

Technical Program

Time	Room: Ibuka	Room: TELUS	Room: CTA
Friday, January 7			
09:00-09:30	AVS-I: AV Systems and Signal Processing (1)	CEA-I: Automotive Applications	IoT-I: Internet of Things (1)
09:40-10:10	AVS-II: AV Systems and Signal Processing (2)	CSH-I: Healthcare Consumer Systems (1)	IoT-II: Internet of Things (2)
10:20-10:50	AVS-III: AV Systems and Signal Processing (3)	CSH-II: Healthcare Consumer Systems (2)	IoT-III: Internet of Things (3)
11:00-11:30	O1: ICCE2022 Opening Ceremony		
11:30-12:00	K1: Keynote 1: Prof. Karlheinz Brandenburg		
12:00-12:30	K2: Keynote 2: CTA SVP Brian Markwalter		
12:30-14:00	IF15: Industry Forum Session 1: Career Advice for Students and Young Engineers		
14:00-15:30	IF04: Industry Forum Session 2: The Value of Consumer Digital Health Devices and their Data for Improving Individual Health and Public Health		

Saturday, January 8

08:00-08:50	BPP: Best Paper Presentation		
09:00-09:30	MDA-I: ML and DL in CE (1)	MDT-I: Mobile Device Technologies	WNT-I: Wireless Networks (1)
09:40-10:10	MDA-II: ML and DL in CE (2)	SMC-I: Smart Cities and 5G	WNT-II: Wireless Networks (2)
10:20-10:50	MDA-III: ML and DL in CE (3)	VAR-I: VR and AR	WNT-III: Wireless Networks (3)
11:00-11:30	K3: Keynote 3: Telus CDO Monty Hamilton		
11:30-12:00	T1: Tutorial 1 Q&A Session		
12:00-12:30	T2: Tutorial 2 Q&A Session		
12:30-14:00	IF09: Industry Forum Session 3: Evolution of Moore's Law for Consumer Electronics		
14:00-15:30	IF00: Industry Forum Session 4: Product Compliance in Consumer Technology		

Sunday, January 9

09:00-09:30	MDA-IV: ML and DL in CE (4)	SS-I: Technologies and Services for Private 5G/6G	HMI-I: Human-Machine Interaction
09:40-10:10	MDA-V: ML and DL in CE (5)	SS-II: Advanced Image and Signal Processing Technologies and Circuits Design for Smarter Systems	SPC-I: Security and Privacy
10:20-10:50	MDA-VI: ML and DL in CE (6)	CPE-SEA-I: Consumer Power and Sensor Systems	SPC-ENT-I: Security and Entertainment
11:00-12:00	A1: Awards Ceremony, (1) Ibuka Awards, (2) CTSoc Awards, (3) ICCE 2022 Award		
12:00-12:30	T3: Tutorial 3: Q&A Session		
12:30-14:00	IF05: Industry Forum Session 5: Leveraging Intelligent Digital Realities to Reconnect You - Always to the World		
14:00-15:30	IF04: Industry Forum Session 6: Current and Future Role/Impact of Consumer Technology During Pandemics Like COVID-19		

Friday, January 7

Friday, January 7 9:00 - 9:30 (America/New_York)

AVS-I: AV Systems and Signal Processing (1)

Room: Room: Ibuka

Chairs: Taewon Song (Soonchunhyang University, Korea (South)), Test User (Testing University, USA)

9:00 Creative Intent Based Ambient Compensation for HDR10+ Content Using Metadata

Dung Trung Vo, Chenguang Liu, McClain Nelson, Bill Mandel and Soojung Hyun (Samsung Research America, USA)

The paper proposes a high dynamic range (HDR) tone mastering system which dynamically corrects the picture quality based on creative intent metadata to preserve content providers' creative intent in different ambient light levels/ranges. Luminance percentile information based creative intent metadata is used to compensate for imagery degradation caused by ambient light. Multiple sections of tone mapping curves with multiple adjustment points along explicit Bezier curve is modified for better tone mapping curve control. Simulation results show that the proposed method can adapt to both ambient light levels and the scene content to keep the creative intent in different ambient conditions.

Presenter bio: Dung T. Vo received the B.S. and M.S. degrees from Ho Chi Minh City University of Technology, Vietnam, in 2002 and 2004, respectively, and the Ph.D. degree from the University of California at San Diego in 2009. He has been a Fellow of the Vietnam Education Foundation (VEF) since 2005 and has been on the teaching staff of Ho Chi Minh City University of Technology since 2002. He interned at Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA, and Thomson Corporate Research, Princeton, NJ, in the summers of 2007 and 2008, respectively. He is currently a staff research engineer at the Digital Media Solutions Lab, Samsung Information Systems America (Samsung Electronics US R&D Center), Irvine, CA, since 2009. His research interests are algorithms and applications for image and video coding and post-processing.

9:04 Black Level Compensation for TVs Using HDR Dynamic Metadata

Chenguang Liu, Dung Trung Vo, McClain Nelson, Bill Mandel and Soojung Hyun (Samsung Research America, USA)

This paper proposes a high dynamic range (HDR) tone mastering system which dynamically corrects the picture quality based on dynamic metadata in various black level conditions to preserve the content providers' creative intent. It permits compensating for the TV panel black level difference and preserving black and shadow details created by studios even though black levels vary across TV panels. The paper also describes a novel HDR image creative intent tuning system to match the content shown on target TV and reference TV. The results show that the proposed method can effectively compensate the black detail for different black levels.

Presenter bio: Dung T. Vo received the B.S. and M.S. degrees from Ho Chi Minh City University of Technology, Vietnam, in 2002 and 2004, respectively, and the Ph.D. degree from the University of California at San Diego in 2009. He has been a Fellow of the Vietnam Education Foundation (VEF) since 2005 and has been on the teaching staff of Ho Chi Minh City University of Technology since 2002. He interned at Mitsubishi Electric Research

Laboratories (MERL), Cambridge, MA, and Thomson Corporate Research, Princeton, NJ, in the summers of 2007 and 2008, respectively. He is currently a staff research engineer at the Digital Media Solutions Lab, Samsung Information Systems America (Samsung Electronics US R&D Center), Irvine, CA, since 2009. His research interests are algorithms and applications for image and video coding and post-processing.

9:08 Barcode Image Identification Based on Maximum a Posterior Probability

Dongwook Kim (Jeonju University, Korea (South))

This paper presents a new method robust to noise for vision-based barcode recognition. We propose an effective and stable barcode recognition technique based on the maximum a posterior probability of observation signals. For robust recognition of barcode image mixed with noise signals, first, the center and angle of the barcode area are extracted without rotation, and second, the barcode recognition techniques using the likelihoods based on multiple barcode scan lines is proposed. This proposed method shows superior performance as a result of its application to various barcode images.

Presenter bio: Dongwook Kim is a professor of the Jeonju University in South Korea. Research Interest Computer Vision, Machine Learning

9:12 Multi-Sensor Speech Enhancement Using In-Ear and Beamforming Signal Synthesis in TWS Voice Communication

Jae-Mo Yang (Samsung Electronics, Korea (South))

Although TWS earphones are flooded these days, most of them suffer from poor voice call quality. We propose a unified speech enhancement method utilizing multiple types of sensors including in-ear microphone and inertial sensor. The proposed method is composed of 4-steps: Beamforming, Robust voice activity detection with inertial sensor, In-ear signal enhancing, Synthesizing beamforming signal and enhanced in-ear signal. In order to further improve the speech quality, the inertial sensor which gets bone conducted vibration is used to extract speaker's voice activity information. The assessment result showed that the new approach outperforms the state-of-the-art commercial TWS earphones in the market.

9:17 Chunk Grouping Method for Low-Latency HTTP-Based Live Streaming

Daichi Hattori and Masaki Bandai (Sophia University, Japan)

Common media application Format (CMAF) provides low-latency HTTP-based live streaming. However, the conventional bandwidth prediction for adaptive bitrate streaming is inaccurate because download time is affected not only network bandwidth but also idle times between chunks in the same segment. The inaccurate bandwidth estimation decreases the viewer's quality of experience. In this paper, we propose a chunk grouping method for low latency HTTP based live streaming. The proposed method introduces the delayed transmissions of HTTP requests for grouping the first multiple chunks to accurately estimate bandwidth. From the result of the simulations, we show that the proposed method can obtain higher video quality without excessive degradation of re-buffering time, bit rate variation, and delay performances compared with the conventional CMAF.

9:21 Multi-Exposure Image Fusion Using Cross-Attention Mechanism

Byungnam Kim (University of Yonsei & LG Electronic, Korea (South)); Hyungjoo Jung (Korea Institute of Science and Technology (KIST), Korea (South)); Kwanghoon Sohn (Yonsei University, Korea (South))

Multi-exposure fusion (MEF) is a popular method for obtaining high dynamic range (HDR) image from

multiple low dynamic range (LDR) images. Even though recent works have employed the convolutional neural networks (CNNs) for solving the MEF problem, there still remain various challenges, such as color distortion and detail loss, due to a limited receptive field. In this paper, we present a cross-attention module for multi-exposure image fusion. Different from existing CNN-based methods that capture the contexts of the local region in the target image, our method adaptively aggregates local features with global dependencies as all positions. Furthermore, we propose a detail compensation module as the feature fusion for restoring the loss (color and detail) in the saturation region. Our proposed network performs a feature extraction with an encoder, a fusion of a cross-attention module and a detail compensation module, and the fused image is reconstructed by a decoder. Experimental results show that compared with the state-of-the-art methods, the proposed method can obtain better performance in both the subjective and objective evaluation, particularly in terms of color expression and detail-preserving.

9:25 *Highly Reliable Vehicle Detection Through CNN with Attention Mechanism*

Wan-Chi Siu, Li-Wen Wang, Xue-Fei Yang and Zhi-Song Liu (Hong Kong Polytechnic University, Hong Kong); Daniel Pak Kong Lun (The Hong Kong Polytechnic University, Hong Kong)

This paper presents a novel approach to provide reliable vehicle detection by using CNN-based approach and lane information. We firstly propose an adaptive RoI strategy that utilizes road lane information to give focus on frontal area for vehicle detection. Then we introduce a novel attention mechanism that automatically learns an attention map to refine the features for detection. Experimental results show a large improvement (+73% on recall rate) for long-range (30 to 60m) vehicle detection which is extremely useful for users of driving assistant systems.

CEA-I: Automotive Applications

Room: Room: TELUS

Chair: Bernard Fong (Providence University, Taiwan)

9:00 *Zero-Knowledge Proof for Enabling Privacy Preserving Electronic Toll Collection with Vehicle-To-Everything Communications*

Jordan McEntyre and Billy Kihei (Kennesaw State University, USA)

ETC systems today use technology that can be exploited to track toll users. This work develops a GPS-free toll collection that uses a zero-knowledge proof to verify V2X On-board units (OBU) in a way that prioritizes security and privacy while accommodating resource limitations of the embedded technology. Our privacy preserving ETC protocol consists of three parts: a mutual authentication handshake, a zero-knowledge proof challenge, and a verification for toll-payment processing. Bench analysis evaluates embedded systems' limitations of algorithmic operations, and field tests of challenges are conducted in a real-life scenario to show proof-of-concept among V2X interference.

9:03 *Mobility-As-A-Service Trials in Japan: Initial Result from a National Project*

Yen Tran (AIST, Japan); Naohisa Hashimoto (National Institute of Advanced Industrial Science and Technology, Japan)

Mobility-as-a-Service (MaaS) is an emerging trend in transport field worldwide. This paper reports the implementation of 16 MaaS trials in Japan, as part of a national initiative towards advancing MaaS.

