges when dealing with non-convex problems, leading to compromised performance. In such scenarios, DL technology can be employed to extract parameter information from acquired data samples, thereby improving algorithm convergence speed and performance. This tutorial aims to explore the utilization of artificial neural networks (ANNs), including deep neural networks (DNNs) and convolutional neural networks (CNNs), to parameterize models or algorithms, with gradient-based methods utilized for optimizing the ANNs. These data-driven techniques, which derive model or algorithm features from massive amounts of data rather than relying on pre-established rules, are collectively known as data-driven methods. The tutorial primarily focuses on the research and application of DL in the physical layer of wireless communication systems. Firstly, DL can enhance model-based algorithms for signal detection or channel estimation, improving computational efficiency and system performance. Secondly, as traditional model-based methods increasingly struggle to meet the growing demands of next-generation communication systems operating in complex interference and uncertain channel conditions, DL presents promising opportunities to redesign baseband modules, including coding/decoding and detection, among others.

Tutorial outline:

- Background and Motivation
- 6G
- Deep Learning based Wireless Communications
- DL-based MIMO Detection
- Wireless Communications with DIP
- Wireless Communications with Super Resolution
- Wireless Communications with Transfer Learning
- Deep Learning based Inter-distance Estimation
- Deep Learning based Automatic Modulation Classification (AMC)
- Deep Learning based Specific Emitter Identification (SEI)
- Deep Learning based Channel State Information (CSI) Inferring
- Deep Learning based Beamforming Design Methods
- Deep Learning based Intrusion Detection Methods
- Summary and Future Work

Speakers' Biography:

Tomoaki Otsuki (Ohtsuki) received the B.E., M.E., and Ph. D. degrees in Electrical Engineering from Keio University, Yokohama, Japan in 1990, 1992, and 1994, respectively. He is now a Professor at Keio University. He has published more than 235 journal papers and 460 international conference papers. He served as a Chair of IEEE Communications Society, Signal Processing for Communications and Electronics Technical Committee. He served as a technical editor of the IEEE Wireless Communications Magazine and an editor of Elsevier Physical Communications. He is now serving as an Area Editor of the IEEE Transactions on Vehicular Technology and an editor of the IEEE Communications Surveys and Tutorials. He has served as general-co chair, symposium co-chair, and TPC co-chair of many conferences, including IEEE GLOBECOM 2008, SPC, IEEE ICC 2011, CTS, IEEE GLOBECOM 2012, SPC, IEEE ICC 2020, SPC, IEEE APWCS, IEEE SPAWC, and IEEE VTC. He gave tutorials and keynote speeches at

many international conferences including IEEE VTC, IEEE PIMRC, IEEE WCNC, and so on. He was Vice President and President of the Communications Society of the IEICE. He is a senior member and a distinguished lecturer of the IEEE, a fellow of the IEICE, and a member of the Engineering Academy of Japan.

Dr. Gui has published more than 200 IEEE Journal/Conference papers and won several best paper awards, e.g., ICC 2017, ICC 2014 and VTC 2014-Spring. He received the IEEE Communications Society Heinrich Hertz Award in 2021, top 2% scientists of the world by Stanford University in 2021, the Clarivate Analytics Highly Cited Researcher in Cross-Field in 2021, the Highly Cited Chinese Researchers by Elsevier in 2020 and 2021, the Member and Global Activities Contributions Award in 2018, the Top Editor Award of IEEE Transactions on Vehicular Technology in 2019, the Outstanding Journal Service Award of KSII Transactions on Internet and Information System in 2020, the Exemplary Reviewer Award of IEEE Communications Letters in 2017, the 2012 Japan Society for Promotion of Science (JSPS) Postdoctoral Fellowships for Foreign Researchers, and the 2018 Japan Society for Promotion of Science (JSPS) International Fellowships for Overseas Researchers. He was also selected as for the Jiangsu Specially-Appointed Professor in 2016, the Jiangsu High-level Innovation and Entrepreneurial Talent in 2016, the Jiangsu Six Top Talent in 2018. Since 2022, he has been a Distinguished Lecturer of the IEEE Vehicular Technology Society. He is a Senior Member of the IEEE, a Member of the IEEE Communications Society and of the IEEE Vehicular Technology Society. He is serving or served on the editorial boards of several journals, including IEEE Transactions on Vehicular Technology, IEICE Transactions on Communications, Physical Communication, Wireless Networks, IEEE Access, Journal of Circuits Systems and Computers, Security and Communication Networks, IEICE Communications Express, and KSII Transactions on Internet and Information Systems, Journal on Communications. In addition, he served as the IEEE VTS Ad Hoc Committee Member in AI Wireless, TPC Chair of PRAI 2022, TPC Chair of ICGIP 2022, Executive Chair of VTC 2021-Fall, Vice Chair of WCNC 2021, TPC Chair of PHM 2021, Symposium Chair of WCSP 2021, General Co-Chair of Mobimedia 2020, TPC Chair of WiMob 2020, Track Chairs of EuCNC 2021 and 2022, VTC 2020 Spring, Award Chair of PIMRC 2019, and TPC member of many IEEE international conferences, including GLOBECOM, ICC, WCNC, PIRMC, VTC, and SPAWC.

Tuesday, November 21 12:30 - 13:30 (Australia/Sydney)

Lunch break

Level 6

Tuesday, November 21 13:30 - 15:00 (Australia/Sydney)

SP1: Signal Processing for Communications

Room: Studio 1, Level 6

13:30 ***MAGLN: Multi-Attention Graph Learning Network for Channel Estimation in Multi-User SIMO***

Liqing Shan and Yuntao Hu (Southeast University, China); Wei Shan (Jiangsu Communications Holdings, China); Zhang Fenghui (School of Electronics and Information Engineering, West Anhui University, Canada); Ming Chen (Southeast University, China)

Channel estimation is one of the fundamental topics in practical multi-antenna systems. With the progress of artificial intelligence, deep learning (DL)-based schemes have presented enormous the potential for performance and efficiency. In this paper, we propose an attention-aided approach to achieve channel estimation for multi-user single input multiple output (SIMO) system. Specifically, the multi-attention graph learning network (MAGLN) is conducted to estimate the uplink channel, which concentrates on the partial more important information in the different dimensions. The channel attention and graph attention mechanisms are adopted to enhance the quality of extracted features and finally output the estimated channel information. Numerical results show that the proposed

scheme has better estimation performance compared with the traditional algorithms and other candidate DL-based architectures.

13:48 ***Demonstration of a Variably Biased Asymmetrically Clipped Optical OFDM for VLC Systems***

Ganesh Miriyala (National Institute of Technology - Warangal, India); Renikunta Mallaiah (NIT Warangal, India); Venkata Mani Vakamulla (National Institute of Technology Warangal, India)

Asymmetrically clipped direct current (DC) biased optical OFDM (ADO-OFDM) is a recently emerged waveform in visible light communication (VLC) to obtain the optimal solution for spectral and power efficiency problems. However, in ADO-OFDM, high DC bias is used to attain unipolar signals, which decreases power efficiency. In this work, we conceive a novel modulation technique called variably biased asymmetrically clipped optical OFDM (VAO-OFDM) for VLC systems, in which the bias varies with respect to the amplitude of the specific samples of unlike constant DC-bias, which results in power efficiency. Further, the performance of the VAO-OFDM system is evaluated using LabView software-based simulations and validated on the experimental setup by the VLC testbed using USRP hardware.

14:06 ***Efficient Joint Parameter Estimation and Soft Noncoherent Detection Scheme for LoRa-based IoT System***

Zhongyang Yu, Zhengying Wen and Jixun Gao (Henan University of Engineering, China)

Considering limited pilot overhead and large delay and Doppler shift in LoRa (Long Range)-based IoT (Internet of Things) systems, this paper presents an efficient joint parameter estimation and soft nonconherent detection scheme. During the parameter estimation, a joint delay and Doppler shift estimation method is proposed, which is called the JDDSE method. Different from the existing estimation methods, the proposed method utilizes the time-domain characteristic of the LoRa signal and only needs to estimate a joint offset of the delay and Doppler shift instead of their respective offsets. Then, a soft noncoherent detection is developed from the existing work in order to match the JDDSE method. Simulation results indicate the validity of the proposed method under the uplink IoT transmission.

14:24 ***Weighted Sum Rate Optimization for Multi-User MIMO Cognitive Radio Systems***

Yongquan Chen (Sun Yat-Sen University, China); Yuan Jiang (Sun Yat-sen University, China); Lei Zhao (Sun Yat-Sen University, China)

This paper considers a MIMO cognitive radio system, where a secondary base station (SBS) transmits signal to multiple secondary users (SUs), while imposing interference to multiple primary users (PUs) in the primary network. We aim at maximizing the weighted sum rate (WSR) of all the SUs subjected to the power constraint of SBS and interference constraints of multiple PUs, by optimizing the linear beamformers matrices associated with all the SUs. We first reformulate the original problem into a convex weighted minimum mean square error (WMMSE) problem, and then a modified subgradient method (MSM) is proposed to solve the WMMSE problem. Simulation results also show that the proposed MSM algorithm outperforms other existing algorithms with lower computational complexity.

14:42 ***Achievable Rate of Relay Massive MIMO With Mixed Low-Resolution ADCs***

Thang Le Nhat (Post and Telecommunications Institute Technologies, Vietnam); Hung Dang (Posts and Telecommunications Institute of Technology, Vietnam); Hoai Bui (Posts and Telecommunications Institute of Technologies, Vietnam); Hieu T. Nguyen (University in Southeast Norway, Norway)

This paper derives a new and general formula to approximately calculate the achievable rate for a relay-based uplink massive multiple-input multiple-out (MIMO) system where a set of mixed low-resolution analog-to-digital converters are employed at the receiver side. Different from previous

research work, the resolution level of the ADCs is constrained within the range from 1 to 5 bits in this research, though the results can be straightforwardly extended to cover the conventional mixed-ADC case where nearly perfect ADCs (10-12 bits) were utilized in the high-resolution antenna group.

Tuesday, November 21 13:30 - 15:00 (Australia/Sydney)

WC1: Wireless Communications

Room: Studio 2, Level 6

13:30 ***Designs of Finite Resolution IRS-aided MIMO Multiuser Communications Based on SZFDPC***

Lian-Ming Lyu and Hsin-Chih Huang (National Yang Ming Chiao Tung University, Taiwan); Hsiao-feng Francis Lu (Taiwan)

A novel design of MIMO downlink communications that is assisted by modern intelligent reflecting surfaces (IRS) is proposed in this paper. The new design employs successive zero-forcing dirty paper coding at base station and allows multiple receive antennas to be used at users, making it much more realistic than existing works, which are applicable only to cases of single receive antenna. Furthermore, the new design requires IRS elements with only finite phase resolution and is much more practical for implementation. Simulation results show that the proposed design can significantly improve the performance of IRS-aided downlink communications. In particular, for the classical scenario of single receive antenna at users, our design, using only a QPSK phases for IRS elements, increases by more than 200-540% the energy efficiency of several existing works that assume IRS elements with infinite resolution for phases.

13:48 ***Lightweight Network for Modulation Recognition Based on Stochastic Pruning-Asymmetric Quantization***

Tianyu Zhao, Zunwen He, Mingyu Chen, Yan Zhang, Hongji Yang and Wancheng Zhang (Beijing Institute of Technology, China)

Automatic modulation recognition (AMR) plays an important role in wireless communication system monitoring, non-cooperative communications, and cognitive communications. Recently, the applications of deep learning in AMR improve classification accuracy. However, it is difficult to deploy a deep learning-based model on resource-constrained devices because of its huge model size. In this paper, we propose a neural network called double pooling convolutional neural network (DP-CNN) and a stochastic pruning--asymmetric quantization (SPAQ) algorithm to realize lightweight and accurate modulation recognition. With the SPAQ algorithm, unimportant parameters are pruned by designing probability intervals and evaluation criteria. In addition, the storage type of parameters will be transformed by creating quantization intervals and mapping criteria. The performance of our method is verified using an open-source dataset RadioML2016.10a. Experimental results show that the SPAQ algorithm has better recognition performance than other lightweight methods at high compression ratios. In addition, the DP-CNN compressed by the SPAQ algorithm outperforms the existing lightweight network in recognition accuracy under the same model size.