Some new mobility services were implemented in these trials, such as on-demand taxi combined with a delivery service, and mobile sales acting as portable small-scaled stores. The initial results confirmed MaaS feasibility in terms of the user's satisfactions and changed behaviors. This result formed a basis for further utilizations of MaaS in eliminating mobility-related problems, particularly for the elderly people without car access and living in rural/mountainous areas.

9:06 IO Virtualization for Real Time Automotive Systems

Sriramakrishnan Govindarajan (Texas Instruments India Pvt. Ltd., India); Mihir N Mody (Texas Instruments, India); Gregory Shurtz and Chuck Fuoco (Texas Instruments, USA); Kedar Chitnis (Texas Instruments India Pvt. Ltd., India); Nikhil Devshatwar (Texas Instruments, India); Donald E Steiss, Jonathan E Bergsagel and Jason Jones (Texas Instruments, USA); Prithvi Shankar Y A (Texas Instruments, India)

Virtualization is common in enterprise systems to isolate multiple server applications using the same underlying HW. In automotive systems virtualization is fast becoming table stakes to isolate safety applications like ADAS (Advanced Driver Assist System) and infotainment using the same underlying SOC. This presents unique challenges related to peripheral IO virtualization, not seen in enterprise systems, like deterministic latency to external memory (< 5 cycles) and high data throughput (6-10GB/s for real-time camera's and display's. Traditional approach to peripheral virtualization involves usage of a centralized IOMMU using 2-level page table with a table walk through, which make the scheme non-deterministic and lower throughput. This paper proposes a automotive friendly approach to peripheral IO virtualization, using multiple innovations like, HW engine for level 1 deterministic scatter-gather operation via Peripheral Address Translation (PAT) unit, level 2 virtual machine context aware translation via Peripheral Virtualization Unit (PVU), and ability for these schemes to co-exists with tradition IOMMU schemes for non-real time traffic. The proposed virtualization system is implemented on the Jacinto 7 platform to virtualize a multi-camera ADAS system with multimedia infotainment application to give deterministic peripheral IO address translation latency of 2 cycles per transaction and system data throughput of 8 GB/s.

9:09 Contact Accident Prevention System Around Snowplows Utilizing LiDAR and Machine Learning Technologies

Kohei Omachi and Hiroshi Yamamoto (Ritsumeikan University, Japan); Yoshinori Kitatsuji (KDDI R&D Laboratories Inc., Japan)

In heavy snowfall areas, the snow removal work by snowplows plays a significant role in securing transportation for local residents. However, there are many pedestrians and cars approaching the snowplows unintentionally, and the snowplow operators should pay attention to avoid the contact accidents with them, which reduces the efficiency of the snow removal work. As a result, it takes a long time to clean the road to keep the safe and secure life of local residents. Therefore, in this study, we develop a new contact accident prevention system around snowplows that detects pedestrians and cars approaching snowplows and notifies the snowplow operator in real-time. In this system, the sensor node installed on the snowplow analyzes the 3D point cloud data obtained by the LiDAR (Light Detection and Ranging) to detect the existence of the pedestrians/cars around the snowplow and notifies the snowplow operator of the results in real-time. In addition, the proposed system adopts the system structure of edge computing so that the system can be used in environments where high-speed mobile communications are not available (e.g., mountainous areas) and the system cannot leverage computing resources on the Internet. Furthermore, a machine learning method is utilized for quickly detecting pedestrians and cars with high accuracy from the 3D point cloud data obtained by the LiDAR.

9:13 AUTOHAL: An Exploration Platform for Ranging Sensor Attacks on Automotive Systems

Bhagawat Baanav Yedla Ravi, Md Rafiul Kabir, Neha Mishra, Srivalli Boddupalli and Sandip Ray (University of Florida, USA)

Security is a critical concern in the emergent era of autonomous vehicles. Nevertheless, security challenges in automotive systems are not well-understood except by a small set of selected experts. In this paper, we address this problem by developing a novel, flexible exploration platform for automotive security. Our framework, AutoHaL enables the user to get a hands-on understanding of security compromises. We discuss the unique challenges and requirements in the design of such an exploration platform. We discuss the use of the platform in exploring automotive ranging sensor attacks.

9:16 Abnormal Condition Detection System Based on Sensing / Analysis of Snow Removal Operations

Kenya Sugimoto and Hiroshi Yamamoto (Ritsumeikan University, Japan); Yoshinori Kitatsuji (KDDI R&D Laboratories Inc., Japan)

Snow removal operations by snowplows play an important role for securing social activities and transportation of local residents in snowy and cold regions in Japan. However, there are situations where the operation must be suspended due to the heavy traffic of cars and pedestrians even at night. In order to improve the efficiency of the snow removal operations, it is necessary to take measures by identifying the areas where such situations are likely to occur. Therefore, in our study, we propose a new system which detects occurrence of the condition where the snow removal operation changes to the abnormal state. The proposed system uses several cameras to observe the motion of the operator to steer the snowplow. In addition, we propose a method to identify the date, time, and location that the motions of the snow removal operations are much different from the usual ones by analyzing the time-series data of the motion to steer. In our study, the proposed system is deployed in the snowplow managed by Hakuba Village of Nagano Prefecture, Japan to observe the maneuvering behavior of the snow removal operator and we evaluate the effectiveness of the proposed method for estimating abnormal conditions during snow removal operations.

9:19 Detection of Cyclists' Crossing Intentions for Autonomous Vehicles

Arief Dharmawan Abadi, Yanlei Gu and Igor Goncharenko (Ritsumeikan University, Japan); Shunsuke Kamijo (The University of Tokyo, Japan)

Improving the safety of bicycle riders is one of the critical issues for Autonomous Driving. The crossing intention of the cyclist is expected to be predicted from the onboard camera of autonomous vehicle. In a real traffic situation, a cyclist usually turns his or her head to check the situation of the back of him or her before he or she crosses the road. Therefore, the action of turning head is an important signal to indicate the intention of crossing a road. This paper proposes to detect the behavior of the turning head based on the body and head orientation using deep neural networks. The proposed system firstly detects the cyclists and extracts the area of the cyclist based on a segmentation neural network. After that, the image of each cyclist is processed by a pose estimation neural network to detect each joint of the cyclist. Finally, the segmented area of the cyclist and the heatmap of each joint of the cyclist are imported into a classification neural network to estimate the body and head orientation, and further predict the crossing intention of the cyclist. A series of experiments have been performed and the experimental results show that the proposed system has a satisfactory performance compared to the conventional method.

9:23 A Local Interconnect Network Controller for Resource-Constrained Automotive Devices

Kwonneung Cho, Hyun Woo Oh, Jeongeun Kim, Young Woo Jeong and Seung Eun Lee (Seoul National University of Science and Technology, Korea (South))

As the amount of data for automotive systems is increased, a dedicated communication controller for in-vehicle networks is required. This paper proposes a local interconnect network (LIN) controller for resource-constrained devices. The designed LIN controller efficiently reduces the workload of target devices by processing the LIN frame header, data response, and protocol errors. To demonstrate the feasibility of design, a Cortex-M0 is employed as a main processor and connected to the LIN controller. We implemented a LIN node by programming the processor, and the functionality of LIN controller was verified with a LIN frame analyzer and hardware scope. In addition, we analyzed the affection of communication loads on the processor and evaluated the benefits of LIN controller.

9:26 PEM Fuel Cell Design Simulation for Electric Vehicles Using Artificial Neural Networks

Amira Y. Mohamed (Chungbuk National University & Mechanical Engineering, Korea (South)); Hatem H.M kamal Ibrahim and Kibum Kim, N/A (Chungbuk National University, Korea (South))

The recent research on fuel cell design has shown the effectiveness of the simulation tools on saving time and money, so we propose a fuel cell design method using artificial neural networks (ANN) for the proton exchange membrane which is the most common and commercially used fuel cell type. We train an artificial neural network on previously performed fuel cell design experiments proposed in another research as a dataset, then we test the trained model by simulating the output power density that can be obtained from user input design data. The used dataset employs commonly used cathode, anode, and membrane types which allows the simulation process using the same materials which are commercially available. We show that the software simulation process using ANN is so beneficial and can produce accurate simulation results imitating the real-world design data.

Presenter bio: I am a master's student at the department of mechanical engineering, the school of Engineering, Chungbuk National University. I am currently performing a research on the proton exchange membrane (PEM) water electrolysis using machine learning.

IoT-I: Internet of Things (1)

Room: Room: CTA

Chair: Hung-Wei Wu (Feng Chia University, Taiwan)

9:00 Efficient Coefficient Bit-Width Reduction Method for Ising Machines

Yuta Yachi, Yosuke Mukasa, Masashi Tawada and Nozomu Togawa (Waseda University, Japan)

Ising machines such as quantum annealing machines can solve various combinatorial optimization problems very efficiently by transforming it into an Ising model. At that time, its coefficient bit-widths have to be kept within the range that an Ising machine can deal with. This paper proposes an effective

method for reducing Ising-model bit-widths. Without adding too many extra spins, we efficiently reduce the coefficient bit-widths of the original Ising model. Furthermore, the ground state before and after reducing the coefficient bit-widths is not much changed in most of the practical cases. Experimental evaluations demonstrate the effectiveness of the proposed method.

9:03 *The Convergence System of an IoT Standard Service Platform and an Autonomous Drone*

Seungwoon Lee and Byeong-hee Roh (Ajou University, Korea (South)); Sj Kim (University of Nevada, Las Vegas, USA)

IoT and drones have been merged rapidly for their respective fields, and their convergence is expected to create high added-value applications in near future. In this paper, we introduce a novel of integrating an IoT with a drone to provide converged services of well-known an IoT open standard and an autonomous drone. The paper explains the role of a drone in an IoT according to related work and demonstrates our convergence system architecture. A prototype and its validation are provided.

9:07 *QUBO Matrix Distorting Method for Consumer Applications*

Tomokazu Yoshimura, Tatsuhiko Shirai, Masashi Tawada and Nozomu Togawa (Waseda University, Japan)

We propose a Quadratic Unconstrained Binary Optimization (QUBO) matrix distorting method to solve combinatorial optimization problems, which are very often seen in consumer applications, with high speed and high accuracy. Combinatorial optimization problems are formulated as the problems of finding the ground state of the energy function determined by the QUBO matrix. The proposed method consists of the local optimization and the distortion of the energy function by adding a constant to each QUBO matrix element with a certain probability. The probability is initially large, decreased during the method linearly, and zero at the end. The distortion process aims to make a local optimal solution to be no longer a local optimum and avoid staying in the local optimal solution with a probability. We apply the proposed method to the graph partitioning problem as a typical combinatorial optimization problem with many local optimal solutions and large energy barriers among them. We verify the effectiveness of the proposed method against the iterative improvement method and the simulated annealing.

9:11 *A Study of Ventilation Guidance Function in Air-Conditioning Guidance System*

Masaki Sakagami, Nobuo Funabiki and Yuan-Zhi Huo (Okayama University, Japan); Kazuyuki Kojima (Shonan Institute of Technology, Japan); Wen-Chung Kao (National Taiwan Normal University, Taiwan)

Previously, we have studied the air-conditioning guidance system (AC-Guide) to optimize the use of AC in the room using the indoor/outdoor discomfort index. Currently, the epidemic of COVID-19 is spreading around the world, and the ventilation of the room becomes critical to avoid the infection, which should be properly guided together. In this paper, we study the ventilation guidance function using the measured CO₂ density in AC-Guide. The opening/closing state of the door and window is automatically detected using the web camera, where the image processing procedures are newly implemented. Experiment results in an Okayama University building confirm the effectiveness.

9:15 *WebRTC-Based Resource Offloading in Smart Home Environments*

Hunseop Jeong, Taehyung Lee and Young Ik Eom (Sungkyunkwan University, Korea)

(South))

Web platforms face new demands for emerging applications, which use machine learning models. These models require significant computing powers in processing enormous inputs such as images for machine learning computation. Unfortunately, smart home appliances do not generally have built-in input devices due to privacy issues and have limited performance compared to mobile devices. This paper proposes a WebRTC-based resource offloading system for web applications, which allows smart home appliances to use resources of nearby mobile devices. Our system was able to run machine learning models on smart home appliances without an attached camera, and achieved up to 1.5x speedup.

9:19 Proposal of a Web of Things Integration Pattern on the Edge-Cloud

Environment

Yoshiyuki Masuda (Daikin Industries, Ltd., Japan); Shinji Shimojo (5-1 Mihogaoka & Osaka University, Japan); Matsuki Yamamoto (Osaka University, Japan)

In this paper, we propose a new architecture to connect various devices in the building to the edge-cloud environment along with Web of Things (WoT) standard proposed by W3C. To cope with the current situation where most IoT devices are connected to their proprietary cloud services and their integration is performed only in the inter-cloud environment, we introduce an intermediary that can span from cloud to the edge and set up a virtual thing so that the integration can be made according to the WOT model. We evaluate POC implementation with small overhead.

9:22 Detecting Hardcoded Login Information from User Input

Yoda Minami, Shuji Sakuraba, Yuichi Sei, Yasuyuki Tahara and Akihiko Ohsuga (The University of Electro-Communications, Japan)

The OWASP 2018 reported that the most common IoT vulnerability is the "weak, guessable, or hardcoded passwords" and the vulnerability has still reported in 2020. In this study, we proposed a method to detect the login information in IoT devices using a static analysis and focus on the user input value. To the best of our knowledge, our method is the first method focusing on the user input. We measured the ability of the method by searching six real-world firmware containing login information. The results showed that the method found the target within a smaller candidate list than previous study.

9:26 An AI Edge Computing-Based Robotic Arm Automated Guided Vehicle System for Harvesting Pitaya

Xiang-Rui Huang, Wei-Han Chen, Wu-Chih Hu and Liang-Bi Chen (National Penghu University of Science and Technology, Taiwan)

This paper proposes an intelligent agricultural robotic arm automated guided vehicle (AGV) system, which is based on AI edge computing for harvesting pitaya. The proposed system is used to detect the growth of pitaya fruit in the natural environment. The proposed system uses computer vision technology to recognize the position of the ripe pitaya fruit in real-time. The robotic arm can grasp the pitaya accurately. Furthermore, the YOLO v3-tiny model is adopted to analyze mature and unripe pitaya. Since the color of the immature fruit and the stem are similar, it produces high variability detection, which brings some challenges in this work.

Friday, January 7 9:40 - 10:10 (America/New_York)

AVS-II: AV Systems and Signal Processing (2)

Room: Room: Ibuka

Chair: Akihiko K. Sugiyama (Yahoo Japan Corporation, Japan)

9:40 Adaptive Bits Selection for DRM Application on High-Quality Audio

Seonghwan Kim (Samsung Electronics, Korea (South)); Jungwon Moon (KAIST University & Samsung Electronics, Korea (South))

Consumption of lossless audio sources such as FLAC is on the rise as rapid increase in the Internet access speed and people's demand for high-quality audio. In addition to this, consumption of MQS (Mastering Quality Sound) sources such as 24bit and 192KHz audio format has been increasing recently. In order to prevent illegally-sharing audio contents with copyrights, DRM technology has been widely used. However, the large file size of MQS quality audio format makes an increase the amount of computation and time taken for decryption when conventional DRM (Digital Rights Management) is applied. This paper presents an effective DRM model that allows for low-quality preview and minimizes battery drain on mobile devices. The proposed method has the advantage of providing the constant audio quality at low-quality pre-listening. This model has been implemented on the Android platform to evaluate its usability and effectiveness.

9:43 Frame Rate Up-Conversion for HDR Video Using Dual Exposure Camera

Hak-Hun Choi, Jae-Won Kim and Ho-Nam Lee (Samsung Electronics, Korea (South))

In this paper, we propose a new frame rate up-conversion (FRUC) for HDR video using a dual exposure camera that captures alternating frames with two different exposure levels (short and long). First, optical flows are estimated in the proposed convolutional neural network (CNN)-based motion estimation (ME) analyzing dual-exposed frames. Then, with the estimated true motions and motion occlusion maps, an HDR frame is interpolated while suppressing ghost artifacts caused by HDR fusion. Finally, FRUC is performed by re-using motions and occlusion maps. Experimental results indicate that the proposed method is effective to eliminate ghost artifacts and increase frame rate at the same time.

9:47 End-To-End Speech to Braille Translation in Japanese

Akio Kobayashi and Junji Onishi (Tsukuba University of Technology, Japan);
Hiromitsu Nishizaki (University of Yamanashi, Japan); Norihide Kitaoka (Toyohashi University of Technology, Japan)

This study addresses an end-to-end braille translation approach from Japanese speech for the deaf-blind. In Japan, automatic Braille translation from spoken language is expected to improve information accessibility for deaf-blind people. Japanese Braille has a high affinity for automatic speech recognition (ASR) because it primarily comprises hiragana characters (kana) reflecting Japanese phonetic features. Therefore, we attempted to use neural networks to translate Japanese Braille directly from speech in an end-to-end (E2E) manner. We also compared our proposed E2E approach with an existing method that combines the ASR and automatic Braille translation.

9:51 *Frame Attention Recurrent Back-Projection Network for Accurate Video Super-Resolution*

So Sasatani (University of Ritsumeikan, Japan); Yutaro Iwamoto and Yen-Wei Chen (Ritsumeikan University, Japan)

In this study, we aim to recover high-resolution (HR) images from multiple low-resolution images using a multi-frame super-resolution (SR) or video SR to increase the resolution of surveillance camera images. The challenge of the multi-frame method is the high-precision alignment between frames, and many techniques have been proposed recently to solve it using convolutional networks, e.g., in the state-of-the-art method (i.e., recurrent back-projection network), the residuals between frames are calculated as subtle changes in the frames and back-projected onto the input image to achieve HR, including alignment. However, since the method uniformly concatenates multiple HR feature maps generated between each frame, it is impossible to focus on extracting important features for HR. Therefore, this study proposes a frame attention recurrent back-projection network for accurate video SR by emphasizing the essential frame features.

9:55 *Scale Recurrent Network for Single Image Dehazing*

Wataru Imai, Yosuke Ueki and Masaaki Ikehara (Keio University, Japan)

The quality of the images taken outside is directly affected by floating atmospheric particles. To keep the quality of the image, haze removal methods play a critical role. In this paper, we propose a new multi-scale network structure that is rarely used in haze removal and a new loss function to generate high-quality haze-free images. Despite a number of proposed dehazing methods, they are not able to capture the haze accurately without being confused by other objects that are similar in color to haze and completely remove the haze throughout the image. Our proposed network architecture takes the Scale Recurrent Network structure [1] and we incorporate dilated convolution to catch the more global features like haze with the wide receptive field. Additionally, we train our network with a new loss function using dark channel prior [2] to more effectively learn the haze features. Compared with state-of-the-art methods, our proposed method achieves better results on both synthetic and real-world images.

9:59 *Single and Double Element Dynamic Programming Algorithm for Melody Matching*

Ping-Hung Chen and Jian-Jiun Ding (National Taiwan University, Taiwan)

Dynamic programming (DP) is an effective algorithm to determine the similarity between two sequences. It plays an important role in text comparison, nucleotide sequence alignment, and melody matching. Conventional DP method performs element-to-element or element-to-space comparison and considers only the cases of replacement, deletion, and insertion. In this work, we improve the DP method by performing multiple element comparison. That is, in addition to perform element-wise comparison, we also compare the similarities of element-space to element and space-element to element. Moreover, the global similarity is also adopted to improve the accuracy of DP. Experiments show that, with the proposed algorithm, the accuracy of melody matching can be much improved. It is helpful for improving the performance of the query-by-humming system and applicable to other sequence comparison problems.

10:02 *Graph Signal Processing and Applications: A Survey*

William C. da Rosa (Universidade Federal do Amazonas, Brazil); Pierre Vilar Dantas (Universidade Federal do Amazonas - UFAM, Brazil); Waldir Silva (Universidade

Federal do Amazonas, Brazil); Celso Carvalho (Federal University of Amazonas, Brazil)

Graph signal processing (GSP) is a field of research with many potential applications, specially in signals with irregular structures. Graphs are structures that represent irregular data attributes. Signal processing approaches mainly focus on analyzing the underlying data. Given the increasing availability of multisensor and multinode measurements, recorded in irregular grids, it can be extremely advantageous to analyze data structured as "signals on graphs". In this paper, we present a survey on applications and methods to solve problems in different areas of digital signal processing applying GSP.

10:06 Robust Noise Canceller Algorithm with SNR-Based Stepsize Control and Gain Adjustment

Akihiko K. Sugiyama (Yahoo Japan Corporation, Japan)

This paper proposes a robust noise canceller algorithm with SNR-based stepsize control and gain adjustment. Use of estimated SNRs for stepsize control reduces interference by the target signal in adaptation. A second SNR estimate, which is the output over an adjusted reference input, initially controls the stepsize to promote coefficient growth, followed by a first SNR estimate which is the output over the noise replica. Changeover from the second to the first SNR estimate takes place when the coefficient growth is saturated. The power gap between the reference input and the noise to be cancelled is adjusted by a factor estimated during an initial period. Evaluations with clean speech and noise recorded at a busy station demonstrate that the coefficient error by the proposed algorithm is as much as 8 dB smaller than that without gain adjustment whereas conventional algorithms exhibit initial increase in the coefficient error and never reach the switchover status at a high SNR.

Presenter bio: He is a Fellow of IEEE and has been active in the field of audio and acoustic signal processing. He had been deeply involved in MPEG-1, -2, -2/AAC, and -4 standardization activities. His team developed the world's first full-solidstate audio player, the Silicon Audio, that is a precursor of iPod, in 1994. He discovered the nonuniqueness problem in stereo echo cancellation in 1990. He was an associate editor of IEEE Trans. Sig. Proc. (1994-1996), a Secretary and Member-at-Large of the Conf. Board, IEEE Sig. Proc. Society (2009-2010), the Chair of the Japan Chapter, IEEE Sig. Proc. Society (2009-2010), Tech. Prog. Chair for ICASSP2012, the Chair of Audio and Acoustic Signal Processing Technical Committee, IEEE Sig. Proc. Society (2011-2012), a Distinguished Lecturer, IEEE Sig. Proc. Society (2014-2015), a Distinguished Lecturer, IEEE Consumer Elec. Society (2017-2018), and is a Distinguished Industry Speaker, IEEE Sig. Proc. Society and a member of the IEEE Fellow Committee.

CSH-I: Healthcare Consumer Systems (1)

Room: Room: TELUS

Chair: Pham The Bao (Sai Gon University, Vietnam)

9:40 An Ontology of Medical Wearables

Lorenzo De Lauretis (UNIVAQ, Italy); Stefania Costantini (University of L'Aquila, Italy); Enrico Pallotta and Clara Balsano (Univaq, Italy)

Nowadays, wearable devices are rapidly conquering the market, and there are wearables for a lot of types of activities. In the medical field, a lot of devices are invading the market, day by day. Our work focuses on the creation of an ontology that will help in the description and classification of the main wearable medical devices. In our ontology, medical wearables are classified following characteristics such as battery life, diseases and symptoms monitored, the presence of an integrated actuator, and so on. To make our work more complete and expandable, we integrated our ontology with an external medical ontology called

DOID, linking the wearable to DOID symptoms and diseases.