14:06 ***Preamble Design for LEO Satellite Communication System***

Yuan Jiang (Sun Yat-sen University, China); Lei Zhao and Wang Yanzhao (Sun Yat-Sen University, China)

With the rapid construction of the Starlink project, the feasibility and superiority of low-orbit communication satellites have been fully demonstrated, and China's low-orbit communication satellites are also developing rapidly. Studying the random access process is the trend of the times. Firstly, We design a conjugate overlapping multi-stage cascading preamble format based on tag

sequences according to the design criteria of preambles and the channel characteristics of satellite communication. Then we design the corresponding time advance (TA) detection and collision detection algorithms. Simulation results show that under satellite communication channels with large delay and large frequency offset characteristics, the random access success rate and collision detection rate of this preamble code are both high. Therefore, the low-orbit satellite preamble designed in this paper meets the capacity and efficiency requirements of satellites as well as can provide a certain degree of value for the further widespread application of low-orbit satellite communication.

14:24 ***Sensing-Communication-Computing-Control Closed-Loop Optimization for Coordinated UAV-Robot Systems***

Xinran Fang and Wei Feng (Tsinghua University, China); Yunfei Chen (University of Durham, United Kingdom (Great Britain)); Yanmin Wang (Minzu University of China, China); Ning Ge (Tsinghua University, China)

This paper investigates an emergency rescue system, which comprises a multi-functional unmanned aerial vehicle (UAV) and multiple robots. The UAV carries sensing, communication, and computing modules. It senses system states, calculates commands, and instructs field robots to take action. In this way, the UAV and robots form multiple sensing-communication-computing-control ((\mathbf{SC^3})) loops, which could finish many mission-critical tasks without human participation. To activate these (\mathbf{SC^3}) loops, we propose a closed-loop optimization scheme. Unlike traditional studies that primarily focus on the communication link, the proposed scheme emphasizes the (\mathbf{SC^3}) loop and adopts the linear quadratic regulator (LQR) cost as the objective. Focusing on the UAV-robot downlink, we model the data transmission in the finite block length regime and take the transmit power and block lengths as optimization variables. We solve the nonlinear integer problem by exploiting the monotonicity and convexity of the objective rate-cost function. The closed-form solution of the transmit power is derived in the assure-to-be-stable region. On this basis, we compare the proposed scheme with the max-sum rate scheme. Through comparisons, the fairness-minded nature of the proposed scheme is revealed.

14:42 ***Software Implementation of O-RAN Fronthaul Interface***

Seung Nam Choi and Nam-il Kim (ETRI, Korea (South))

To meet the 5G requirements for large-capacity transmission in the RAN architecture, 3GPP and O-RAN Alliance discussed new open fronthaul interface specifications. Functional split option 7-2x of O-RAN is widely used by many vendors for their fronthaul. Recently, since the modem of the base station access platform is being developed as software that operates in real time, the fronthaul interface function is also implemented as software. This paper introduces a structure that implements the High-PHY function in software, which was designed in hardware in the O-DU platform, which serves as a 5G base station. In addition, the software implementation of the fronthaul interface on this platform and the performance of the compression method of the fronthaul link were analyzed.

Tuesday, November 21 13:30 - 15:00 (Australia/Sydney)

WN1: Wireless Networks

Room: Studio 3, Level 6

13:30 ***Design, Implementation and Analysis of L1 Control SW for FAPI based 5G NR gNB***

Seung-Que Lee and JunHwan Lee (ETRI, Korea (South)); Moon-Sik Lee (Electronics and Telecommunications Research Institute, Korea (South)); Seung-gyu Kim and Seongjin Lee (NESSLAB, Korea (South))

This paper presents the design, implementation and performance analysis of the L1 Control SW among the components of a 5G NR gNB using FAPI interface. In addition, this paper proposes HW platform selection and a load distribution method for each processor for real-time operation. For the implemented SW, we performed size and timing analysis of FAPI messages/CH PDUs in an actual execution environment, and it is verified that real-time operation to support downlink 8CC and uplink 1CC is possible.

13:48 ***MARL-based Resource Allocation for Heterogeneous Traffic in V2X Communications***

Insung Lee and Duk Kyung Kim (Inha University, Korea (South))

New Radio Vehicle-to-Everything (NR-V2X) has been recognized as a key technology for advanced driving applications such as autonomous driving, platooning, and Intelligent Transportation Systems (ITS). However, this also has led to the emergence of a heterogeneous traffic environment, where packets with diverse purposes, formats, and priorities are transmitted over the V2X network. Therefore, in order to meet the strict Quality of Service (QoS) requirements of NR-V2X in a heterogeneous traffic environment with limited shared resources, developing appropriate resource allocation methods for NR-V2X became one of the major problems. This paper proposes a Multi-Agent Reinforcement Learning (MARL) approach to address this issue. We propose to improve the overall Packet Reception Ratio (PRR) performance of the V2X network. Through simulations, we demonstrate a comparison of the PRR of the proposed approach with random/optimal resource allocation methods. We confirm that our proposed method performed almost similarly to an optimal resource allocation scheme.

14:06 ***A Multi-objective Reinforcement Learning solution for Handover optimization in URLLC***

Azadeh Arnaz (University of Technology, Sydney, Australia); Justin Lipman (University of Technology, Sydney (UTS), Australia); Mehran Abolhasan (University of Technology Sydney, Australia)

The growth of wireless communications enables cutting-edge technologies, such as the combined use of Tactile internet and robotics, which requires ultra-reliable low-latency communications (URLLC). To provide users with greater quality of experience (QoE), the effective handover (HO) of user equipment (UE) between access points (AP) is an important enabler of URRLC. HO can fail for many reasons, such as an outage event while connecting to the new access point (AP). Many use cases tolerate this failure and can repeat the HO process and connect to the correct AP. But URLLC use cases rely on the reliability of services for their promised performance. This paper presents a multi-objective reinforcement learning model (HORLA) that considers improving the received signal strength and mitigating the outage probability at the same time when selecting an AP for UE. HORLA outperformed the standard HO algorithm based on the maximum received signal strength by reducing failure attempts by more than 40%. This performance resulted in reducing the energy consumption for processing reattempted HO requests by almost 57%.

14:24 ***High Reliability Air-to-Ground Communication System based on Aggregation of Terrestrial Networks***

Claes Beckman (KTH Royal Institute of Technology, Sweden); Helmut Brutscher and Frank Gottfried (Airbus, Germany); Mats Karlsson, Herman Mikkelsen and Rikard Reinhagen (Icomera AB, Sweden)

Providing connectivity to helicopters and drones is a challenging issue both from a technical as well as financial perspective. One possible cost efficient solution to the problem is for the aircraft to connect directly to the already deployed terrestrial public networks and aggregate their combined capacity and coverage at the Internet Protocol (IP) level. In this study we equipped an Airbus helicopter H135 with external antennas from VITES GmbH, two Icomera "X5/X6" multi-SIM routers, including Icomera's autonomous test and monitoring system "Surveyor", and conducted multiple test flights over a rural area in southern Germany. The results showed that using Icomera's patented technology it is possible to connect a helicopter or a drone, flying at an altitude of 10.000 ft (3048 m), to multiple terrestrial

public cellular networks. Thus, obtaining high capacity, large coverage and high reliability connections to the helicopter.

14:42 ***Modelling and Implementation Tools for SDWSN Smart Applications***

Duaa Zuhair Al-hamid, Pejman Karegar and Peter Han Joo Chong (Auckland University of Technology, New Zealand)

With unprecedented advances in cutting-edge technologies such as Internet of Things (IoT), network virtualization, digital twin, etc., various applications such as vehicular networks (VN) need to be modelled and evaluated using suitable tools. Given the dynamic nature of VN, there is a need for a virtual flexible model that can be tested prior to implementation to avoid real-time network disruptions. It also offers network maintenance without requiring major modifications to the model in real-life execution. Therefore, software-defined networking (SDN) is one of the approaches that can provide flexibility to such applications as well as other applications such as clustering for trap monitoring using UAV. Applying this advanced technology to vehicular networks can involve significant costs and complex tools. Therefore, utilizing tools such as the Contiki-Cooja network simulator allows for trailing network scenarios and testing performance virtually to obtain the best network topology that can be applied to the physical network. The aim of the paper is to offer the modelling and implementation tools that can be employed towards concept development and testing. It provides insight into the ability of various accessible tools, including software and hardware, to investigate the concept of flexible vehicular network grouping and network re-orchestration.

Tuesday, November 21 13:30 - 15:00 (Australia/Sydney)

ET1: Emerging Technologies, Applications, and Services

Room: Studio 4, Level 6

13:30 ***Fast-Convergence Federated Edge Learning via Bilevel Optimization***

Sai Wang (Southern University of Science and Technology, China); Yi Gong (Southern University of Science and Technology, Shenzhen, China)

In this paper, we investigate a fast convergence design for federated edge learning. By jointly optimizing the epoch number and batch size, we formulate a bilevel optimization problem, where the upper level problem aims to trade off the aggregating time and loss error; the lower level problem is designed to eliminate the synchronization time. To address this issue, we develop an approximate projection method. Firstly, the optimal solution of the upper level problem is obtained by convex optimization. Based on the derived optimal condition for lower level problem, a projection optimization problem is formulated to minimize the distance between the projected points and the optimal solution of the upper level problem. The results reveal that the proposed methods significantly outperform other benchmark solvers.

13:48 ***Provenance-based smart parking system with multilevel fog nodes***

Asad Masood Khattak (Zayed University, United Arab Emirates); Bashir Hayat (IM|Sciences Peshawar, Pakistan); Noman Gul (Institute of Management Sciences (IMSciences), Pakistan)

The advent of smart cities and IoT resulted in smart applications like smart traffic, energy management systems, smart parking systems, waste management systems, and public safety systems, which are rapidly expanding. These smart systems significantly address everyday life issues and are very helpful in mitigating the risks involved in establishing smart cities. Smart and environment-friendly transportation can be achieved by reducing traffic jams and parking problems. Many researchers have attempted to automate parking space allocation using cutting-edge technologies such as WSN, cloud

computing and fog computing. This paper addresses the issues and introduces a provenance-based smart parking system for reducing traffic jams and parking space availability. The proposed article depicts multilevel fog nodes, namely upper-level fog and lower-level fog nodes, for efficient data storage, transfer, utilization, and real-time availability of resources in parking areas. The provenance component of the system is used to assist users in knowing about the parking areas. Simulation is carried out in iFogSim, and evaluated in terms of network usage and latency. The proposed system outperforms others by providing efficient network usage and less latency with limited resources. Experimental results indicate that the proposed provenance-based model outperforms latency reduction and fog environment network usage. The proposed model also implements upper-level and lower-level fog nodes that minimize downtime and enhance the reliability of the fog network.

14:06 ***IEEE 802.15.6: Physical Layer Implementation and Evaluation of Medical Bands for ns-3***

Drishti Tushar Oza (Ritsumeikan University, Japan); Alberto Gallegos Ramonet (Tokushima University, Japan); Masami Yoshida and Taku Noguchi (Ritsumeikan University, Japan)

IEEE 802.15.6 is a standard for wireless body area networks (WBANs). The purpose of this standard is to establish communication for medical and other wireless short- range devices used around human bodies. Even with considerable research published around WBAN, it remains an area of study that still needs to be explored. For WBAN simulations, it is necessary to perform evaluations as close to real use conditions as possible. In this paper, we present our implementation of the IEEE 802.15.6 standard in the ns-3 network simulator. Our implementation of IEEE 802.15.6 includes only the Physical Layer and captures its essential features, such as the DBPSK modulation scheme and BCH codes. We performed the tests for coded and uncoded bit error probability and analyzed their impact on the network performance. The code for our simulation model is publicly available.

14:24 ***Deep Learning-based Anomaly Detection in Radar Data with Radar-Camera Fusion***

Dong Seog Han and Dian Ning (Kyungpook National University, Korea (South))

Sensors such as cameras, lidars, and radars are crucial to understanding driving situations in autonomous vehicles. These sensors are susceptible to external and internal abnormalities, potentially leading to severe traffic accidents. A radar sensor is inevitably affected by the obstruction caused by small objects, which can cause the system to malfunction. This paper presents a deep learning approach for detecting anomalies in radar data. The accuracy of anomaly detection is improved by using radar-camera fusion. Our proposed model detects the data anomaly by calculating the deviation from the standard radar cross section (RCS) range. The result demonstrates that the model is capable of identifying the normal range of radar signal and anomaly signal under several different obtained features situations. It enables the detection of potential hazards and warns of dangers to drivers and higher-level control systems, creating a more resilient environment for ensuring autonomous driving safety.