9:44 Design and Implementation of a Smart Air Quality Monitoring and Purifying System for the School Environment

Hyuntae Cho (Tongmyong University, Korea (South)); Yunju Baek (Pusan National University, Korea (South))

This study proposed a smart air quality monitoring and purifying system for the school environment. The system consists of an outdoor air quality monitoring system, indoor air purifiers, and a server program running on PC. The proposed system allows teachers and students to choose when to use the air purifier or natural ventilation by comparing outdoor air quality and indoor air quality. In addition, the proposed air purifier system includes an intelligent operation that controls the speed of the fan and blower to make sure it does not generate noise that interfere with students in class.

9:48 Big Data Edge on Consumer Devices for Precision Medicine

Kiirthanaa Gangadharan and Qingxue Zhang (Purdue University School of Engineering and Technology, Indianapolis, USA)

Consumer electronics like smartphones and wearable computers are furthering precision medicine significantly, through capturing/leveraging big data on the edge towards real-time, interactive healthcare applications. Here we propose a big data edge platform that can, not only capture/manage different biomedical dynamics, but also enable real-time visualization of big data. The big data can also be uploaded to cloud for long-term management. The system has been evaluated on the real-world biomechanical data-based application, and demonstrated its effectiveness on big data management and interactive visualization. This study is expected to greatly advance big data-driven precision medicine applications.

Presenter bio: Dr. Zhang has shaped his career with multidisciplinary expertise in AI, Wearable Monitor, Precision Medicine, and Industry. He spent six years in industry and afterwards worked at Harvard Medical School. He started the faculty position and directing the Ubiquitous Embedded Intelligence Lab from 2018, in Purdue University School of Engineering and Technology, Indianapolis. Dr. Zhang received NSF CAREER Award in 2021 - the most prestigious award in NSF. He serves as NSF panelist, IEEE Workshop Chairs, IEEE Access AE and Special Issue Leading editors. He owns 7 commercialized patents.

9:52 Video-Based Oxygen Saturation Measurement

Thomas Pursche, Roland Clauß, Bernd Tibken and Moeller (University of Wuppertal, Germany)

For a comprehensive overview of a persons's health status oxygen saturation and respiratory frequency is needed beside heart rate. As presented in [1,2] a contact free heart-rate measurement based on photoplethysmography is capable to achieve great results compared to gold standards like electro cardiogram. From this starting point the adoption of the well established technique is obvious. Therefore our goal is to present a method of oxygen saturation measurement based on the technique of photoplethysmography in this paper. By using the well established technique presented in [1,3,4] we are able to achieve a comparative high accuracy within the same framework.

Presenter bio: He received his B.S., M.S. degrees from Wuppertal University, Germany, in 2013 and 2014, respectively. He received his PhD. Degree from Wuppertal University in 2019. His research interests include control theory, system identification and computer vision.

9:57 Gait Analysis: Head Vertical Movement Leads to Lower Limb Joint Angle Movements

Tong-Hun Hwang (Leibniz University Hannover & Institute of Sports Science, Germany); Alfred Effenberg (Leibniz Universität Hannover, Germany)

Supported by the increasing number of head-worn devices, such as earbuds and smart glasses, research on gait analysis using head-worn sensors has been emerged. These head-worn sensor solutions can analyze natural gait patterns in daily life at lower costs. However, these approaches are limited to spatial-temporal gait parameters, and it is so far impossible to measure joint angle movements of the lower body because angles are normally measured by at least two sensors. It is necessary to scrutinize the relationship between the head and the lower body joint to overcome the limitation. Thus, in this paper, the causality between head vertical movement and lower limb joint angle movement was estimated using transfer entropy during walking. In total, 12 participants' gait patterns were analyzed. Strikingly, the transfer entropy direction of the head movements to the joint angle movements is dominant. The strongest causal relationship was formulated between the head and hip. This finding can lay the groundwork for simple secondary measurement of joint problems using simple head-worn sensors.

Presenter bio: Tong-Hun Hwang (S'18) was born in Anyang, Korea, in 1982. He received the B.S. degree in electrical and computer engineering from the Hanyang University, Seoul, Korea, in 2008 and the M.S. degree in electronics and computer engineering from the same university in 2010. From 2010 to 2013, he joined Multimedia Platform Group of the System LSI Division in Samsung Electronics. Since 2015, he is a research assistant with the Institute of Sport Sciences, Leibniz University Hannover, Germany. In 2020, he received PhD degree in the Institute of Microelectronic Systems at the same university. He is currently a postDoc fellow in the institute of Sports Science. His research interest includes socializing sensorimotor contingency, human-human interaction, human-robot interaction, health monitoring systems and home-based rehabilitation.

10:01 Seat-Driven Sit-To-Stand Assistance System Using EMG for Movement Prediction

Tsuyoshi Inoue (Osaka Institute of Technology, Japan)

We developed an assistive system that predicts Sit-to-stand (STS) movement in real time using the measurement results of trunk angle changes and lower limb muscle activities. We conducted an evaluation experiment to verify the effectiveness of the system. In the experiment, we measured the muscle activity when the system was driven at three different speeds, to confirm the change in the support effect depending upon the driving speed of the system. The results confirmed that the muscle activity decreased at all driving speeds when this system was used, compared to the unassisted STS movement.

10:05 Health Monitoring in a Smart Home Environment

Cristinel Gavrila and Vlad Popescu (Transilvania University of Brasov, Romania); Roberto Girau (University of Bologna, Italy); Mariella Sole (University of Cagliari, Italy); Mauro Fadda (University of Sassari, Italy); Matteo Anedda and Daniel D Giusto (University of Cagliari, Italy)

In the Home Environment context, the TV set has regained its place in the past few years, together with the Smart Home (SH) concept. In this very dynamic framework, the use of health monitoring devices combined with typical SH appliances and the TV set could allow the entire home environment to monitor the consumer's health status. This paper presents an initial architecture integrating health monitoring devices within the SH environment through a HbbTV - enabled TV set.

Presenter bio: Vlad Popescu received the M.Sc. degree in Electronic and Computer Engineering in 1999 and the PhD degree in Telecommunications in 2006, both from the Transilvania University of Brasov / Romania. In 2001 / 2002 he spent one year as a research fellow at the Technical University in Aachen (RWTH) / Germany. In 2004 / 2005 he returned to Aachen at the same University to finish his PhD studies with a DAAD Scholarship. At present, he is an associated professor at the Dept. of Electronics and Computers, Transilvania University of Brasov and a visiting professor at the Dept. of Electrical and Electronic Engineering, University of Cagliari. His main research topics of interest are telecommunications, multimedia, SDR, IoT, multisensorial media.

IoT-II: Internet of Things (2)

Room: Room: CTA

Chair: Srinivas Katkoori (University of South Florida, USA)

9:40 Identity Relationship Management for Internet of Things: A Case Study

Mohammad M Nur (Dakota State University, Amazon Web Services); Yong Wang (Dakota State University, Madison, SD, USA)

This paper presents an Identity Relationship Management framework for Internet of Things (IoT). The framework overcomes the limitations observed in traditional IAM systems with IoT by providing a perimeter-less, Internet scale, modular, dynamic and high velocity access control solution based on relationships among users, organizations and devices. To demonstrate how the framework can be used for access management in the IoT, a use case in healthcare is presented. Moreover, we implement the proposed framework by adapting User Managed Access 2.0 protocol and demonstrate the benefit of integration of IRM with existing IAM technologies. IRM is promising for identity and access management for the IoT. However, a use case of IRM is missing in the literature and this paper presents the use case where relationships are essential for identity and access management in the IoT.

Presenter bio: Mohammad Muntasir Nur was born in Dhaka, Bangladesh, in 1979. He earned his Ph.D. in Cyber Operations from Dakota State University, USA, in 2021, and BS/MS degrees in Computer Science from Minnesota State University, USA, in 2002/2005. He currently works at Amazon Web Services as a Security Engineer. He previously worked at T-Mobile, HPE, IBM, and Microsoft as a software developer in ICAM and Data Security domains. His research interests include serverless computing, identity and access management, big data security, and software exploitation.

9:45 SfM/MVS-Based Three-Dimensional Structural Diagnosis System for Damaged Houses

Hiroaki Tamakawa and Hiroshi Yamamoto (Ritsumeikan University, Japan)

In areas where major disasters (e.g., huge earthquakes, heavy rains, floods) occur, the victims need to obtain a "disaster victim certificate". The certificate proves the degree of the damage to the house and is needed to apply for subsidies and other support for disaster recovery. To issue the certificate, the staff of the local government should survey the damage to the house. However, the number of houses that the staff can survey in one day is limited and the number of staffs cannot easily be increased even in the area where the large disaster occurs. The delay in issuing the certificates slows down the recovery of the disaster area. Therefore, in this study, we propose and develop a new diagnostic system that the surveyors in the remote site can conduct a survey of the damaged house through the Internet. The proposed system creates a three-dimensional model of the damaged house and transmits it to the remote surveyors. The Three-dimensional model of the house is created using SfM/MVS (Structure from Motion/Multi View

Stereo) based on the collected images of the exterior of the house, which are taken by the smartphones of the victims themselves and the UAVs (Unmanned Aerial Vehicle) owned by the local government in the disaster area. In addition, to support for detecting the damage condition of the house, we propose a new observation method for the created three-dimensional model to automatically calculate the inclination of the house.

9:50 Household Behavior Observation System Utilizing Mesh Sensor Network Consisting of Smart Taps

Ryuichi Inoue and Hiroshi Yamamoto (Ritsumeikan University, Japan)

In recent years, the devices focusing on the smart home have rapidly been spreading and have been expected to be applied to the services that support daily life of the residents such as the observation of daily activity of the elderly people living alone and controlling the energy efficiency. To realize the smart home, the system that can recognize daily activities of the residents with high accuracy and low cost is indispensable. The existing studies have proposed the recognition methods using various sensors such as cameras and ultrasonic sensors for estimating the living behavior. However, the existing methods have problems in terms of the privacy and installation cost. Therefore, in this study, we propose and develop a new behavior observation system that estimates daily activities of the residents by placing smart taps supporting the wireless communication on various places at home. The smart tap has a function of measuring and analyzing the power consumption of the connected devices and the received signal strength of radio waves between the smart taps. In addition, the system constructs a mesh network of the smart taps using the Thread, a type of short-range wireless communication, and the location and behavior of the residents are estimated by collecting and analyzing the measurement data. By analyzing only the measurement results of the power consumption of appliances and the received signal strength of the radio wave, the proposed system achieves accurate behavioral estimation with no privacy issues and low installation cost.

9:55 A Low-Cost Brine Level Measurement System for Farmers Through NB-IoT Technology

Dao-Jiun Wang, Yong-Yi Fanjiang and Chi-Huang Hung (Fu Jen Catholic University, Taiwan); Yao-Yun Hsiao (Lee-Ming Institute of Technology, Taiwan)

Because of the usually changes weather. In the past, farmers had to constantly check whether their crops were maintained in a good growing environment. This research uses the technology of the Internet of Things, and uses ultrasonic module, a lens and micro control unit (MCU) to measure the water level in the pickled cabbage barrel. In addition to using a non-contact ultrasonic module, a lens is also used to capture the image in the pickled cabbage barrel so that farmers can understand the condition without going out. If the brine level is abnormal, farmers can be notified via instant messaging software.

10:00 On-Target Test Automation for an Embedded Digital Signal Processing Device

Christian Charles Dias, Clarice Sofia Soares and Larissa da Silva (Federal University of Campina Grande, Brazil); Cleuves Cajé de Carvalho, João Paulo Moreno Matos and Yago Luiz Monteiro Silva (VIRTUS/UFCG, Brazil); Danyllo Albuquerque (Intelligent Software Engineering Group, Brazil); Danilo F S Santos (Federal University of Campina Grande, Brazil)

Test Automation of embedded systems is a challenging task, especially when dealing with specific

components, such as Digital Signal Processing devices. In this article, we present an architecture that uses a well-adopted and generic automation framework, the Robot Framework, by adding an abstraction layer in the embedded device firmware to perform calls to DSP functions or firmware modules. The presented architecture enables the execution of tests on the target device integrated with other software components which are tested in the Robot Framework.