14:42 ***Energy-Efficient Federated Learning-enabled Digital Twin in UAV-aided Vehicular Networks***

Giang Pham (The University of Aizu, Japan); Hoang D. Le (University of Aizu, Japan); Thanh Pham (Shizuoka University, Japan); Chuyen T. Nguyen (Hanoi University of Science and Technology, Vietnam); Anh T. Pham (The University of Aizu, Japan)

Federated learning (FL)-enabled digital twin (DT) has recently attracted research attention to bring intelligent applications. However, enabling the FL-enabled DT in vehicular networks becomes challenging due to vehicle mobility's impact on communication channels. In this regard, we propose to deploy an unmanned aerial vehicle (UAV) as a relay node to support the vehicular network. The objective is to minimize energy consumption under the trade-off with the latency and accuracy constraints of the DT model via a joint optimization of local accuracy, the local computation frequency, relay decision, and transmission power. To do so, we derive instantaneous formulas to update the accuracy and latency constraints, then solve the proposed problem using an iterative algorithm with

convex optimization techniques. Numerical results show that the proposed dynamic optimization for UAV-aided vehicular networks can reduce up to 39.9% of consumption energy compared to conventional methods.

Tuesday, November 21 13:30 - 15:00 (Australia/Sydney)

ASC Meeting

Level 9

Room: Level 9

Tuesday, November 21 15:00 - 15:30 (Australia/Sydney)

Tea break

Level 6

Tuesday, November 21 15:30 - 17:00 (Australia/Sydney)

SP2: Signal Processing for Communications

Room: Studio 1, Level 6

15:30 ***Improving Signal Quality in Terahertz Communications with Neural Networks***

Mariam Abdullah (University of Adelaide, Australia); Estrid He (RMIT, Australia); Ke Wang (RMIT University, Australia); Withawat Withayachumnankul (The University of Adelaide, Australia)

The emergence of 6G wireless networks brings a lot of potential in advanced wireless applications, but also faces plenty of challenges. This work aims to address the challenges posed by the emerging 6G networks, specifically in the terahertz band (252--325 GHz). The goal is to meet the demanding requirements of high data rates, low latency, and increased reliability. To overcome this, this work proposes an ML model for enhanced signal processing that incorporates domain knowledge of the terahertz field into the traditional ML architecture. The proposed model is demonstrated to be able to increase linearity of the received signal by 66.6% from the original received signal, with a linearity increase of 18.8% compared to the Volterra filtering method.

15:48 ***Deep learning-based Collision-aware Multi-user Detection for Grant-free Sparse Code Multiple Access***

Minsig Han and Metasebia D. Gemeda (Korea University, Korea (South)); Ameha Tsegaye Abebe (Samsung Electronics, Korea (South)); Chung G. Kang (Korea University, Korea (South))

In grant-free sparse code multiple access (SCMA) systems, SCMA codebooks (CBs) are used for efficient grant-free random access. However, CB collisions can occur when multiple active users select the same CB, degrading the performance of multi-user detection (MUD) at the base station (BS). Existing methods modify the message-passing algorithm (MPA) factor graph for each CB collision scenario, resulting in high computational complexity. To overcome this, we propose a deep learning (DL)-based MUD approach that handles multiple CB collisions with a single DL-based receiver, minimizing the number of distinct MUD processes. We introduce a virtual system model to reduce training data requirements by limiting active CBs and setting a maximum tolerable CB collision. This

allows unique collision-aware MUD configurations for specific numbers of active CBs, avoiding the need for separate MUDs for each CB activity case as in conventional methods.

16:06 ***Study on Rydberg Atomic-based Millimeter Wave Electric Field Measurement***

JungHoon Oh (ETRI, Korea (South))

The inherent advantages of the Rydberg atom, including its sensitivity, dynamic range and immunity to electromagnetic interference, allow for precise electric fields and can be applied in a variety of applications such as telecommunications, electronics and environmental monitoring. In this paper, we propose a method for accurately measuring the electric field in a wide frequency range from several GHz to THz frequency by utilizing the Rydberg state of non-metallic Rb atoms, and compare existing antenna measurements and a comparison provides insight into the performance and shows that it is a promising technology for electric field sensing using the unique properties of Rydberg atoms.

16:24 ***Multi-User Semantic Communication on Hybrid NOMA***

Meng Zian (Huazhong University of Science and Technology, China); Likun Huang (Wuhan Institute of Technology, China); Qiang Li (Huazhong University of Science and Technology, China); Wensheng Zhang (Shandong University, China); Bing Tang and Chen Wang (Huazhong University of Science and Technology, China); Xiaohu Ge (Huazhong University of Science & Technology, China)

To facilitate the practical application of semantic communication, the coexistence and interplay between multiple users that operate in semantic communication and traditional bit communication respectively is paramount. In this paper, multi-user semantic communication is investigated on a traditional-semantic hybrid non-orthogonal multiple access (TSH-NOMA), which allows for the transmissions from both the bit user and the semantic user simultaneously at the same frequency. In view of the continuous semantic signals generated by the semantic encoder, its compatibility with the discrete signals generated by traditional digital modulations remains an open problem. Although quantization on semantic signal can alleviate this problem, it often leads to apparent performance degradation. To address this issue, a novel normalization method is first proposed to enable the encoder to generate a semantic constellation that is similar to quadrature amplitude modulation. Then a vector quantization algorithm is proposed, through which the quantized semantic constellation can be readily transmitted on the digital channel, while without impacting the traditional bit user. Simulation results demonstrate that by using the proposed normalization and quantization methods, the semantic user's signal can be transmitted in the digital channel with negligible performance degradation. Additionally, the semantic user in the proposed TSH-NOMA system exhibits considerable performance improvement over its counterpart in traditional NOMA, particularly at low-to-medium signal-to-noise ratio, while without compromising the performance of the traditional bit user.

16:42 ***Dither-free Auto Bias Control Technique for In-service Optical IQ modulator Using Reference Pulsed L***

Hiroto Kawakami, Yoshiaki Kisaka and Etsushi Yamazaki (NTT, Japan)

We propose a dither-free auto bias control technique for IQ modulators utilizing two pulsed reference lights. This technique does not dither the signal light after the startup sequence is complete. Therefore, no penalty is caused by the dithering during a transmission service. The bias conditions can be monitored by the built-in optical power monitor inside the IQ modulator, without using an external high-speed optical power monitor. Experimental results show that each bias voltage precisely and quickly converged to its optimal value despite bias drift due to temperature change. Measured Q-factor shows degradation of the 16QAM signal was negligible.

Tuesday, November 21 15:30 - 17:00 (Australia/Sydney)

WC2: Wireless Communications

Room: Studio 2, Level 6

15:30 ***Low Complexity Hybrid Precoding Design for Sub-Connected Massive MIMO Systems***

Lei Zhao and Junjie Li (Sun Yat-Sen University, China); Yuan Jiang (Sun Yat-sen University, China)

Hybrid analog and digital precoding architectures facilitate the practical implementation of millimeter wave (mmW) massive multiple-input multiple-output (mmW-mMIMO) systems by reducing the number of employed radio frequency chains. The spectral efficiency (SE) optimization problems of these systems are non-convex and NP-hard due to the joint optimization between the analog and digital precoding and the constant modulus constraints required by the analog phase shifters. To address this problem, we propose a decoupled two-stage design where in the first stage, a closed approximation of the effective channel is proposed, hence the SE maximization problem is recast as a effective channel gain maximization problem, then the analog precoding matrices are determined, which are taken into account in the second stage to design the digital precoding matrix to maximize the system's SE. Simulation results are provided and validate the effectiveness of our proposed hybrid precoding schemes.

15:48 ***Tailoring Routing Protocols for Flying Ad Hoc Networks: Challenges and Possible Countermeasures***

Wei Liu (Chongqing University of Technology, China); Ming Xu (Nanjing University of Aeronautics and Astronautics, China); Yun Feng and Yabo Zhang (Chongqing University of Technology, China); Yu Xia (Nanjing University of Aeronautics and Astronautics, China); Jing Mao (Chongqing University of Technology, China); Daqing Huang (Nanjing University of Aeronautics and Astronautics, China)

Implementing an resilient, efficient, and reliable network structure is crucial for highly dynamic unmanned aerial vehicle (UAV) swarms, for which flying ad hoc network (FANET) is the most suitable form. Similar to traditional ad hoc networks, the performance of FANET largely depends on the efficiency, reliability, and stability of routing schemes. However, unique characteristics of UAV make the routing design of FANET face more challenges. In order to better understand the development of FANET routing schemes, this paper attempts to clarify the current research status and grasp the future development trend of FANET routing by reviewing and analyzing relevant literatures in the past decade. Results show that geographic routing, delay tolerant network, and opportunity forward are possible countermeasures to the challenges of FANET routing.

16:06 ***An Overloaded MIMO 2-Hop Network With Physical Layer Network Coding***

Satoshi Denno, Tomoya Tanikawa and Yafei Hou (Okayama University, Japan)

This paper proposes an overloaded multiple-input-multiple-output (MIMO) 2-hop network with physical layer network coding for high speed wireless communications. The number of the spatial multiplexed signal streams can be raised to that of the transmit antennas in the proposed network even where the number of antennas on the relay is less than that on the terminals. The proposed overloaded MIMO network applies precoding and relay filtering to reduce computational complexity. Furthermore, we propose a technique to select the best filter among candidates relay filters. The performance of the proposed network is evaluated by computer simulation. The proposed filter selection technique attains a gain of about 1.5 dB at the BER of 1.eE-5 in the network where 2 antennas and 4 antennas are placed on the relay and the terminal, respectively. This paper shows that 6-stream spatial multiplexing can be exchanged between the terminals via the relay with 2 antennas.

16:24 ***TDM Scheduling Based on Receiver Grouping for Indoor Wireless Power Transfer***

Yuna Sawada, Shino Shiraki and Takahiro Matsuda (Tokyo Metropolitan University, Japan); Takefumi Hiraguri (Nippon Institute of Technology, Japan); Kazuki Maruta (Tokyo University of Science, Japan); Tomotaka Kimura (Doshisha University, Japan)

In wireless power transfer (WPT) systems, multiple-input single-output (MISO) signal processing enhances the power transfer efficiency by optimizing array antenna weight vectors according to channel coefficients between the transmitter and receivers. In a MISO based WPT system, a time division multiplexing (TDM) scheduling should be jointly optimized; transmitter periodically switches weight vectors for receivers by assigning a time slot to each weight vector. This paper proposes a receiver grouping strategy for TDM scheduling to improve the fairness and efficiency of the WPT system. Receivers with correlated channel conditions are classified into a group because the transferred energy with a beamforming weight directed to a certain receiver is supplied to other receivers, which is called beneficial interference. Beamforming weight vectors are derived to maximize the harvested energy of each group. The time slots duration assigned to weight vectors is then optimized to maximize the minimum harvested energy among receivers. The simulation experiments in an indoor multipath environment reveal that the proposed method improves the minimum and average harvested energy.

16:42 ***Implementing Hardware-in-the-Loop Protocol Simulation for UAV Networks***

Ming Xu (Nanjing University of Aeronautics and Astronautics, China); Wei Liu (Chongqing University of Technology, China); Cheng Xu (Nanjing University of Aeronautics and Astronautics, China); Yabo Zhang, Ke Zhang and Yun Feng (Chongqing University of Technology, China); Yu Xia and Daqing Huang (Nanjing University of Aeronautics and Astronautics, China)

Existing works on UAV network protocols generally use software simulators for performance evaluation, which makes the analysis results often differ significantly from the test results in actual environments. In order to make the analysis of UAV network protocols more realistic, it is necessary to introduce actual UAV nodes into the simulation. By drawing on the idea of hardware-in-the-loop (HIL) simulation, this paper proposes a simulation framework with real UAV nodes in the loop. To show the potentials of the proposed simulation framework, an instance for HIL simulation of routing protocols is implemented. Preliminary results indicate that using a small number of actual flying UAV nodes as an organic component of simulation could reduce the gap between simulation results and actual situations.

Tuesday, November 21 15:30 - 17:00 (Australia/Sydney)

WN2: Wireless Networks

Room: Studio 3, Level 6

15:30 ***A Deep Learning Approach for Detecting Virtual Link Anomalies in LEO Satellite Networks***

Rui Pang, Lizhi He and Liu Zhanjun (Chongqing University of Posts and Telecommunications, China); Chengchao Liang (Chongqing University of Posts and Telecommunications, China & Carleton University, Canada)

This paper proposes a deep learning (DL)-based time series (TS) anomaly detection method (DLTS) for the low earth orbit (LEO) satellite network slicing scenario, aiming to address the virtual link anomalies induced by software and hardware abnormalities. Initially, the time series anomalous variations of each resource utilization in satellite network slicing are categorized into three types based on the utilization of computing, storage, and network resources of virtual nodes. Thereafter, the anomaly detection problem is formulated as a classification problem, and the time series are transformed into images

using the Gramian Angular Field (GAF) for model input. Lastly, we propose a design principle for a time-constrained deep neural network architecture to mitigate training time, and design a DL model architecture to classify the TS transformation images of resource utilization for each virtual node. This aligns with the objective of the satellite network slicing scenario. Additionally, a new evaluation metric is introduced. Experimental results underscore the shorter training time of the proposed model, and affirm its efficacy, demonstrated through accuracy, F1 score, and the newly proposed evaluation metric.

15:48 ***5G Millimeter Wave Array with Compact End-fire MIMO Architecture***

Yi Gong, Xian-Long Yang, Wen-Liang Song, Dong-Yi Huang and Xiao-Wei Zhu (Southeast University, China)

In this paper, a multi-channel 5G millimeter wave array is presented, operating between 24.25 and 27.5 GHz. The array is composed of array antenna and multi-channel radio frequency (RF) front-end, which utilizing 4-channel mixer chips to achieve brick-shaped massive MIMO array design. It supports wide band signal transmission and is suitable for fully digital beamforming (DBF) architecture. Besides, a 5G millimeter array testing platform based on intermediate frequency (IF) phase control and mechanical turntable is built to verify the performance of beam scanning. The measured gain achieves over 14.2dB and the error vector magnitude (EVM) of 5G NR signal is lower than 1.07%. Beam scanning patterns demonstrate that the 5G millimeter wave array can cover ±30° region. This multi-channel array provides a foundation for 5G millimeter wave fully digital massive MIMO transceiver implementation.

16:06 ***Analytical Perspective of 5G PCF with Proxy BSF***

Priyatosh Mandal and Shubham Verma (Centre for Development of Telematics, New Delhi, India); Anurag Gupta (C-DOT, India)

The policy control function (PCF) node of the 5G network is used for provisioning QoS to session management function (SMF), and access and mobility management function (AMF). It is necessary to use the binding support function (BSF) node in the presence of multiple PCF nodes. BSF can be used as a proxy. In this present work, we derive the system delay analytically to get response from application function (AF) with proxy BSF. Further, we find the delay to get response from AF in the presence of diameter routing agent (DRA) with proxy BSF. Finally, we compare the delay of all different variations of PCF deployment.

16:24 ***Drone Detection and Classification approaches based on ML algorithms***

Maha Sliti and Mouna Garai (Communication Networks and Security Research Lab., Tunisia)

Drone detection has become an important field of research as drones are increasingly used in commercial and military applications. Drones, on the other hand, can be used for unlawful surveillance, reconnaissance, or even to carry out attacks on people or property. Anti-drone systems can identify and track drones, preventing them from entering regions where they may pose a safety hazard. A typical anti-drone system ensures drone detection, classification, and neutralization. Traditional detection methods, such as radar and acoustic sensors, have issues with detecting small, low-flying drones, necessitating the development of new alternatives. Because of their accuracy and effectiveness in detecting drones in a variety of contexts, machine learning (ML) algorithms have emerged as a promising solution for drone detection and classification. In this work, we find that machine learningbased classification of drones holds promise, supported by numerous successful individual contributions. However, it is worth noting that the majority of research conducted are experimental, making it challenging to directly compare the outcomes reported in different papers. Furthermore, the lack of standardized reference datasets hampers the evaluation and comparison of various solutions proposed in the field.

16:42 ***Radar-Communication Integration System based on PMCW Radar using Zadoff-Chu Sequence***

Masahiro Umehira (Nanzan University & Ibaraki University, Japan); Katsuyuki Fujii (Nanzan University, Japan); Yasuyuki Okumura (NANZAN University, Japan)

Next generation wireless communications such as B5G (Beyond 5G)/6G and wireless LAN are expected to support sensing function in addition to broadband wireless access to support new applications, and radar-communication integration is becoming a hot topic nowadays. This paper compares radar communication integration approaches, i.e. FMCW (Frequency Modulated Continuous Wave) radar-based, OFDM (Orthogonal Frequency Division Multiplexing) radar-based and PMCW (Pulse Modulation Continuous Wave) radar-based approach, and proposes radar-communication integration based on PMCW radar using Zadoff-Chu sequence which is CAZAC (Constant Amplitude Zero Auto-Correlation) sequence suitable for PMCW radar applications. This paper describes basic design issues such as signal format, maximum detection range and range resolution and shows correlation detection performance of the proposed PMCW radar when filtering is applied.

Tuesday, November 21 15:30 - 17:00 (Australia/Sydney)

ET2: Emerging Technologies, Applications, and Services

Room: Studio 4, Level 6

15:30 ***Performance of a Dielectric Resonator Antenna for Structural Health Monitoring Applications***

Reenu Tresa Jacob, Robert Salama and Ranjith Liyanapathirana (Western Sydney University, Australia)

Dielectric-loaded waveguides and resonators operating in microwave frequency bands have been successfully used for measuring displacement in structures, detecting gaps between concrete and metal surfaces, and monitoring cracks. This paper presents a novel dielectric resonator antenna (DRA) that operates in the X-band (8.2 - 12.4 GHz) that can be used for structural health monitoring applications. The proposed DRA is initially designed and optimized to operate in free space, and then embedded in a concrete block and its performance is analyzed. The simulated and measured magnitude of reflection coefficient, S11, are in good agreement. The modeled DRA has the potential to be used for structural health monitoring applications.

15:48 ***FingerFi: An Alpha-numeric Character-based Gesture recognition using Wi-Fi Sensing***

Sruthi Penmetsa and Udgata Siba Kumar (University of Hyderabad, India)

Gesture recognition based on WiFi channel state Information (CSI) has attracted much attention due to its applications in home automation, robotics, healthcare, and so on. Recognition of alphanumeric characters drawn by a finger in a WiFi sensing zone has its own applications, such as nonverbal communication, accessibility, document digitization, and many more. In this paper, we propose a novel model for alphanumeric gesture recognition using CSI-ratio, the variance of the CSI values in the sub-carriers, and different machine learning models like K-nearest neighbors (KNN), Linear Discriminant Analysis (LDA), Decision Tree (DT). Exhaustive experiments are conducted involving different persons to draw alphanumeric characters using fingers and the CSI values are collected using an Intel 5300n network interface card as a receiver and a TP-Link commodity commercially off-the-Shelf (COTS) router as a transmitter. The collected values are pre- processed using the CSI ratio method and the variance of the CSI matrix is used as a feature to classify the alphanumeric gestures using different machine learning models like KNN, LDA, and DT. The DT machine learning method outperforms the other two models and The accuracy of recognizing only digits with DT is 98.26% and 96.24% for both alphabets

and digits. We also tried to identify the participating person based on the pattern of their gesture and the DT method is able to detect the participant with 99% accuracy.

16:06 ***Energy Efficiency in Semantic Networks: A Heuristic Optimization Approach for Resource Allocation***

Ao Xiao, Kaixuan Zhao and Liu Zhanjun (Chongqing University of Posts and Telecommunications, China); Chengchao Liang (Chongqing University of Posts and Telecommunications, China & Carleton University, Canada)

Anticipated to substantially enhance communication efficiency, semantic communication emerges as a novel communication paradigm. Considering the constraints of wireless resources, it becomes crucial to design resource allocation schemes that ensure efficient data transmission in a semantic communication system. This paper proposes a resource allocation scheme that maximizes the energy efficiency of the entire semantic network, ensuring the performance of semantic tasks within the confines of limited wireless resources. Specifically, we begin by defining the energy efficiency measurement metrics (S-EE) in semantic communication systems and subsequently optimize S-EE through the joint allocation of semantic symbols, bandwidth, and power. This problem is formulated as an optimization problem. Given the absence of a mathematical closed-form expression for semantic similarity, an effective solution to the problem is proposed via a whale optimization algorithm with a penalty strategy, targeting joint semantic symbols assignment and resource allocation. Simulation results substantiate the effectiveness and feasibility of the proposed scheme.

16:24 ***Client Selection Based on Channel Capacity for Federated Learning Under Wireless Channels***

Satoshi Yamazaki (National Institute of Technology, Numazu College & Control & Computer Engineering, Japan); Takuma Furuki (Tokyo University, Japan)

This paper proposes a user selection scheme for federated learning (FL) over wireless networks to reduce communication time based on channel capacity. In particular, the edge server calculates the Shannon channel capacity of each client for each round, and clients with a certain threshold capacity are randomly selected to participate in FL. We show that the convergence time of the proposed scheme outperformed that of the conventional scheme through computer simulation based on an image processing task under a wireless channel with pass-loss, shadowing, and Rician flat-fading. Moreover, the superiority of FL to centralized learning (CL) regarding total time is demonstrated theoretically and validated through computer simulation.

16:42 ***Online Learning based Matching for Decentralized Task Offloading in Fog-enabled IoT Systems***

Tran Hoa and Dong Seong Kim (Kumoh National Institute of Technology, Korea (South))

Matching theory has been applied to design efficient offloading solutions to the multi-task multi-helper (MTMH) problem in the fog computing networks, which is modeled as a matching game between a set of task nodes (TNs) having task computation needs and a set of helper nodes (HNs) having available computing resources. However, the uncertainty of computing resource availability of HNs as well as dynamics of QoS requirements of tasks result in the lack of preferences of TN side that mainly poses a critical challenge to obtain a stable and reliable matching outcome. To address this challenge, we apply a multi-armed bandit (MAB) learning using Thomson sampling (TS) mechanism to acquire better exploitation and exploration trade-off, allowing TNs to match with their corresponding HNs efficiently. Based on these, this paper proposes online learning based matching (OLM) algorithm for decentralized task offloading to reduce the offloading delay in Fog-enabled IoT Systems. Extensive simulation results demonstrate the potential advantages of the TS-type algorithm over the epsilon-greedy and UCB based offloading algorithms.

Tuesday, November 21 18:00 - 21:00 (Australia/Sydney)

Banquet

Buffet at River Canyon Bar & Grill 94-96 Philip Street, NSW2150 Tel. (02) 8074 1117

Wednesday, November 22

Wednesday, November 22 8:30 - 9:00 (Australia/Sydney)

Registration

Wednesday, November 22 9:00 - 10:30 (Australia/Sydney)

Keynote speech #4

Level 9

Prof. E. Wong

Elaine Wong received her Ph.D. (2002) degree in Electrical Engineering from the University of Melbourne, Australia. She is currently an Associate Dean and Professor with the Melbourne School of Engineering. Her current research interests include low-latency communication networks and prescriptive analytics to facilitate human-to-machine applications over the Tactile Internet. She has co-authored 4 book chapters, 75 refereed international journals, 152 refereed international conferences (40 invited international conference publications) and 5 patents. Elaine has previously served as Associate Editor of the IEEE/OSA Journal of Optical Communications and Networking, IEEE/OSA Journal of Lightwave Technology, and OSA Journal of Optical Networking. She currently serves on the ECOC Technical Program Committee and the OFC Technical Program Committee.

Wednesday, November 22 10:30 - 11:00 (Australia/Sydney)

Tea break

Level 6

Wednesday, November 22 11:00 - 12:30 (Australia/Sydney)

SS1/1: Ambient Intelligence for Smart City

Room: Studio 1, Level 6

11:00 ***Adopted Acceptance Test-Driven Development to produce RPA for reducing teaching workload***

Jirayus Arbking (Burapha, Thailand); Wantana Sisomboon and Nuttaporn Phakdee (Burapha University, Thailand)

Robotic Process Automation (RPA) has emerged as a significant technology across various industries, including the field of education. However, educators face a substantial workload that hinders their ability to effectively develop students. To address this issue, the implementation of RPA can be considered to alleviate the burden on teachers. Additionally, Acceptance Test-Driven Development (ATDD) is a collaborative methodology involving stakeholders, developers, and testers, ensuring

software adherence to desired requirements. By integrating ATDD with RPA, teaching processes can be streamlined, repetitive tasks automated, and overall workload reduced. Consequently, instructors can dedicate more time to critical aspects of their roles. The RPA development process can be guided by the six phases of the RPA Life Cycle. During the discovery phase, an evaluation report, specifically the Forrester Wave™, identified UiPath as the optimal tool. Its features aligned well with the requirements of the teaching support process. Furthermore, a combination of the RPA position strategy, group interviews, and online questionnaires involving lecturers from the Faculty of Informatics at Burapha University guided the word validation process for the RPA application. The design phase followed a structured flow to produce the automated application. The results demonstrated a 71.42-fold reduction in time spent on checking word errors in student project reports and communication between teachers and students. This successful integration of RPA in the education sector showcases its potential for enhancing instructional efficiency and student development.