10:05 SIAR: Signing in the Air Using Finger Tracking Technology for Authentication on Embedded System

Shih Hsiung Lee and Hsuan-Chih Ku (National Kaohsiung University of Science and Technology, Taiwan)

In this paper, we propose a novel, convenient, fast and contactless identity authentication method. We use the camera to capture the image data when the user is signing in the air. In addition, the trajectory of the finger is captured by using deep learning model on the embedded system. The trajectory of the finger is the unique signature of the user's identity. For signature verification, the dynamic time warping algorithm is adopted to compare the similarity between the current signature and the registered signature. In order to evaluate the accuracy in the experiment, we collected the trajectories of the signatures in the air, including the registered, genuine and forged signatures. The experimental results show that the proposed method has significant effects. Add to this, this paper has the commercial values of low power consumption and low cost to meet the needs of the consumer market.

Friday, January 7 10:20 - 10:50 (America/New_York)

AVS-III: AV Systems and Signal Processing (3)

Room: Room: Ibuka

Chair: Deepayan Bhowmik (University of Stirling, United Kingdom (Great Britain))

10:20 FPGA Implementations of VVC Fractional Interpolation Using High-Level Synthesis

Ilker Hamzaoglu, Hossein Mahdavi and Elif Taskin (Sabanci University, Turkey)

In this paper, the first FPGA implementations of Versatile Video Coding (VVC) fractional interpolation algorithm using a high-level synthesis (HLS) tool in the literature are proposed. Three different C++ codes are developed. They implement constant multiplications with multiplication operations, addition and shift operations, and multiplierless constant multiplication algorithm, respectively. These C++ codes are synthesized using Xilinx Vivado HLS tool. The best proposed HLS implementation can process 62 full HD (1920×1080) video frames per second. It has higher performance than manual VVC fractional interpolation hardware implementations at the cost of larger area.

10:24 A Parallel and Pipelined Hardware Architecture for Fractional-Pixel Motion Estimation in AVS3

Yuning Zeng (Peking University & Advanced Institute of Information Technology, Peking University, China); Xizhong Zhu and Guoqing Xiang (Peking University, China); Zhijian Hao (Fudan University, China); Peng Zhang (Advanced Institute of Information Technology, Peking University, China); Xiaofeng Huang (Hangzhou

Dianzi University, China); Wei Yan (Peking University, China)

The latest generation of video coding standards has significantly improved video coding performance. The third generation of audio video coding standards (AVS3) is one of these latest standards. However, due to the more flexible block partition mechanism in AVS3, the computational overhead brought by fractional-pixel motion estimation (FME) increases significantly, making it more difficult to implement a real-time FME hardware. In this paper, a parallel and pipelined hardware architecture supporting block sizes from 4x4 to 64x64 is proposed for FME in AVS3, and it is specially designed for coding tree unit (CTU)-level pipelined architecture of AVS3 encoder. Three necessary modules are developed in this architecture. The first module concerns derivation of motion vector predictors (MVPs). The second module is used to derive fractional-pixel motion vectors (FMVs) of coding units (CUs) partitioned by Binary-tree (BT) and Quad-Tree (QT) mechanisms. And a motion vector substitution (MVS) module is proposed to substitute the FMVs of the remaining CUs with the FMVs derived in the second module. Experimental results show that the proposed methods suffer only 0.62% performance degradation in BD-Rate. Furthermore, the architecture is implemented on XILINX ALVEO U250 FPGA at 400 MHz and the presented FME hardware design can support the real-time encoding of 4K@30fps.

10:28 AVS3 Decoder Architecture and VLSI Implementation for 8K UHD TV

Application

Keewon Joe (Samsung Electronics Inc. Korea); Hwayong Oh (Samsung Electronics Inc. Korea, Korea (South)); Seung-ho Jeon, Hansoo Seong and Choonsik Jung (Samsung Electronics, Korea (South))

In this paper we propose video decoder architecture using homogeneous decoder core in parallel for 8K video. This architecture is applied to implement the third generation of audio video coding standard, also known as AVS3, the latest audio video coding standard developed by China AVS working group. The generated video sequences are evaluated in an external SDRAM access latency environment of 900 nsec and performance of 78 frames per second for 8K resolution video is achieved.

10:32 A Fast CU Partition Decision Strategy for AVS3 Intra Coding

Changxin Chen, Xinjie Luo, Yunyao Yan and Guoqing Xiang (Peking University, China); Peng Zhang (Advanced Institute of Information Technology, Peking University, China); Wei Yan (Peking University, China); Xiaofeng Huang (Hangzhou Dianzi University, China)

Third generation audio and video coding standard (AVS3) is a latest video coding standard developed by China. AVS3 allows flexible coding unit (CU) partition by applying quad-tree (QT), binary tree (BT), and extended quad-tree (EQT) partitioning structures. The increased block partition flexibility brings the significant coding complexity cost. This paper proposes a fast CU partition decision method based on the gradient and the variance for AVS3 intra coding. Experimental results show that the proposed fast algorithm can achieve a good balance between computational complexity and coding performance. Compared with AVS3 software reference HPM4.0, the coding time is reduced by 43%, while the average BD-Rate is only increased by 0.9% in AI (All-Intra) configuration.

10:37 Low Error Approximate Absolute Difference Hardware

Ilker Hamzaoglu, Berke Ayrancioglu and Hasan Azgin (Sabanci University, Turkey)

In this paper, we propose low error approximate absolute difference (LAD_X) hardware. LAD_X hardware

has lower maximum and average error, and higher accuracy than the approximate absolute difference (AD) hardware in the literature. It has similar performance with and smaller area than the approximate AD hardware in the literature. The H.264 motion estimation (ME) hardware using LAD_X hardware performs higher quality ME than the H.264 ME hardware using the approximate AD hardware in the literature. It has similar performance with and smaller area than the H.264 ME hardware using the approximate AD hardware in the literature.

Presenter bio: Ilker Hamzaoglu received Ph.D. degree in Computer Science from University of Illinois at Urbana-Champaign, IL, USA in 1999. He worked as a Senior and Principle Staff Engineer at Motorola Inc. in Schaumburg, IL, USA from August 1999 until August 2003. He started working as an Assistant Professor at Sabanci University, Istanbul, Turkey in September 2003, where he is currently working as an Associate Professor. He is an IEEE Senior Member.

10:41 A Cross-Layer Framework for Multi-user 360-Degree Video Streaming over Cellular Networks

Duc Nguyen (Tohoku Institute of Technology, Japan); Nguyen Viet Hung (East Asia University of Technology, Vietnam); Huong Thu Truong (Hanoi University of Science and Technology, Vietnam); Truong Cong Thang (The University of Aizu, Japan)

In this paper, we propose a novel cross-layer framework for Multi-user 360-degree video streaming over cellular networks. At the content layer, Scalable Video Coding is utilized to encode a tile into multiple layers. At the transport layer, the tiles' layers are delivered to users in hybrid unicast/multicast mode. The experiment results show that the proposed method can improve the average viewport quality by up to 4.85% compared to state-of-the-art methods.

Presenter bio: His research interest includes multimedia communications, big data processing, transfer learning.

10:45 A Hybrid Approach of Wavelet-Based Total Variation and Wiener Filter to Denoise Adventitious Lung Sound Signal for an Accurate Assessment

Chang Sheng Lee (University of Glasgow & Hill-Rom Services Ptd Ltd, Singapore); Minghui Li (University of Glasgow, United Kingdom (Great Britain)); Yaolong Lou (Hill-Rom Services Pte Ltd, Singapore); Ravinder Dahiya (University of Glasgow, United Kingdom (Great Britain))

Adventitious sounds and their characteristics are the critical indicators of lung dysfunctions. Unfortunately, the captured lung sound often contains noise interferences, which may hinder the accuracy assessment of lung health. This paper proposes a hybrid approach of wavelet-based empirical Wiener filter and wavelet-based total variation (WATV) to denoise adventitious lung sound signals. As an optimal filter, the wavelet-based empirical Wiener filter requires appropriate selections of two wavelet transform bases, whereas WATV indirectly eliminates the need to select the wavelet transform bases by modifying a single objective function to achieve a minimax optimal filter in the sense of mean-squared error. We combined the two approaches by using the improved signal estimation from WATV to design an empirical Wiener filter for suppressing noise and smoothing the denoised signal. The performance of our proposed technique is evaluated via root-mean-squared error (RMSE) and signal-to-noise ratio (SNR) on simulated lung sound containing crackle and wheeze transmitted out of the chest wall and being corrupted with white Gaussian noise at various power levels. In simulation studies, our proposed technique achieved optimal RMSE similarly to the WATV filter accomplishes as an optimal filter - not only preserving signal characteristics but also further improving SNR by 6-9 dB compared to the wavelet soft and hard threshold functions, total

variation denoising filter and the WATV filter. Additionally, our proposed technique is less sensitive to the variation of SNR values of the input signal.

CSH-II: Healthcare Consumer Systems (2)

Room: Room: TELUS

Chair: Haneul Ko (Korea University, Korea (South))

10:20 Development of Physical Fitness Tests Management System for Health Education

Rei Kobayashi (National Institute of Technology(KOSEN), Nagano College, Japan); Koichi Karasawa (National Institute of Technology (KOSEN), Nagano College, Japan); Koji Terasawa (Shinshu University & Education, Japan); Kazuki Ashida (National Institute of Technology (KOSEN), Nagano College, Japan)

This study has developed a system to collect the data of six types of physical fitness tests automatically. In the current system, much staff and time are needed for the measurement and each measurer has to handwrite the results and input them into computers manually. As a result, mistakes might occur and it is hard for measured persons to receive their results instantly. To solve these problems, the system, consisting of the transmitting and the receiving device, has developed and makes it possible to collect the data and send them to computers automatically and give the measured persons the printed results instantly. Using this system, easier and more precise measurement could be possible with less staff, and it could contribute to the promotion of health education.

10:23 Digital Twin Agent for Super-Aged Society

Toru Kobayashi and Kazuki Fukae (Nagasaki University, Japan); Tetsuo Imai (Hiroshima City University, Japan); Kenichi Arai (Nagasaki University, Japan)

We propose a digital twin agent that constructs elderly digital twins by digitally transforming daily life of the elderly. We developed the digital twin agent as an avatar run on a smartwatch. The digital twin agent provides cooperation support functions with the society to the elderly. Those support function histories will be integrated with the digital twin. The digital twin agent can also monitor indoor daily life activities using distributed small sensors inside home. Then, those monitoring results will be integrated with the same digital twin. We confirmed that the digital twin agent could provide cooperation support functions with the society through evaluation experiments in Nagasaki city in Japan. We also confirmed that the digital twin agent could construct the digital twin based on those support function histories and offer mental health support functions using the constructed digital twin.

Presenter bio: Toru Kobayashi is a Senior Research Engineer and a group leader of Application Architecture Project of NTT Information Sharing Platform Laboratories. He joined NTT in 1987 just after graduating from Graduate School of Mechanical Engineering, Tohoku University. During his career in NTT, he has been engaged in R&D of software development technology, Groupware, security technology and ubiquitous computing, etc. He also had an experience of staying in Germany for almost 4 years to manage joint research projects or standardization activities relating to smart card technologies.