11:18 ***Visible Light Communication Systems Using a High-speed Display and Rolling-shutter Camera***

Hiraku Okada and Taiga Hayashi (Nagoya University, Japan); Kentaro Kobayashi (Meijo University, Japan); Tadahiro Wada (Shizuoka University, Japan); Chedlia Ben Naila and Masaaki Katayama (Nagoya University, Japan)

This study focuses on visible light communications using a high-speed display and rolling-shutter camera of a smartphone. We aim to achieve high-quality communication imperceptible to the human eye through the high-speed display. The capture rate of an image sensor is generally slow. Then, the image sensor cannot obtain some parts of a transmitted data image because of the high-speed display rate. We employ the rolling shutter camera that reads pixels row by row and propose a receiving scheme in which the camera obtains some transmitted data images in a captured image. The proposed scheme can acquire transmitted data, even if the display rate is higher than the capture rate. We experimentally evaluate the proposed scheme in terms of the quality of the visual information and the communication quality to clarify its superiority.

11:36 ***An LSTM-Based Approach for Fall Detection Using Accelerometer-Collected Data***

Yoshiya Uotani and Kohei Yamamoto (Keio University, Japan); Chen Ye (Nanjing University of Posts and Telecommunications, China); Mondher Bouazizi and Tomoaki Ohtsuki (Keio University, Japan)

Over the past few years, there has been a significant rise in the number of fall accidents occurring among elderly individuals, a problem that has been accentuated with to the aging population. Researchers and developers have focused their efforts on investigating and creating various fall detection methods that utilize an accelerometer. However, conventional fall detection methods typically target specific positions where accelerometers are placed. In addition, they suffer from low accuracy which can be attributed to the fact that the classification algorithms commonly employed, such as the support vector machine (SVM) and the random forest (RF), are not specialized in making predictions based on time series data. In this paper, we propose the fall detection method based on a long short-term memory (LSTM) neural network, using an accelerometer. In the proposed method, four kinds of possession positions are set: (i) in hand, (ii) inside a chest pocket, (iii) inside a waist pocket, and (iv) in a bag. The acceleration data collected are classified using the LSTM classifies into one of four classes: (i) standing, (ii) walking, (iii) falling, and (iv) lying down. The results of the multi-class classification are further reclassified into two classes, i.e., fall and non-fall. The experimental results demonstrate that our approach outperforms the conventional methods in terms of fall detection accuracy.

11:54 ***Leveraging Fog Layer Data Prediction Using Deep Learning for Enhanced IoT Sensor Longevity***

Made Adi Paramartha Putra (Kumoh National Institute of Technology, Korea (South) & Primakara University, Indonesia); Mideth Abisado (National University, Philippines); Gabriel Avelino R Sampedro (University of the Philippines, Philippines & Kumoh National Institute of Technology, Korea (South))

This research paper presents a novel approach to improving the longevity of IoT sensors by implementing a testbed architecture that leverages sensor data prediction. Unlike previous studies that primarily focused on enhancing prediction accuracy through increased hidden layers in Deep Learning (DL) models, this paper takes into account both prediction accuracy and energy efficiency as key metrics. To achieve this, a combination of DL models and the Fog-layer Data Prediction algorithm is deployed at the fog layer to forecast incoming data from edge devices. Various look-back intervals of historical data are evaluated to determine the most efficient approach. Simulation results indicate that LSTM algorithms with four and eight data look-backs achieved the highest accuracy rates compared to other DL models. Furthermore, the evaluation of the testbed architecture demonstrates that using sensor data prediction can enhance total energy efficiency by up to 20% compared to traditional IoT architectures.

12:12 ***Decentralized Optimal Parking Lot Allocation via Dynamic Parking Fee***

Toru Namerikawa (Keio University, Japan)

In this study, we propose a novel method for parking lot allocation. In conventional methods, information about drivers and parking lots is collected by a system manager, and the allocation is determined centrally. However, the computational load increases exponentially as the target area expands. Therefore, a decentralized system is needed that can flexibly respond to the expansion of the area size, in which the allocation is determined by communicating the results of the calculations performed by each participant. In building a decentralized system, it is desirable for the system to be fair and efficient. Therefore, we propose a decentralized parking system that satisfies this property by using matching theory, a field that studies how people and things should be matched in a market. We propose a unique matching method that takes into account the difference between drivers as consumers and parking service providers. We also propose a reallocation method based on dynamic parking fees to reduce the number of unallocated drivers.

Wednesday, November 22 11:00 - 12:30 (Australia/Sydney)

WC3: Wireless Communications

Room: Studio 2, Level 6

11:00 ***Beam Direction Optimization for Next-Generation GEO Satellite Networks***

Heba Shehata, Hazer Inaltekin and Iain B. Collings (Macquarie University, Australia); Stephen Hanly (School of Engineering, Macquarie University, Australia); Philip Whiting (Macquarie University, Australia)

This paper develops a beam direction optimization framework for next-generation GEO satellite networks, with the objective of meeting traffic demands at user locations being served. For given beam pointing directions, the downlink of the GEO satellite is in the form of a vector broadcast channel that consists of a single transmitter and multiple distributed ground users. We characterize the downlink channel matrix for multibeam GEO satellite networks by using the array factor formula for uniform planar arrays. We obtain a necessary and sufficient condition, which depends on the downlink channel matrix, to provision traffic demands by meeting given SINR targets at user locations. Utilizing the necessary and sufficient condition, we formulate a joint beam direction and power optimization problem to attain target SINRs by using minimum total power. Our results demonstrate that analog

beamforming with optimized beam shifts can achieve an SINR gain of 8 dB when compared to analog beamforming without beam direction optimization. It also offers a spatial multiplexing advantage of 90 km by enabling simultaneous provisioning of user locations in close proximity within the same frequency band. When compared to hybrid beamforming, our scheme can achieve an SINR gain of 2 dB.

11:18 ***Endurance Enhancement of Aerial Vehicle Energy Transmitters Using Conical Corrugated Horn Antenna***

Archiman Lahiry (School of Engineering Design and Built Environment, Western Sydney University, Penrith Kingswood, Australia & Western Sydney University, Australia); Khoa N Le (Western Sydney University, Australia); Vo Nguyen Quoc Bao (Posts and Telecommunications Institute of Technology, Vietnam); Vivian W.Y. Tam (School of Engineering, Design and Built Environment, Western Sydney University, Australia)

A corrugated horn antenna is proposed for the unmanned aerial vehicle energy transmitter (UAV-ET) application. Firstly, the proposed antenna can be manufactured using polylactic acid (PLA) 3-dimensional (3-D) printing with copper conductive paint coating, which is lightweight and cost-effective compared to metal 3-D printing. Secondly, the results confirm that the sidelobe level of the antenna is below -30 dB, and radiation efficiency is above 99 % throughout the operating frequency band. Also, the proposed antenna increases the UAV-ET wireless power transfer (WPT) time by 47.5 % and 4.5 % compared to UAV-ETs equipped with a dipole array and a slotted waveguide array respectively. Furthermore, the mass production of the antenna is easy because of its design simplicity which is highly desirable for the large swarm of UAV-ETs to increase the wireless power transfer coverage for charging ground sensors.

11:36 ***Priority Based Spectrum Allocation***

Chamath Divarathne (RMIT University, Australia); Tharaka Samarasinghe (University of Moratuwa, Sri Lanka); Sithamparanathan Kandeepan and Ke Wang (RMIT University, Australia)

Dynamic spectrum access is recognized as a potential solution to the problem of spectrum scarcity. Consequently, a significant amount of research has been conducted on spectrum allocation. In this study, we present a multi-traffic class queue-based spectrum allocation solution. The proposed solution is designed for a scenario where communication and other systems do not necessarily require agility in the frequency bands they operate in. The spectrum sensing and forecasting processes are carried out over relatively long time periods compared to the actual transmission rates. The study considers two traffic classes: priority and non-priority. Three packet handling strategies are presented and their average queuing delay performances are compared. While all three strategies yield satisfactory results under low/medium traffic conditions, Strategy 3 exhibits the greatest flexibility in terms of delay performance. Additionally, the study examines the selection of delay thresholds in Strategy 3 using three fairness indices. It is worth noting that although the proposed algorithm focuses on spectrum allocation, it can be easily adapted to address resource allocation problems involving requests with multiple priorities.

11:54 ***Proactive Cell Switching for mmWave Networks with Hybrid Beamforming and Dynamic Blockers***

Xiaohui Zhou and Iain B. Collings (Macquarie University, Australia); Stephen Hanly (School of Engineering, Macquarie University, Australia); Philip Whiting (Macquarie University, Australia)

In this paper, we consider a millimeter wave network deployed to cover an urban street. Each base station (BS) employs hybrid beamforming with a limited number of radio frequency (RF) chains. Its link to any user equipment (UE) is prone to being blocked by vehicles and pedestrians moving along the street. We propose a Round Robin (RR) access protocol with proactive cell switching in which each UE switches its connection to the least loaded line of sight BS at the end of its RR transmission frame or

any time when its link is blocked. We compare the UE connectivity performance of the proposed protocol to the conventional cellular network association protocols and the RR protocols which switch only when the link is blocked. Our results reveal the impacts of different system parameters (i.e. the number of BSs, the number of RF chains, the length of RR transmission frame) on the performance of the protocol, and the importance of cell switching in dealing with load balancing as well as blockage.

12:12 ***An Efficient Client Selection for Wireless Federated Learning***

Jingyi Chen, Wang Qiang and Wenqi Zhang (Beijing University of Posts and Telecommunications, China)

As a promising distributed learning technology, federated learning (FL) is used in wireless communication to efficiently utilize distributed data. However, statistical heterogeneity is often ignored as a crucial factor affecting wireless federated learning (WFL) performance. Besides, free rider is common in real world. In this paper, we consider the statistical heterogeneity and free rides jointly with limited resources. We first define a new measurement considering the substitutability and wholeness of client, called contribution degree. Then we propose the Contribution Degree-based Client Selection (CDCS) algorithm to improve WFL performance. Experiments validate that the proposed algorithm improves the global model accuracy, achieves fast convergence and reduces total delay.

Wednesday, November 22 11:00 - 12:30 (Australia/Sydney)

SS2/1: Emerging Technologies for B5G/6G Wireless Communication Systems

Room: Studio 3, Level 6

11:00 ***Over-the-Air Computation for Partial Aggregation of IoT Data***

Go Fukuda and Seiji Miyoshi (Kansai University, Japan); Hiroyuki Yomo (Kansai University & ATR Adaptive Communications Research Lab., Japan)

The aggregation of a large amount of distributed data is one of the important functions in many IoT applications. Over-the-air computation (AirComp) realizes an efficient aggregation by exploiting the superposition property of wireless medium: all IoT nodes simultaneously transmit their signals, which are received and processed to obtain the aggregated value of their data. The conventional AirComp assumes that all nodes in a given system always join the aggregation process. However, in some practical applications, only a subset of nodes in a given system, which own updated information, are supposed to join the aggregation process. In this case, AirComp should be executed for the partial, unknown subset of nodes, which make it difficult to optimize its transmitting-receiving (Tx-Rx) parameters. To address this issue, in this paper, we propose the over-the-air computation for partial aggregation, called partial AirComp. Our numerical results show that the proposed partial AirComp achieves smaller mean-squared error (MSE) than the conventional AirComp when applied for the partial data aggregation.

11:18 ***Performance Analysis of MIMO-Underwater Optical Wireless Communication***

Maha Sliti and Mouna Garai (Communication Networks and Security Research Lab., Tunisia)

Underwater optical wireless communication (UOWC) is a promising technology for high-speed data transmission in underwater environments. UOWC uses light as the carrier signal, allowing for higher data rates compared to traditional acoustic methods. However, the underwater environment presents unique challenges, such as scattering, turbidity, temperature, salinity, and underwater particles. This

research aims to analyze UOWC systems' performance using Multiple-Input Multiple-Output (MIMO) technique which has the potential to improve the data transmission performance. The analysis compare the SISO (Single Input Single Output) and MIMO techniques in underwater environment for different types of water (low turbulence and turbid water). To this end, we assess key performance metrics, such as bit error rates (BER) and received optical power versus transmission range.

11:36 ***Energy Efficiency Optimization of Intelligent Reflective Surface-assisted Terahertz-RSMA System***

Xiaoyu Chen (University of Sydney, China); Menghan Hu (University of Sydney, Australia); Feng Yan (Southeast University, China); Zihuai Lin (University of Sydney, Australia)

This paper examines the energy efficiency optimization problem of Intelligent Reflective Surface (IRS)-assisted multi-user Rate-Splitting Multiple Access (RSMA) downlink systems under terahertz propagation. The objective function for energy efficiency is optimized using the Salp Swarm Algorithm (SSA) and compared with the Successive Convex Approximation (SCA) technique. SCA technique requires multiple iterations to solve non-convex resource allocation problems, whereas SSA can consume less time to improve energy efficiency effectively. The simulation results show that SSA is better than SCA in improving system energy efficiency, and the time required is significantly reduced, thus optimizing the system's overall performance.

11:54 ***Collaborative MIMO Reception: Measurement Campaign and Mutual Information Rate Analysis***

Hidekazu Murata (Yamaguchi University, Japan); Daisuke Umehara (Kyoto Institute of Technology, Japan)

We are developing a collaborative multiple-input multiple-output reception system consisting of a base station (BS) with multiple antennas and surrounding multiple mobile stations (MSs) with a small number of antennas for future cellular systems. The MSs virtually increase the number of receiving antennas by forwarding the received waveform data using higher-frequency bands and decode the multiple received streams from the BS. The multiple received spatially multiplexed streams experience quantization errors, which are induced by digitized waveform forwarding. We obtain experimental results for the mutual information rate by conducting a measurement campaign around an urban area, in which channel state information is measured on a moving vehicle.

12:12 ***Millimeter-Wave Band Coverage Extension by Reducing Noise Figure at Cryogenic Temperatures***

Yasunori Suzuki (NTT DOCOMO, INC., Japan); Tomoyuki Furuichi and Noriharu Suematsu (Tohoku University, Japan)

This paper presents millimeter-wave band coverage extension when the front-end module can operate at cryogenic temperatures. It is very important to attain sufficient coverage area for servicing millimeter-wave band communications. However, in general, the coverage area becomes smaller than that of operating cellular bands such as 2 GHz. The cryogenically cooled front-end module provides to reduce noise figure (NF) by several dB from the room temperature. This feature means that the coverage area can expand by the reduced NF at cryogenic temperatures. The calculation results confirm that the coverage can expand 2.75 times when the cryogenically cooled front-end module operates at 100 K. These results lead to reduce the number of millimeter-wave base stations.

Wednesday, November 22 11:00 - 12:30 (Australia/Sydney)

ET3: Emerging Technologies, Applications, and Services

Room: Studio 4, Level 6

11:00 ***Evaluation of Applying Blockchain Technology to IoT Data Distribution***

Hayato Kumazaki and Osamu Mizuno (Kogakuin University, Japan)

We have proposed the Ticket-based Access Control Method. It provides access control with a token called a ticket and Tag ID. A token has an ID for data acquisition tied to multiple devices. The Ticket-based Access Control Method realizes the IoT data distribution infrastructure that supports the collection/analysis, scalability, and security of various types of IoT data. It includes the TAAI node (Ticket Authentication and Authorization Infrastructure node), which acts as a role of Broker in the Pub/Sub communication model. It is always involved in authentication and authorization. The TAAI is a single point of failure because when the TAAI fails, the entire system will go down. Therefore, to eliminate the single point of failure in the Tag ID-based Pub/Sub model using Ticket-based AC, we propose a method to distribute the processing performed by the TAAI to each node by applying blockchain (BC) technology. Having the BC take charge of authentication can reduce the load on each node.

11:18 ***Fun Button Experiment: The Long-Term Effect of Gamification on User Engagement and Behavior***

Mohammad Hajarian, Paloma Diaz and Ignacio Aedo (Universidad Carlos III de Madrid, Spain)

Implementing gamification is a great way to increase user engagement in software applications. For this reason, gamification and its effects have been the subject of many studies. Nevertheless, the long-term effect of gamification and its relationship with users' engagement, demography, and behavior was less studied in the literature. In this article, we aim to feel this gap by looking at the long-term effects of gamification on social network users. This study investigates how many social network users who used gamification continue using it after five years by checking the status of a fun button in the social network. Our findings suggest a statistically significant negative relationship between the user age group and using gamification in the long term. Younger people are more likely to keep using gamification for a long period than older people. Moreover, most women might give up on gamification in the long run, while fewer men will do that in the same situation. Also, a weak negative relationship exists between users' education level and their long-term use of gamification. Users with a high level of education are less likely to keep up with gamification for a long time. In addition, users who used personalized gamification had more user engagement than regular gamification users. Besides, in the long run, regular gamification users who turned the fun button off had more engagement with the application than those who kept using gamification. While in personalized gamification, users who kept their gamification on had more engagement with the application.

11:36 ***Evaluation of Dynamic Routing in Information-Centric based Wireless Sensor Networks***

Kohei Yamamoto, Takafumi Taya and Osamu Mizuno (Kogakuin University, Japan)

We have proposed Information-Centric Networking-based Wireless Sensor Networks (ICSN) to realize multiple IoT services. In ICSN, data in FIB (Forwarding Information Base) must be statically assigned in advance to set up routes between each sensor node. Therefore, the dynamic routing method to build a sensor network automatically is required to reduce set-up time. We propose the dynamic route setup method for ICSNs and confirm the effectiveness of the proposed method by emulation and trial manufacture.

11:54 ***A Review of Recent Trends in Blockchain Consensus Algorithms: Artificial Intelligence-Based Approach***

Jauzak Hussaini Windiatmaja (University of Indonesia, Indonesia); Muhammad Salman (Universitas Indonesia, Indonesia); Riri Sari (University of Indonesia, Indonesia)

Blockchain has emerged as an important technology, offering safe, decentralized, and transparent platforms for recording and validating transactions. Blockchain technology consist of several main components, i.e., consensus algorithm. The consensus algorithm guarantees that all participating nodes in a blockchain network agree over the data control. Traditional consensus methods, such as Proof of Work (PoW) and Proof of Stake (PoS), present issues in terms of energy consumption and attack vulnerability. To overcome these constraints, there has been a rising interest in incorporating Artificial Intelligence (AI) techniques, especially deep learning, into blockchain consensus algorithms. We highlight blockchain fundamentals in this article, while also stressing the importance of the consensus algorithm. Furthermore, we address the most recent advancements in blockchain consensus methods in both performance-based and reputation-based paradigm, emphasizing the use of AI inside these decentralized systems. The use of AI, especially deep learning, in consensus algorithms has the potential to overcome the limitations of previous techniques. Blockchain networks may improve its performance by employing AI capabilities. However, incorporating AI into blockchain consensus algorithms is having its own challenges. Therefore, we also highlight several issues related with AI-based techniques in blockchain consensus algorithms, such as dealing with the quality and variety of data utilized by consensus algorithms and maintaining the openness of the AI models. In addition to those challenges, we propose a future direction for the AI-based approach in blockchain, which includes merging the mechanisms of performance-based and reputation-based consensus algorithms to incorporate the merits of both methods

12:12 ***Research on the Charging Socket Detection based on Improved YOLOv5 Algorithm***

Guangmeng Chen (& Xidian University, China)

With the rapid increase in the number of electric vehicles, mobile charging robots have been attracting widespread attention worldwide. The primary task of a mobile charging robot, which enables intelligent charging for electric vehicles, is to identify and locate the charging ports. Currently, the detection of charging ports relies mainly on traditional algorithms, which suffer from low real-time performance and accuracy. Therefore, this paper proposes an improved algorithm network based on YOLOv5. It incorporates a target detection head (DYHEAD) based on the attention mechanism into YOLOv5s and utilizes SIoU as the loss function to enhance the accuracy and precision of object detection. The experiment shows that the improved algorithm achieved an average precision improvement of 3.4% and an mAP50 improvement of 2.7%. Simultaneously, with the integration of a depth camera, the algorithm successfully recognized and located three different standard charging ports. The recognition frame rate reached 85-90 frames per second, and the detection range exceeded 1.5 meters. Therefore, this algorithm can be used for the detection of charging ports in tasks involving mobile charging robots. Keywords-mobile charging robot, YOLOv5, attention mechanism, loss function

Wednesday, November 22 12:30 - 13:30 (Australia/Sydney)

Lunch break

Level 6

Wednesday, November 22 13:30 - 15:00 (Australia/Sydney)

SS1/2: Ambient Intelligence for Smart City

Ambient Intelligence for Smart City

Room: Studio 1, Level 6

13:30 ***Evaluation of path planning algorithms for mobile energy storage and charging robots***

Kaixinguang Li (Xidian University, China)

The rapid growth of the new energy industry has fostered the rapid development of the mobile energy storage and charging robot industry, with the path planning algorithm being a vital component. This study focuses on the raster-based path planning algorithms, namely the A *algorithm, D* algorithm, and JPS algorithm. Firstly, the algorithms are compared in a simulated environment to assess their feasibility, advantages, and limitations. Subsequently, the Robot Operating System(ROS) framework is employed as the development platform, along with LIDAR and other equipment, to validate the effectiveness of the path planning algorithm using a physical mobile energy storage and charging robot. Experimental results demonstrate the algorithm's feasibility and provide insights into its optimization direction.

13:48 ***Laser SLAM research for mobile energy storage and charging robots***

Ziheng Wang (Xidian University & Hangzhou Enrgmax Technology Co., Ltd., China)

With the rapid development of electric vehicles, the limitations of traditional fixed located charging stations are gradually highlighted, mobile energy storage charging robots have a wide range of application scenarios and markets. SLAM technology for mapping the environment is one of the important technologies in the field of mobile robotics. Selecting suitable algorithms is crucial for mobile energy storage charging robots to get more accurate environment maps and achieve autonomous navigation, obstacle avoidance and other functions. In this paper, based on Robot Operating System(ROS) system, three laser SLAM algorithms, Fast-Lio, Gmapping and Cartographer, are proposed to run in simulation environment and real scenario, and the maps generated by them are evaluated. The experimental and evaluation results demonstrate the successful map creation capability of all three algorithms. In comparison, Cartographer exhibits superior robustness and generates more comprehensive maps that closely align with the ground truth map. Consequently, Cartographer is better suited for large-scale and complicated scenarios.

14:06 ***Facial Expression Recognition by Photo-Reflective Sensors Considering Time Series and Head Posture***

Yuki Nakabayashi (Keio University, Japan); Fumihiko Nakamura (Ritsumeikan University, Japan); Maki Sugimoto (Keio University, Japan)

There is a method to recognize facial expressions of Head-Mounted Display (HMD) wearers by machine learning of reflection intensity information from photo-reflective sensors embedded into the interior of an HMD. This study evaluates whether facial expression recognition accuracy can be improved by using a learning model that considers temporal changes in sensor values. We assessed whether facial expression recognition accuracy could be improved by adding the head posture data acquired from the Inertial Measurement Unit (IMU) in the HMD to the discriminator input and performing time-series learning. The experimental results showed that PRS-based facial expression recognition with time-series data was more accurate than without. The multimodal recognition using the reflection intensity and head posture data was slightly more accurate than the discrimination using only the reflection intensity information. It was especially effective for the learning condition without considering the time-series.

14:24 ***An Efficient Radio Frequency Fingerprint Extraction Method Using Asymmetric Masked Auto-Encoder***

Zhisheng Yao and Xue Fu (Nanjing University of Posts and Telecommunications, China); Shufei Wang (Nanjing & Nanjing University of Posts and Telecommunications, China); Yu Wang and Guan

Gui (Nanjing University of Posts and Telecommunications, China); Shiwen Mao (Auburn University, USA)

In real communication environments, it is necessary to process timely received signal samples, which are limited in quantity and are difficult to obtain labels, the performance of most radio frequency fingerprint (RFF) methods is generally poor. To effectively extract features from the limited and unlabeled signal samples, we propose an efficient RFF extraction method using an asymmetric masked auto-encoder (AMAE). Specifically, we design an asymmetric extractor-decoder, where the extractor is used to learn the latent representation of the masked signals and the decoder as light as a convolution layer reconstructs the unmasked signal from the latent representation. Using commercial off-the-shelf LoRa datasets and WiFi datasets, we show that the proposed AMAE-based RFF extraction method achieves the best performance compared with four advanced unsupervised methods whether in the case of large data size or small data size, or under line of sight (LOS) and non-line of sight (NLOS) channel scenarios. The codes of this paper can be downloaded from Github: https://github.com/YZS666/An-Efficient-RFF-Extraction-Method.