10:27 Evaluation for Biorhythm of Japanese University Students During COVID-19 Pandemic Using Wearable Device

Hazuki Masuda (Ritsumeikan University, Japan); Koki Nakauchi (Meitec Corporation, Japan); Tianyi Wang (Ritsumeikan University, Japan); Shima Okada (Ritsumeikan University & Science & Engineering, Japan); Masaaki Makikawa (College of Science and Engineering, Ritsumeikan University, Japan)

This study focused on university students' sleep and circadian rhythms during the COVID-19 pandemic by monitoring the lowest point of circadian rhythms based on heart rate during nighttime sleep. Five healthy male university students wore a wristwatch-type wearable device for approximately one month. We measured the heart rate and monitored the lowest point of the circadian rhythm during nighttime sleep. The average minimum time of the estimated circadian rhythm was 5:48:06 \pm 0:50:18 (five subjects). The standard deviation (SD) of the lowest point time was 1:46:41 \pm 0:46:25 (five subjects). The SD of the lowest point time of two subjects was two and three hours, implying that the self-restraint imposed by the COVID-19 pandemic caused a disturbance in the body clock. Our method of monitoring circadian rhythms by measuring the heart rate during nighttime sleep with a wearable device enables individuals to monitor their circadian rhythm status, which is expected to contribute to health care for people living with the COVID-19 pandemic, shift workers, business workers, and athletes.

10:31 3D Printed Electromagnetic Micropump for Implantable Drug Delivery

Haoliang Lu, Selma Amara, Khalil Moussi, Sofiane Benmbarek, Ahmad Ainine and Hossein Fariborzi (King Abdullah University of Science and Technology, Saudi Arabia)

This paper introduces an electromagnetic micropump for drug delivery applications. The diffuser-nozzle structure allows a valveless unidirectional flow. The performance of the electromagnetic actuator is investigated theoretically and evaluated experimentally. More importantly, we present a proper compromise between the device miniaturization and the electromagnetic pumping force for implantable drug delivery applications. For an input current and voltage of 160 mA and 4.6 V, respectively, the micropump produces a flow rate of 1.2174 \pm 0.0041 μ l/s. The low power consumption, small size, and precise flow rate make the proposed micropump suitable for implantable drug delivery applications.

10:35 An Emotion-Aware Persuasive Architecture to Support Challenging Classroom Situations

Edgar Sarmiento-Calisaya, Pablo César Calcina Ccori and Álvaro Cuno (Universidad Nacional de San Agustín de Arequipa, Peru)

Nowadays, students face stressful situations that affect their mental health and negatively impact their academic performance. This situation has been exacerbated due to the COVID-19 pandemics. Teaching and learning process stakeholders face two main problems: the lack of awareness of the situations arising from students and the little available information that support the teaching activities. Here, we propose an emotion-aware architecture for persuasive systems in education, identifying challenging classroom situations and promoting mental health through multi-modal persuasive notifications. An important module is emotion inference, which reads real-time physiological data from students through the Empatica E4 wristband. Based on this architecture, we developed the Kuisqa persuasive system, to support students in regulating their negative emotions (e.g. stress or anxiety) during challenging classroom situations. Preliminary results provide insights that teachers achieved an increased awareness of the situations of students and perceived the prototype tool as useful.

Presenter bio: Assistant Professor at Universidad Nacional de San Agustín de Arequipa, Perú, Sarmiento-Calisyaya Edgar received the master degree in Informatics from Federal University of Rio de Janeiro - UFRJ - Brazil in 2009 and the PhD degree in Informatics from the PUC-Rio, Brazil in 2016. His research interests include Requirements Engineering, Software Testing, Model-driven Engineering, Context-Aware Software Systems and IoT.

10:39 A New Method for Notifying the Status of Home Appliances by Monitoring Their Control Panel

Kohichi Ogawa (Gunma University, Japan)

Home appliances have become an integral part of our lives. We can determine the status of a home appliance from monitoring their control panel. However, such control panels are not always easy to use for the elderly and people with disabilities. In our previous study, we have proposed a method for monitoring LED indicators of network devices. In this paper, we apply our monitoring method using control panels to monitor home appliances. We developed a monitor rack for mounting the monitoring devices. Using the developed monitoring devices, an image of the LED indicators of a washing machine panel was captured through an experiment. The results described in this paper are part of an ongoing study.

10:42 Estimation System of Sensitivity to Eye Fatigue Based on Blinking for the Prevention of VDT Syndrome

Akihiro Kuwahara, Rin Hirakawa, Yoshihisa Nakatoh and Hideaki Kawano (Kyushu Institute of Technology, Japan)

We live in an information society, and convenient information devices like smartphones and PCs have become indispensable in our lives. This situation has not only good effects on us but also bad effects. Most of them are health-related problems, and VDT syndrome is a typical example. This disease is caused by the accumulation of ocular fatigue due to prolonged VDT work, leading to a variety of systemic symptoms. Most of these problems can be avoided with proper preventive measures, but many users ignore them. We believe that this is since users do not know their eye fatigue accurately. In order to improve this situation, we present a new eye fatigue prevention system that focuses on the relationship between the accumulation of eye fatigue and changes in blink rate. Our system detects the discrepancy between the ocular fatigue calculated by CFF (Critical Fusion Frequency) and the subjective ocular fatigue from the user's blink features. The experimental results suggest the possibility of predicting the discrepancy between the subject's subjective time of eye fatigue and the objective time of eye fatigue from the median number of blinks. Regular use of our proposed system will make users aware of their eye fatigue sensitivity and will significantly reduce the risk of VDT syndrome and eye strain.

Presenter bio: ✦ Apr 2016 - Mar 2020 Kyushu Institute of Technology, Japan Bachelor of Electrical and Electronic Engineering ✦ Apr 2020 - current Kyushu Institute of Technology, Graduate School of Engineering, Japan Master of Electrical and Electronic Engineering

10:46 Accelerated SVM Algorithm for Sensors Fusion-Based Activity Classification in Lightweighted Edge Devices

Juneseo Chang (Seoul National University, Korea (South)); Myeongjin Kang (Kyungpook National University, Korea (South)); Daejin Park (Kyungpook National University (KNU), Korea (South))

Smart homes assist users by providing convenient services from human activity classification with the help of machine learning (ML) technology. However, most of the conventional high-performance ML algorithms

require high computing power and memory usage. Therefore, they are inapplicable for resource-limited embedded systems such as smart homes. In this study, we propose a memory-efficient, high-speed ML algorithm for smart home activity data classification. We propose a method for comprehending activity data as image data, thereby using the MNIST dataset as a substitute for real-world activity data. The proposed ML algorithm consists of three parts: data preprocessing, training, and classification. In data preprocessing, training data of the same label are grouped into further detailed clusters. The training process generates hyperplanes by accumulating and thresholding each cluster of preprocessed data. Finally, the classification process is done by calculating the similarity between the input data and each hyperplane using the bitwise-operation-based error function. We verified our algorithm on 'Raspberry Pi 3' by loading trained hyperplanes and performing classification on 1,000 training data. Compared to a linear support vector machine implemented from Tensorflow Lite, the proposed algorithm improved performance to 45%, memory usage to 15.41%, and execution time per accuracy to 41.3%.

Presenter bio: Juneseo Chang is an undergraduate student in department of Computer Science and Engineering, Seoul National University(SNU).

IoT-III: Internet of Things (3)

Room: Room: CTA

Chair: Hui Zhao (University of North Texas, USA)

10:20 *Wide-Area Road Surface Condition Observation System Utilizing Traveling Sensing by LiDAR*

Ryota Akiyama and Hiroshi Yamamoto (Ritsumeikan University, Japan); Yoshinori Kitatsuji (KDDI R&D Laboratories Inc., Japan)

In order to improve the efficiency of the snow removal activity in heavy snowfall areas, the measurement of the amount of snowfall on roads is one of the most important tasks. However, at present, the snow removal operator visually measures the snow depth by using rulers and poles, which becomes a burden for the operator. In addition, the measurement of road surface condition is also an important task for the maintenance of paved roads but it is difficult for local governments to perform the measurement in a wide area due to lack of budget and staff in charge. The existing research has proposed a method of measuring conditions of the road surface by using ultrasonic distance sensors and by analyzing camera images. However, the measurement range is limited to the vicinity of the place where the measurement device is installed, and it is difficult to correctly measure the undulations of the road surface and snow surface. Therefore, in this study, we propose a new system that utilizes high precision sensors such as LiDAR (Light Detection and Ranging) which can measure the shape of the road surface. By installing the sensors on the snowplows and vehicles owned by local governments, the system can measure the point cloud data for a wide area while the vehicles are in operation. Furthermore, the method to estimate the undulations of the road surface by analyzing the point cloud data that represents the shape of the road surface is proposed.

10:24 *An IoT System for Detection and Identification of Radioactive Material in Scrap Metal Recycling*

Vinh Tran-Quang (Hanoi University of Science and Technology & School of Electrical and Electronic Engineering, Vietnam); Hung V. Dao (Hanoi University of Science and

Technology & School of Electronics and Telecommunications, Vietnam); Tran-Tien Dat and Duong-Van Doan (Hanoi University of Science and Technology, Vietnam)

In this paper, we propose and develop an Internet of Radiation Sensor System (IoRSS) to enhance the use of nuclear detection systems to detect nuclear and other radioactive materials out of regulatory control in scrap metal recycling and production facilities. This is a complete IoT system of stationary and portable radiation detection devices connected to a radiation detection network using LoRa communication. With a robust and flexible network architecture along with advanced data fusion algorithms that combine information from many detectors, the IoRSS provides an advanced search, detection, and identification in the presence of radioactive material across a large coverage area and in difficult operational environments. The IoRSS demonstration has facilitated improved situational awareness and better capabilities to detect, identify, locate, and respond to incidents by integrating data from multiple portable and stationary radiation detectors across distributed sensors.

Presenter bio: He received a B.E. (2000) and M.S. (2003) degrees in Electronics and Telecommunications from Hanoi University of Science and Technology, Vietnam, a Ph.D. degree (2009) in Computer Science at Shibaura Institute of Technology, Japan. He was a postdoctoral fellow at Shibaura Institute of Technology, Japan. Currently, he is a lecturer at School of Electronics and Telecommunications, Hanoi University of Science and Technology, Hanoi, Vietnam. His interests include mobile communications, wireless networks, mobile ad-hoc networks, and wireless sensor network. He received the IEEE Section Prize Student Award in 2008, the Osamu Omoto International Students Scholarship for outstanding student, 2009, and the English Session Award for an excellent paper of ICM committee at IEICE General and Society conferences, 2011. He is a member of IEEE, IEICE.

10:28 Sensor Network System for Observing Environmental Information and Growth Condition to Support Indoor Agriculture

Naoki Nakayama and Hiroshi Yamamoto (Ritsumeikan University, Japan); Masao Arakawa and Itsuo Naka (Asahi Rubber Group Co., Ltd., Japan)

In recent years, the aging of workers of the Japanese agricultural industry and the shortage of successors have become more serious problems. As a countermeasure against them, vegetable factories have been attracting attention for achieving stable harvests. In the vegetable factory, the construction of the sensor network consisting of the sensor nodes supporting the short-range wireless communication is focused to collect environmental information and the image pictures of the plants from various places. However, when many sensor nodes communicate at the same time in a narrow area, many packet losses occur on the communication of large amounts of data such as images. In addition, there is a need for a system to accurately estimate the growth of the plants from the collected data to stabilize and improve the efficiency of the harvest. Therefore, in this study, we develop a new sensor network system where the sensor nodes have a function of selecting an appropriate wireless channel according to a type of the communication. In addition, we propose a new method of estimating the accurate growth condition of the plant by analyzing various types of images (i.e., RGB, depth) of the target plants.

10:32 Robot-on-Chip: Computing on a Single Chip for an Autonomous Robot

Young Woo Jeong, Kwang Hyun Go and Seung Eun Lee (Seoul National University of Science and Technology, Korea (South))

The interest in autonomous robots is growing due to diverse usability. Autonomous robots are equipped with various sensors for stable operation. As the sensor data increases, the system for sensor signal processing and actuators controlling is complicated. In this paper, we propose the robot-on-chip (RoC) which processes all functions for an autonomous robot on a single chip mounted on a robot. In order to

realize the RoC, we designed an autonomous robot with a lightweight algorithm and a hardware-friendly architecture. We demonstrated the feasibility of the RoC that the robot moves successfully by recognizing the environment without bumping into people in a building.