14:42 ***HomeShelf: Cultivating Individual Relationships with Digital Contents***

Sota Tanaka and Issei Fujishiro (Keio University, Japan)

The digitization of material objects is rapidly advancing, progressively offering people an unprecedented level of convenience and accessibility. However, studies have shown that people feel a lesser attachment to digital contents than to material objects. In this paper, we focus on shelves, thought to be hubs for cultivating individual relationships with material objects in daily life. We thus propose HomeShelf, an application that accelerates interactions with digital contents and fosters deeper attachments to them. Further, we discuss the features to be added using new technologies and the impact on digitized material objects.

Wednesday, November 22 13:30 - 15:00 (Australia/Sydney)

WC4: Signal Processing for Communications

Room: Studio 2, Level 6

13:30 ***Efficient Multiple UAV Deployment for Maximal Communication Connectivity over Wide Areas***

Qiwei Yang and Iain B. Collings (Macquarie University, Australia); Stephen Hanly (School of Engineering, Macquarie University, Australia)

This paper proposes an efficient 3D deployment approach for multiple UAV base stations, to maximize the probability of connections for users spread over a wide area. We consider covering a circular region, such as might apply in a disaster scenario affecting a city centre where terrestrial base stations have become inoperable. We compare two approaches to deploying UAVs. One is a regular triangular arrangement of UAVs and the other is an optimized circle packing arrangement. We start by considering a flying height optimized for a single UAV. We then show that both approaches can be improved by varying the height and flying locations of the UAVs, to expand the overall desired coverage area and overlap the individual UAV coverage areas. We show that the simple regular triangular arrangement can obtain superior connectivity compared to the circle packing approach, with significantly lower complexity.

13:48 ***A Resource Allocation Scheme in Heterogeneous Multi-system Satellite Network with Beam-hopping***

Yilin Zhai and Yu Zhang (Chongqing University of Posts and Telecommunications, China); Chengchao Liang (Chongqing University of Posts and Telecommunications, China & Carleton University, Canada)

The emerging architecture in the next generation of mobile networks leverages the coexistence of Low Earth Orbit (LEO) and Geostationary Orbit (GEO) satellites in a heterogeneous network. This setup not only offers seamless coverage but also enhances user rates. Nevertheless, the efficient allocation of onboard resources, particularly spectrum resources, poses a significant challenge due to their scarcity in such heterogeneous satellite coexistence networks. A practical solution is found in the use of beam hopping (BH) technology. This technology enables multi-beam satellites to serve users using fewer beams than traditional spot-beam systems. This paper proposes a resource allocation strategy for the heterogeneous LEO-GEO coexistence satellite network. We formulate this resource allocation strategy as a joint optimization problem. Due to the complexity of the system arising from the coupling of multiple variables, we break down the original problem into two manageable sub-problems. The first addresses user association, subcarrier, and power allocation and employs a standard convex optimization algorithm for a solution. The second tackles the illuminated beam selection issue, with a genetic algorithm (GA) providing a solution. The effectiveness of our proposed scheme is established through simulation experiments, demonstrating clear performance gains.

14:06 ***Performance of PSA-EKF Phase Noise Compensation in 3GPP Phase Noise Models for Mobile Backhaul Links***

Ryota Kuribayashi and Mamoru Sawahashi (Tokyo City University, Japan); Norifumi Kamiya (NEC Corporation, Japan)

The time-varying phase noise (PN) due to a local oscillator of a base station (BS) and a user equipment (UE) is one of the major impairments in the millimeter-wave bands. This paper presents bit error rate (BER) performance of pilot symbol assisted (PSA)-extended Kalman filter (EKF) phase noise compensation (PNC) method that combines a PSA PNC in time domain and the iterative PNC using EKF in the 3rd Generation Partnership Project (3GPP) PN model for OFDM backhaul links. We first derive the discrete-time transfer function of the power spectral density (PSD) based on z-function for the time domain 3GPP PN signal generation employing a small number of low-pass filter (LPF) taps, and show the validity of the generated PN signal by comparing with the continuous-time transfer function that is specified in the 3GPP technical report. We then show that when using the PSA-EKF PNC with LDPC code of coding rate of 8/9, the loss in the required received SNR satisfying the low BER of 10^{-8} in the 3GPP PN model from that in the conventional single pole single zero PN model and the case without PN is only approximately 1.6 dB and 2.3 dB, respectively.

14:24 ***Performance of NR Downlink Initial Access Using Synchronization Signal Block for mm-Wave Bands***

Shun Yoneda and Mamoru Sawahashi (Tokyo City University, Japan); Satoshi Nagata (NTT DoCoMo, Inc., Japan)

This paper presents the performance of the NR downlink initial access including the physical-layer cell ID (PCID) detection, and demodulation and decoding of the physical broadcast channel (PBCH) payload using the synchronization signal block (SSB) in the millimeter-wave bands. Link-level simulation results show that the impact of the PSS detection error on the detection probabilities of the PCID and the PBCH demodulation reference signal (DMRS) sequence and thereby the detection error of the PBCH payload block is large. We also show that the residual carrier frequency offset (CFO) also affects the above-mentioned detection errors. Hence, the accurate CFO estimation method is necessary. Finally, we show that the correct radio frame timing detection probability of 90% is achieved at the average received SNR of approximately -2dB for the TDL-C channel model.

14:42 ***Double Deep Reinforcement Learning for UxV-Enabled Multi-User Communication Systems***

Silvirianti Silvirianti and Soo Young Shin (Kumoh National Institute of Technology, Korea (South))

This study proposes a double deep reinforcement learning (D-DRL) to improve an index of rate fairness and sum-rate in UxV-enabled multi-user communication systems. In this study, a UxV-assisted multi-user communications scenario is considered. By taking into account the tradeoff between the two objectives and the time-sequential movement of the UxV, two DRL-based actor-critic networks are integrated to solve the designated problem. In the first actor-critic network, the rate fairness is maximized by jointly optimizing a hybrid precoder with a UxV trajectory. Subsequently, considering the rate fairness as a learning reward of the first network, sum-rate is maximized in the second network under the consideration of transmission power budgets, limited UxV battery capacity, and quality of service (QoS) constraints. The results show that the D-DRL which considered rate fairness outperformed DRL which did not by achieving maximum rate fairness and a higher sum-rate.

Wednesday, November 22 13:30 - 15:00 (Australia/Sydney)

SS2/2: Emerging Technologies for B5G/6G Wireless Communication Systems

Room: Studio 3, Level 6

13:30 ***Bandwidth Enhancement of A Planar Monopole Antenna Using CMA-ES Optimizer for B5G/6G Applications***

Agus D. Prasetyo (Telkom University, Indonesia & Institut Teknologi Bandung, Indonesia); Hurianti Vidyaningtyas (Telkom University, Indonesia); Deny Hamdani and Achmad Munir (Institut Teknologi Bandung, Indonesia)

This paper presents the use of the covariance matrix adaptation evolution strategy (CMA-ES) optimizer in helping bandwidth enhancement on a planar monopole antenna. The antenna, whose patch shape is bounded by a spline curve formed from symmetrical cycles of 14 control knots, was initially oval. Using CMA-ES, each knot's position is then translated in the x-, y-, and its combined axis direction to get an improved bandwidth response due to changes in the patch shape resulting from the spline generation. By simulation, the shifting scenarios succeed in widening the antenna's bandwidth. Furthermore, the antenna with the best bandwidth response of the three scenarios is fabricated and validated through measurement. The simulation shows that the antenna works in the range of 2.9 to 20 GHz, with a geometrical bandwidth of 224.5%, while the measurement results show that the antenna works from 3.7 to 20 GHz or a geometrical bandwidth of 189.5%. The agreement between the simulation and measurement results makes the proposed antenna a good candidate for further development supporting B5G/6G applications.

13:48 ***Performance Evaluation of MIMO Channel Capacity Based on Polarization Loss Factor***

Trasma Yunita (Telkom University, Indonesia); Hartuti Mistialustina (Institut Teknologi Bandung, Indonesia); Imelda UV Simanjuntak (Universitas Mercu Buana, Indonesia & Institute Technology Bandung, Indonesia); Chairunnisa Chairunnisa (Institut Teknologi Bandung, Indonesia); Aloysius Adya Pramudita (Telkom University, Indonesia); Achmad Munir (Institut Teknologi Bandung, Indonesia)

This article will discuss the performance of MIMO channel capacity due to polarization mismatch in the receiver. The polarization of the electromagnetic wave sent by the transmitting antenna will change on the wireless channel, which is depolarization. When the electromagnetic wave reaches the receiving antenna, the polarization does not match the antenna's polarization, resulting in a polarization loss factor. The polarization loss factor will reduce the received power level. It will also affect the channel capacity of the system. In MIMO antennas, the depolarization effect does not only occur in one

element or one channel. This significantly reduces the received power based on the number of MIMO elements. The more antenna elements, the more the polarization loss factor affects the system's channel capacity. Therefore, it is necessary to know the effect of the polarization loss factor on the received power intensity at the receiver and the ability of the MIMO channel.

14:06 ***Construction of partially-doped generalized LDPC codes over regular LDPC codes***

Jaewha Kim (Electrical and Telecommunications Research Institute (ETRI), Korea (South)); Jae-Won Kim (Gyeongsang National University, Korea (South)); Jong-Seon No (Seoul National University, Korea (South))

In this paper, we propose a new code design technique for GLDPC codes which we call partial doping. The proposed partial doping technique enables higher degrees of freedom in constructing protograph-based GLDPC codes. We optimize the partially-doped generalized LDPC codes over the binary erasure channels and the finite length analysis shows that it outperforms the regular LDPC codes for both code rates 1/2 and 1/4.

14:24 ***Envelope Correlation Evaluation of MIMO Antenna with Guard Trace Structures***

Zulfi Zulfi (Telkom University, Indonesia); Joko Suryana (Institut Teknologi Bandung, Indonesia); Nachwan Mufti Adriansyah (Universitas Telkom, Indonesia); Achmad Munir (Institut Teknologi Bandung, Indonesia)

This contribution presents an evaluation of the performance of a MIMO antenna with a decoupling technique implemented using guard trace structures. Evaluation is performed by computing the envelope correlation coefficients of MIMO antennas using a scattering parameter approach, in which the scattering parameters of the MIMO antenna are used as input parameters. The scattering parameter data, which include reflection and transmission coefficients, are generated from simulations and measurements. For this purpose, a 2.4 GHz 2×2 MIMO antenna has been designed, realized, and tested. Evaluation results demonstrate the good performance of the MIMO antenna in terms of envelope correlation coefficient. The envelope correlation coefficients of the MIMO antennas are less than 0.01 within the 10-dB reflection coefficient bandwidth.

14:42 ***Advancements in Millimeter Wave MIMO Antenna Arrays for Enhanced 5G Connectivity***

Akram A Almohammedi (Karabük University, Turkey)

This study proposes an optimized MIMO antenna array design for 5G mm-wave communication systems that operates in the 38 GHz band. The design consists of two antenna arrays, each with four evenly spaced elements. The two arrays are assembled with a 90-degree shift, which provides improved performance in terms of gain, efficiency, and beamforming. The substrate is a Rogers RT5880 with a thickness of 0.254 mm and dielectric constants of 2.2 and a loss tangent of 0.0009, respectively. The proposed work combines the most desirable characteristics, including unique design, high gain, efficiency and wide operation of bandwidth. The proposed array antenna design offers a high efficiency up to 86.56% and high average gain up to 12.35 dBi for port-1 and port-2, resulting in attractive performance. The achievable bandwidth in the 38 GHz frequency band (37.5 - 38.4 GHz) is up to 927 MHz for port-1 and port-2. The return loss of our design is up to - 23.28 dB, which is still considered low loss for 38 GHz. The results obtained show that the antenna is a viable candidate for 5G applications at 38 GHz.

Wednesday, November 22 13:30 - 15:00 (Australia/Sydney)

ET4: Emerging Technologies, Applications, and Services Track

Room: Studio 4, Level 6

13:30 ***Software-Defined IoT with Machine Learning-Based Enhanced Security***

Ali Husnain, Chau Nguyen and Ngoc Thuy Le (University of Wollongong, Australia)

The widespread adoption of IoT devices has revolutionized multiple sectors, including healthcare, military, agriculture, and smart cities. This surge in IoT-generated data raises significant security concerns, necessitating efficient strategies for large-scale data analysis to safeguard IoT devices. Existing research has explored the fusion of Software-Defined Networking (SDN) and machine learning (ML), particularly flow-based monitoring, for intrusion detection. However, as IoT data volumes grow, challenges such as scalability, adaptability to new attack vectors, and resource-intensive monitoring persist. Our solution combines SD-IoT and ML to enhance IoT network security. By isolating virtual networks based on device characteristics, we improve intrusion detection efficiency and facilitate research on emerging threats. We present a real-world implementation, demonstrating a scalable and robust ML-based security for SD-IoT system.

13:48 ***Design and Implementation of IoT-enabled Intelligent Irrigation System Using Machine Learning***

Akram A Almohammedi (Karabük University, Turkey)

Water scarcity poses a significant challenge to sustainable cultivation, driven by geographical and environmental factors. Traditional irrigation systems fall short in effectively addressing water shortage. Precision agriculture offers a promising solution by optimizing production and minimizing water usage. This study introduces a smart irrigation system that incorporates essential parameters such as soil moisture, humidity, temperature, and wind speed. Additionally, a decision-making method based on collected sensor data is implemented in a microcontroller. Four classification algorithms are assessed using RStudio to determine the most accurate algorithm for the specific scenario. Experimental testing over a ten-day period reveals an irrigation water consumption of approximately 1 liter, with a relatively low detection speed of around 1 second, which can be attributed to using a small pot for testing purposes.

14:06 ***Predicting Traffic Accidents Severity using Collaborative ML on Blockchain***

Priyanshi Jain, Yashvi Ramanuj and Debasis Das (IIT Jodhpur, India)

With an increasing number of accidents and inefficient resources to inform authorities and hospitals quickly, there is a rise in the number of death cases because of traffic accidents. As per a report [9], in India, a total of 151,113 deaths have been reported in 480,652 traffic accidents in 2019, resulting in an average of 17 deaths per hour! As we continue to make progress towards building smart cities, the expectations to predict the anomalies such as traffic accidents also rise. In this paper, we have built a highly secure and increasingly accurate accident prediction system, which we believe brings us one step closer to Intelligent Transportation Systems. Our system runs a trained Machine Learning algorithm and can be updated by participants collaboratively, which makes it a system that can potentially achieve the highest accuracy following secure protocol. Besides, data breaches and changes in models' parameters are prevented with the use of blockchain. To avoid malicious participants, we have designed an astute incentive mechanism. To validate the claims and our system's performance, we have further used a dataset from the UK govt website with information about accidents, vehicles, and casualties. We have experimented with various machine learning models as participants of the system hosted on a blockchain

14:24 ***Edge-Centric Security Framework for Electric Vehicle Connectivity: A Deep Learning Approach***

Koustav Kumar Mondal (Indian Institute of Technology, Jodhpur, India); Divya Mahendia (Indian Institute of Technology Jodhpur, India); Debasis Das and Sumit Kalra (IIT Jodhpur, India)

As connectivity in electric vehicles (EVs) expands, so does their vulnerability to cyber threats within the Internet of Vehicles (IoV). This study introduces a potent Intrusion Detection System (IDS) that leverages distributed edge computing, Convolutional Neural Networks (CNNs), and ensemble techniques to address this concern in EV systems. Performance evaluations on reputable IoV security datasets have demonstrated this IDS's efficacy, delivering detection rates and F1-scores over 100%. These results affirm the system's potential to significantly enhance the cybersecurity of both internal and external vehicular networks in the context of connected EVs.

14:42 ***Performance analysis of FSO communication systems under different atmospheric conditions***

Maha Sliti and Mouna Garai (Communication Networks and Security Research Lab., Tunisia)

Free-Space Optical (FSO) communication has received a lot of interest as a last mile technology with several benefits, such as high data speeds, scalability, license-free spectrum usage, and ease of implementation. FSO offers effective data transfer using modulated laser beams by employing the atmosphere as its transmission medium, making it an appealing solution for a variety of applications. However, air interference can have a significant influence on the performance of FSO systems. In this study, we explore the impact of several weather factors on the performance of FSO communication systems, including Clear Air, Haze, Moderate Fog, and Heavy Fog. We examine the quality of received signals under various atmospheric conditions, taking into account critical aspects like transmission range, transmitted power, and data bit rates.

Wednesday, November 22 15:00 - 15:30 (Australia/Sydney)

Tea break

Level 6

Wednesday, November 22 15:30 - 16:24 (Australia/Sydney)

SS1/3: Ambient Intelligence for Smart City

Room: Studio 1, Level 6

15:30 ***Blockchain-Based Data Management System for Validation and Accuracy of Technical Data in Broadband N***

Sigit Anggraito (Researcher Telco Company & Telkom Indonesia, Indonesia); Rahman Parentio (Innovator & Telkom Indonesia, Indonesia); Ratih Ruffianti (Senior Expert & PT TELKOM INDONESIA, Indonesia); Baskoro Nugroho and Dian Hendrayana (PT. Telkom Indonesia, Indonesia); Arief Hamdani Gunawan (Telkom Indonesia, Indonesia)

Data integrity and accuracy in fiber-optic network management are crucial for Telkom as they directly relate to Telkom Group's core business. The extensive and widespread network infrastructure across Indonesia, coupled with its complex operations and aging infrastructure, necessitates the adoption of new technologies. Blockchain technology, with its inherent data integrity capabilities, can also serve as an intelligent software solution, particularly through smart contracts and the concept of Enterprise Blockchain 3.0. This research presents a prototype application named "Infrastructure Care Blockchain Application," featuring three main modular components: 1) Technical Data Accuracy and Integrity Module for Broadband Network, 2) Blockchain Reward & Punishment Module, and 3) Collaboration and Dispute Forum Module. These modules are built on the Hyperledger Besu blockchain platform and were validated through a Lab Usability Testing workshop in March 2023. The positive results from this workshop led to the decision to proceed with the Go-Live Production phase. Notably, the tokens

generated by this blockchain application can also be utilized as a new valuation metric for Telkom's future strategies, particularly the 5 Bold Moves Fixed Mobile Convergence initiative

15:48 ***Monitoring System Based on LoRa and IoT for BTS to Enhance 5G Network Efficiency in Smart Cities***

Muhammad Ary Murti (Telkom University, Indonesia); Leonardus Sandy Ade Putra and Eka Kusumawardhani (Universitas Tanjungpura, Indonesia)

Smart city development is a vision of the future that aims to increase efficiency and take advantage of the urban environment through technology. In this context, 5G technology has a crucial role, even though it requires sophisticated infrastructure, including additional BTS units. Monitoring systems using LoRa technology are important in managing BTS. This monitoring system provides significant benefits, including optimizing the energy consumption of base stations, early problem detection, quality of service improvement, and valuable information for network planning. Using LoRa for data transmission and IoT technology for sending data to cloud databases and monitoring websites enables real-time and accurate monitoring. The results showed that the monitoring system could track the real-time parameters of AC/DC voltage, current, and temperature in BTS. The placement of sensors on rectifier devices and room temperature monitoring has proven effective in maintaining the performance of BTS shelter equipment and environment.

16:06 ***Efficient and Accurate HD Map Generation for Unstructured Automated Valet Parking (UAVP) Environment***

Sung-Il Kim and Han-You Jeong (Pusan National University, Korea (South))

This paper proposes a new approach to detecting road boundary for generating high-definition (HD) maps of unstructured automated valet parking (UAVP) environments. The proposed framework presents a height moment tile to efficiently represent the height distribution of UAVP environments, a filtering scheme to remove both static and dynamic obstacles, a curb detection algorithm, and a road boundary expansion algorithm. Our approach is evaluated through experiments conducted at an outdoor parking lot in the Pusan National University. The results show that the proposed framework is able to detect accurate and efficient road boundary in UAVP environments.

Wednesday, November 22 15:30 - 16:42 (Australia/Sydney)

SS3: Image processsing for Communications

Room: Studio 3, Level 6

15:30 ***U-Net-based Chip Detection in CNC Machine***

Dong Seog Han and Hyojeong Seo (Kyungpook National University, Korea (South)); Sehoon Park (DN Solutions, Korea (South)); Min Jae Kang (DNsolutions, Korea (South))

Removing chips from machine tools is critical to maintaining the quality and integrity of the machining process. However, this procedure also presents significant issues, including resource waste and processing time delays, particularly when the use of cutting oil for chip removal is constant or when frequent human inspection is required. Chip detection methods using traditional image processing are limited due to their vulnerability to environmental factors such as low lighting and dust. To address these limitations, we propose an approach using U-Net for segmenting the areas where chips accumulate within machine tools. Further, we suggest an optimal backbone for chip detection by modifying the existing backbone of the U-Net model. Despite complex environmental factors, our

proposed method demonstrates robust segmentation performance showing its superiority over traditional image processing techniques.

15:48 ***An Uniformalized Quality Encoding in Cloud Transcoding System***

Jeong-mee Moon (SKBroadband, Korea (South)); Jaeil Kim (SK Telecom Co, Korea (South)); Taeseung Hwang, Dongwon Kim and SeongSoo Park (SK Telecom, Korea (South))

To provide video on demand (VOD) services to customers on IPTV or OTT, it is necessary to transcode the contents to suit the playback device and the user's viewing experience. This paper introduces a multi-pass quality control method designed to achieve consistent video quality when transcoding IPTV VOD content within a transcoding system specifically configured for cloud computing environments. We conduct performance testing by implementing this method as a commercial service, utilizing a parallel processing encoding workflow that is specifically optimized for cloud environments. The proposed method successfully achieves the required visual quality for each chunk, ensuring stable video quality across various types of content. Moreover, the encoding time is on average 1.21 times longer compared to a single pass of encoding.

16:06 ***Performance Characteristics of CS-Based Image Reconstruction on Microwave Imaging Using Horn Antenna***

Folin Oktafiani (Lembaga Ilmu Pengetahuan Indonesia, Indonesia); Budi Syihabuddin and Levy Olivia Nur (Telkom University, Indonesia); Effrina Hamid and Achmad Munir (Institut Teknologi Bandung, Indonesia)

This paper discusses the performance characteristics of image reconstruction based on compressive sensing method on microwave imaging using horn antennas. A tree trunk with a circular hole in the center is employed as a targeted object for the image reconstruction, and two quadridge horn antennas (QRHA) with dual polarization are used as a transmitter and a receiver on microwave imaging. The transmission coefficient of two antennas obtained from the data acquisition process are used for processing the image reconstruction. The selected method for image reconstruction is using compressive sensing which considers the variation in transmission signal strength. In order to carry out the process, the object of tree trunk is positioned between two antennas. A parallel beam setup recognizes the object with 72 projections produced by an angular rotation of 5 degrees for 360 degrees. Two transmission coefficient data are obtained by utilizing dual polarized feature of QRHA, namely vertical polarization and horizontal polarization. Here, the compressive sensing method is used to decrease the required number of data acquisition on microwave imaging. The result of image reconstruction obtained from the data acquisition is observed at several working frequencies of the antennas. It shows that the image of targeted object could be successfully reconstructed using compressive sensing method with variety on the image quality for different frequency observation.

16:24 ***Path Loss Models in Dense Urban Areas: A Study of Lagos Island, Nigeria***

Simon Karanja Hinga and Tokunbo Ogunfunmi (Santa Clara University, USA)

Path loss is a major factor affecting the performance of wireless networks in dense urban areas. This paper investigates the path loss models in Lagos Island, Nigeria, a dense urban area with high-rise buildings and high population density. This paper presents a detailed large-scale 3D ray-tracing investigation of the Lagos Island environment. Path loss analysis was conducted using the Close-In path loss model at 700 MHz for a TR/RX height of 20/2 m. The optimal path loss prediction model for the investigated environment was compared with existing empirical models, and the results show favorable agreement. The Close-in path loss model had a better prediction accuracy with an RMSE of 0.4331 dB, the ECC-33 path loss model achieved an accuracy with the least RMSE of 0.6743 dB. The EGLI path loss prediction model showed a pessimistic performance with the highest RMSE of 2.2496 dB, followed by Hata-Okumura with 1.9606 dB and COST-231 extension-to-Hata path loss model with 1.9399 dB. Network service providers can adapt the projected 4G LTE network path loss prediction

model to benchmark-related wireless propagation environments. The findings of this study are important for network service providers in Lagos Island and other dense urban areas. The study provides insights into the factors that affect path loss in these areas, and it can help network service providers optimize their transmit power and improve the performance of their wireless networks in areas where 5G is still in development and pilot trials like Nigeria and other parts of developing nations.

Wednesday, November 22 16:45 - 17:00 (Australia/Sydney)

Closing ceremony

Level 9