10:37 *An Extensible and Secure Architecture Based on MicroServices*

Roberto Oliveira, Ruan Carlos Silva and Marcelo Santos (VIRTUS/UFCG, Brazil); Danyllo Albuquerque (Intelligent Software Engineering Group, Brazil); Hyggo Almeida and Danilo F S Santos (Federal University of Campina Grande, Brazil)

In the Internet of Things scenario, the distributed cross-domain nature of microservices needs secure token service (STS), key management and encryption services for authentication and authorization, and secure communication protocols. Similarly, the nature of clustered containers (in which microservices are implemented) calls for secure service discovery. The availability requirement calls for: (a) resiliency techniques, such as load balancing, circuit breaking, and throttling, and (b) continuous monitoring (for the health of the service). The service mesh is the best-known approach that can facilitate specification of these requirements at a level of abstraction such that it can be uniformly and consistently defined while also being effectively implemented without making changes to individual microservice code. The purpose of this work is to provide deployment guidance for a robust security infrastructure for supporting microservices-based applications.

10:41 *Data Completeness-Aware Transmission Control for Large Spatio-Temporal Data Retention*

Hotaka Kaneyasu, Daiki Nobayashi, Kazuya Tsukamoto and Takeshi Ikenaga (Kyushu Institute of Technology, Japan); Myung Lee (CUNY, City College, USA)

With the development of IoT technology, various kinds of data are generated by IoT devices. Some of this data contains information on geographical location and time. We refer to such data as spatio-temporal data (STD). Since the "local production and consumption" of STD is effective for location-dependent applications, we have proposed an STD retention system that utilizes vehicles as data sources. STD sources ranges from simple sensory data to large video data. However, since previous methods assumed to retain an STD consisting of only one packet, retention of large STD sources may suffer from frequent packet collisions due to the increase in the number of packet transmissions. In this paper, we propose a data completeness-aware transmission control mechanism for large STD retention. Our simulation results showed that the proposed scheme reduces channel collision by suppressing the forwarding of incomplete data, and achieved a nearly 100% coverage rate.

10:45 *Novel Analytical Models for Sybil Attack Detection in IPv6-Based RPL Wireless IoT Networks*

Jae-Dong Kim, Minseok Ko and Jong-Moon Chung (Yonsei University, Korea (South))
A reliable routing scheme is essential for seamless data transmission of Internet of Things (IoT) networks. Routing Protocol for Low power and Lossy networks (RPL) is a key routing technology used in IPv6-based low power and lossy networks (LLNs). However, in the networks that are configured, such as small wireless devices applying the IEEE 802.15.4 standards, due to the lack of a system that manages the identity (ID) at the center, the maliciously compromised nodes can make fabricated IDs and pretend to be a legitimate node. This behavior is called Sybil attack, which is very difficult to response since attackers use multiple fabricated IDs which are legally disguised. In this paper, Sybil attack countermeasures on RPL-based networks published in recent studies are compared and limitations analyzed through simulation

performance analysis.

Friday, January 7 11:00 - 11:30 (America/New_York)

O1: ICCE2022 Opening Ceremony

Room: Room: Ibuka

Friday, January 7 11:30 - 12:00 (America/New_York)

K1: Keynote 1: Prof. Karlheinz Brandenburg

Room: Room: Ibuka

Friday, January 7 12:00 - 12:30 (America/New_York)

K2: Keynote 2: CTA SVP Brian Markwalter

Room: Room: Ibuka

Friday, January 7 12:30 - 14:00 (America/New_York)

IF15: Industry Forum Session 1:
Career Advice for Students and Young Engineers

Moderator: Stu Lipoff

Room: Room: Ibuka

A panel of hiring managers from a diverse group of mainstream commercial consumer technology stakeholders will share their advice to young engineers on topics to enhance their careers. Among the topics to be discussed are identification of emerging technologies categories where specific expertise would be highly valued. However, the discussion will go beyond the identification of specific technical expertise and include advice about choosing, and succeeding, with alternate career path topics and choices. Like any engineering tradeoff selecting a career path requires considering a balance between employer's needs, self satisfaction, career growth, and the fit with the non-technical aspects of your personality, communications skills, and creativity. Join the audience to profit from the advice from these hiring managers

Friday, January 7 14:00 - 15:30 (America/New_York)

IF04: Industry Forum Session 2:
The Value of Consumer Digital Health Devices and their Data for
Improving Individual Health and Public Health

Moderators: Michael Condry and Lucia Billeci

Room: Room: Ibuka

Chair: Michael W. Condry, ClinicAI and Consultant Consumer devices to make healthcare measurements have been a growing market, this includes devices that measure traditional measures

such as temperature, blood oxygen, EKG, and so on and devices that collect data that will evaluate indications of symptoms such as colorectal cancer toilet monitor from ClinicAI. Included are both wearable and home devices. The pandemic has accelerated the growth of products in this area aiming to assist individuals and their medical professionals. The data from these devices offer major opportunities for health management for the individual, medical and pharmaceutical researchers, public health, and other businesses. The panel is to evaluate the situation looking at existing product directions and the best opportunities to organize their data for maximum usability safely and privately. Discussion topics include: • Product and Technology directions with consumer health devices including wearable and home devices. • Types consumer devices and what measure • Organization of data for greatest utility in individual health management, research, and public health • Requirements on these systems for maximum benefit to all. This includes data compatibility, quality requirements, etc. • Potential opportunities growing from the availability and utilization of this data. • Utilization of AI for symptom prediction Speakers will include Michael Condry, from ClinicAI both chairing and discussing data organization and requirements Potential speakers from Mayo Clinic, Johns Hopkins, NIH

Saturday, January 8

Saturday, January 8 8:00 - 8:50 (America/New_York)

BPP: Best Paper Presentation

Room: Room: Ibuka

Chair: Srinivas Katkoori (University of South Florida, USA)

8:00 Deep Neural Network Based Multi-Channel Speech Enhancement for Real-Time Voice Communication Using Smartphones

Soonho Baek, Myungho Lee and Han-gil Moon (Samsung Electronics, Korea (South))
Recently, the performance of speech enhancement has been improved via deep neural networks. However, most of them are too heavy for voice communication using smartphones, and some are non-causal systems. In this paper, we introduce some effective techniques improving the performance even with light-weight models at causal system. We extract the input features by incorporating two kinds of beamformers. Furthermore, a normalization scheme is proposed to diminish the inter-channel variance between two beamformer outputs. The experimental results show the superiority of the proposed features. Moreover, the proposed method is extendable to any number of microphone systems without additional model training.

8:10 IoT Device Identification Using Supervised Machine Learning

Yong Wang (Dakota State University, Madison, SD, USA); Bhaskar Rimal and Mark Elder (Dakota State University, USA); Sofia I. Crespo Maldonado (University of Puerto Rico Río Piedras, USA); Helen Chen (University of Maryland, USA); Carson Koball and Kaushik Ragothaman (Dakota State University, USA)

Internet of Things (IoT) has been increasingly becoming mainstream and can be considered as the next stage of the internet revolution. The increasing use of IoT-based applications presents several issues to massively connected devices. For example, companies and organizations need to have a fast and reliable way to identify IoT devices on their networks to manage access and prevent vulnerable devices from connecting. On the other hand, machine learning has been widely used for image processing, intrusion detection, and malware classification. However, there are few studies on device identification using machine learning. In this paper, we propose a machine learning-assisted approach for IoT device identification. That includes four essential components: network traffic collection, feature extraction, data labeling, and machine learning. We test and evaluate four machine learning classifiers in a testing network, including multiple IoT devices. The evaluation results indicate a 79% accuracy in identifying the IoT devices in the considered network testbed.

Presenter bio: Dr. Wang is an associate professor of computer science and network security at Dakota State University. He received his B.S. and M.S.E degrees in Computer Science from Wuhan University (China) in 1995 and 1998, respectively. He received his Ph.D. degree in Computer Science from University of Nebraska-Lincoln in 2007. Before he joined DSU in 2012, he had spent 10 years in telecommunication industry as a senior software engineer and a team leader. His research area includes wireless networks, sensor networks, optical networks, and network security and privacy issues. He has published 60+ peer-reviewed papers in prestigious journals/conferences such as IEEE ICC, BroadNets, and Journal of Security and Communication Networks. He is a co-author of three books and served as Technical Program Committee (TPC) members and reviewers for many international conferences in Computer Science such as IEEE Globecom, IEEE ICC, and ACM CoNEXT.

8:20 Implementation of Distributed Microwave Power Transfer with Backscatter Feedback and LM-Based Phase Optimization

Kazuki Aiura (Osaka University & Graduate School of Information Science and Technology, Japan); Kentaro Hayashi (Osaka University, Japan); Yuki Tanaka (Panasonic Corporation & Connected Solutions Company, Japan); Kazuhiro Kizaki (Osaka University, Japan); Takuya Fujihashi (Osaka University & Graduate School of Information Science and Technology, Japan); Shunsuke Saruwatari and Takashi Watanabe (Osaka University, Japan)

To realize a distributed cooperative power transfer system, reduction in the phase optimization time is a major issue. For this purpose, backscatter-based feedback has been proposed as a fast feedback method for the received signal strength of the target node. On the other hand, as existing phase optimization algorithms based on backscatter feedback optimize each Tx antenna, the time required for phase optimization increases as the number of Tx antennas increases. We propose a method that combines backscatter-based feedback and levenberg-marquardt (LM) optimization to further speed up phase optimization. Based on the proposed method, the phase set suitable for the proposed method and initial parameters of the nonlinear regression algorithm are verified. The experiments showed that phase sets based on a continuous function suppressed the frequency spreading caused by the switching of phase sets and the determination of the initial solution based on the received strength improved the received power by 2.5 dB and accelerated the calculation time of the LM method by 10 ms.

8:30 A Two-Stage LSTM Based Approach for Voice Activity Detection with Sound Event Classification

Yarong Feng (Amazon, USA); Zongyi Liu (Amazon.com, USA); Yuan Ling (Amazon, USA); Bruce Ferry (Senior Manager, USA)

We introduce a two-stage approach using LSTM for voice activity detection with sound event classification. This approach proves to be effective when training data is limited. Moreover, it achieves better performance than pre-trained model using large-scale data set (AudioSet). Apart from clip-level accuracy, we also introduce two metrics for evaluating overall audio segmentation accuracy: mean IoU, and mean front miss. On test set, our method achieves 98% accuracy, 0.95 mean IoU for speech and 0.99 mean IoU for music, and 0.03 mean front miss for both speech and music.

8:40 A Lightweight CNN Net for AMD Detection Using OCT Volumes

Heng Chi Hsu and Cheng-Hung Lin (Yuan Ze University, Taiwan); Cheng-Kai Lu (Universiti Teknologi PETRONAS, Malaysia); Tzu-Lun Huang and Jia-Kang Wang (Far Eastern Memorial Hospital, Taiwan)

To popularize age-related macular degeneration diagnosis in rural and remote areas, we proposed a lightweight convolution neural network (CNN) architecture that aims to identify whether the patient has age-related macular degeneration through the optical coherence tomography images. The proposed CNN model achieves 2,322 parameters and 0.0573 GFLOPs, which is only 4.98% of the Mobile net. Besides, the CNN model achieves 98.18% of accuracy. With the fixed-point simulation using 14 bits on weights and 5 bits on input data, the CNN model achieves accuracy of 97.73%.

Saturday, January 8 9:00 - 9:30 (America/New_York)

MDA-I: ML and DL in CE (1)

Room: Room: Ibuka

Chair: Karandeep Singh (Institute for Basic Science, Korea (South))

9:00 Automatic Street Parking Space Detection Using Visual Information and Convolutional Neural Networks

Tala Bazzaza, Zuhao Chen, Sandhiya Prabha, Hamid Reza Tohidypour and Yixiao Wang (University of British Columbia, Canada); Mahsa T Pourazad (TELUS Communications Company, Canada); Panos Nasiopoulos (University of British Columbia, Canada); Victor C.M. Leung (Shenzhen University, China & The University of British Columbia, Canada)

This paper proposes a unique real-time street parking detection scheme that utilizes visual information and the YOLOv4 convolutional neural network to accurately detect available parking spaces. We also introduce a new video dataset that is captured specifically for this task and is used for training our network. Our network being the first of its kind, successfully detects available street parking spaces. Performance evaluations of our model confirm its efficacy across all types of scenarios.

9:04 Bridging Fuzz Testing and Metamorphic Testing for Classification of Machine Learning

Dongsu Kang (Korea National Defense University, Korea (South))

Artificial Intelligence (AI) built-in Consumer Electronics is popular, but it is hard to test and evaluate AI-based system with the existing performance metrics. Even though AI-based systems are implemented

in software with flexibility, bias and non-determinism property etc., they can suffer the same defects as other software. That is why new software testing approaches are needed when testing AI-based systems. Therefore, this paper proposes a bridging approach between fuzz testing and metamorphic testing focus on the classification of machine learning. This approach can be used as a test oracle for classification of training data.

9:08 Architecture Exploration and Customization Tool of Deep Neural Networks for Edge Devices

Seung-Ho Lim, Shin-Hyeok Kang, Byeong-Hyun Ko, Jaewon Roh, Chaemin Lim and Sang-Young Cho (Hankuk University of Foreign Studies, Korea (South))

Recently, Deep Neural Network(DNN)-based applications are increasing in embedded edge devices. However, due to the high computational complexity, DNN has limitations in properly executing and optimizing on edge devices. As a result, DNN exploration framework is required to customize various DNN models for edge device from the software to hardware perspectives. In this paper, we provide a GUI-based framework for architectural exploration of DNN networks in edge devices. It provides software optimization such as quantization and pruning, as well as hardware performance analysis using Virtual Platform(VP)-based Deep Learning Accelerator(DLA).

9:12 Simultaneous Brightness and Contrast Enhancement Using Derived Inputs and Residual Squeeze Network

Sangjae Ahn (Chung-Ang University, Korea(South)); Joongchol Shin (Chung-Ang University, Korea(South), Korea (South)); Heunseung Lim, Hayoon Kim and Joonki Paik (Chung-Ang University, Korea (South))

In this paper, we propose method to simultaneously improve the contrast and brightness of low-light images by using the concept of derived inputs and residual squeeze and excitation block (RSEB) network. The proposed method decomposes the input image into reflectance and illumination based on Retinex theory. Decomposed illumination, gamma corrected illumination, and histogram equalized illumination are combined to create Derived inputs. The RSEB network receives the Derived inputs as input and rescales feature map to show the resulting image with enhanced brightness and contrast. Experimental results demonstrates that proposed method provides excellent result images for both quantitative and qualitative measurements.

9:17 Deep High Dynamic Range Imaging Without Motion Artifacts Using Global and Local Skip Connections

Jaehee Lee (Chung-Ang University, Korea (South)); Joongchol Shin (Chung-Ang University, Korea(South), Korea (South)); Heunseung Lim and Joonki Paik (Chung-Ang University, Korea (South))

This paper proposes new HDR image generation method using deep residual network. The proposed method aligns input images of low dynamic range images with different exposure times and uses them as input to the network. In the network, LDR images and three images converted into high dynamic range regions are input, and LDR images with improved artifacts and alpha map are output to generate HDR images. The method proposed through the experimental results can show HDR images without distortion or ghosting artifact when compared to existing method, and good performance compared to the HDR function used in consumer imaging systems.

9:21 *Lightweight Super-Resolution Network with Information Distillation and Recursive Methods*

HeeJo Woo (Korea Polytechnic University: Siheung, KR, Korea (South)); Jiwoo Sim and Eung Tae Kim (Korea Polytechnic University, Korea (South))

At single-image super-resolution, the number of parameters and computations required by deep networks increase, due to the excessive use of convolutional neural networks. So, deep networks could be difficult to use in real-time or low-power devices. To overcome this problem, we propose a lightweight recursive distillation super-resolution network (RDSRN) that uses recursive and information distillation methods to gradually extract hierarchical features, and creates more accurate high-frequency components using high-frequency residual refinement blocks (HFRRB). Experimental results show that the proposed method has better performance with fewer parameters, fewer computations, and faster processing than the conventional methods.

Presenter bio: *Korea Polytechnic University: Siheung, KR - 2014-03 to 2020-02 | Bachelor of Engineering (Electronics Engineering) *Korea Polytechnic University: Siheung, KR - 2020-03 to present | Master of Engineering (Electronic Engineering) *Research fields: Deep Learning, Super-Resolution, Lightweight, Pruning

9:25 *Identification of Peritonitis Using Two-Stream Deep Spatial-Temporal Convolutional Networks*

Kawahara Toshiki (Ritsumeikan University, Japan); Inoue Akitoshi (National Hospital Organization Higashi-Ohmi General Medical Center, Japan); Yutaro Iwamoto (Ritsumeikan University, Japan); Bolorkhand Batsaikhan (Tokyo Metropolitan University, Japan); Chatani Syohei (Shiga University of Medical Science, Japan); Furukawa Akira (Tokyo Metropolitan University, Japan); Yen-Wei Chen (Ritsumeikan University, Japan)

In our previous work, we used deep optical flow network (DOFN) to extract temporal-spatial features intestinal movements and differentiate peritonitis from intestinal peristalsis. Since the DOFN is based on the difference image of two neighboring frames, it lacks texture and spatial information of the small bowels. To solve these problems, this paper proposed a new model with two-stream deep convolutional networks (two-stream DCN), which consists of two streams: optical flow stream (i.e., DOFN) and dynamic image stream. The final result is obtained by average fusion of the two streams. The accuracy is improved by about 3% by the proposed method.

MDT-I: Mobile Device Technologies

Room: Room: TELUS

Chair: Dong Seog Han (Kyungpook National University, Korea (South))

9:00 *A PDR Method Using Smartglasses Reducing Accumulated Errors by Detecting User's Stop Motions*

Dai Sato and Nozomu Togawa (Waseda University, Japan)

Pedestrian navigation using a smartglass is more intuitive and easier to use because various information is displayed directly in the field of view. When using it in indoor areas, pedestrian dead reckoning

(PDR) can be utilized, which estimates user's current positions using his/her device's sensors. Since PDR estimates relative positions based on its initial position, errors accumulate as the walking distance increases and reducing them effectively is important in smartglass-based PDR. This paper proposes a smartglass-based PDR method that effectively utilizes user's stop motions and thus reduces the accumulated errors. Experimental evaluations show the effectiveness of the proposed method.

9:04 Prediction-Guided Performance Improvement on Compressed Memory Swap

Taejoon Song, Myeongseon Kim, Gunho Lee and Youngjin Kim (LG Electronics, Korea (South))

Due to ever increasing demands for memory size, compressed memory swap technique has been widely deployed in many consumer electronics. Although reducing data size effectively extends available memory, it inevitably brings computational overhead. Also, the effectiveness of this technique highly depends on the compression ratio. If there is a significant amount of incompressible data, the compression only brings unnecessary overhead without any benefits. In this paper, we address this problem by skipping the compression of incompressible pages in an efficient manner. We propose a novel compression predictor which quickly and accurately estimates whether a page is compressible or not.

Presenter bio: He is currently working at LG Electronics as a system software engineer and a kernel expert. His research interest lies in computer architecture, operating systems, memory and storage.

9:08 A Novel Efficient Power Saving Method for Always-On Display

Un-Ki Park, Min-Sik Kim, Jong-Hyuk Lee, Hyeonsu Park, Hyunwook Lim and Jae-Youl Lee (Samsung Electronics, Korea (South))

This paper proposes a method of Always-On Display (AOD) function, named H/W Efficient Standalone AOD that operates AOD function inside Display Driver IC (DDI) itself with Application Processor (AP) sleep mode for low-power operation. Moreover, this paper also proposes a novel AOD operating architecture that can remove the additional memory required to express AOD information. Through experimental results, the proposed method demonstrates that the power consumption is reduced by 17.6% effectively without costing additional memory or causing cognitive image quality loss compared to the conventional AOD method.

9:12 A Group Photographing Auxiliary System Using Multi-Task Cascaded Convolutional Networks

Shih-Kai Tai, Cheng-You Hu, Hsuan-Yu Liu, Wei-Syuan Lee and Huang-Chia Shih (Yuan Ze University, Taiwan)

This paper illustrates a group photographing auxiliary system that enables to detect the eyes if closed and the face if occluded by another subject in group photo. To consider the practical issue, the proposed auxiliary system is designed to remind the photographer when any face of subject is occluded or eyes closed. We perform eyes-closed detection on every detected face region. If the eyes of subject were closed during the shot, system will notice the photographer automatically. In this study, the Multi-task Cascaded Convolutional Networks (MTCNN) is applied for face detection. MTCNN is efficient for the group photo with a large amount subjects. Compared with media-pipe contributed by Google, the number of human and bounding box detected by MTCNN is more accurate and complete. For eyes detection, a simple convolution neural network is used. In the experiments, we demonstrated that the results well-performed in terms of the occluded ratio of every covered face as well as whose eyes are closed.

Presenter bio: Huang-Chia Shih is an professor in the electrical engineering (EE) department at the Yuan-Ze University, Taiwan. His research interests include content-based video analysis, human-computer interaction, semantic computing, and model-based human motion capturing and recognition. Shih has a PhD in EE from National Tsing Hua University. He is a senior member of the IEEE.

9:17 A New DVFS Algorithm to Minimize Energy Consumption on System-On-Chip Architecture and Electrical Characteristics

Choonghoon Park, Jonglae Park, Youngtae Lee, Bumgyu Park, Jungwook Kim, Donghee Han, Chulmin Jo and Woonhaing Hur (SOC Development & Samsung Electronics, Korea (South))

Over the decades, lots of power management methods have been devised to increase battery life time in mobile devices. Among them, DVFS (Dynamic Voltage and Frequency Scaling) algorithms have been introduced to minimize energy consumption while meeting the required performance at the same time. Generally, most DVFS algorithms aim to minimize energy consumption without hurting QoS (Quality of Service) by selecting the lowest frequency which satisfies the performance required by workloads. However, it becomes more difficult to achieve energy efficiency with the existing DVFS algorithms on highly complex systems, such as de-coupling between operating frequency and voltage, and increasing static power due to the fine process trend. Therefore, the need for an entirely new DVFS algorithm has come to the fore. The new algorithm is designed to be well-deployed onto such complex systems, and follow the fundamental goal - minimizing energy, not simply reducing the power. In this paper, we are going to introduce an algorithm to satisfy the requirements.

9:21 A Context-Aware Automatic Smartphone Reconfiguration

Elian Souza and Edwin Monteiro (Federal University of Amazonas, Brazil); Raimundo Barreto (Universidade Federal do Amazonas, Brazil); Rosiane deFreitas (Federal University of Amazonas & IComp/UFAM, Brazil)

New technologies emerge every day to improve people's well-being. However, as people's daily lives become more and more intense, some small details may go unnoticed. One of these issues is related to the suitable configuring smartphones in specific contexts. Failure in these settings can result in embarrassing situations. Examples of contexts might be at a meeting, at the cinema, or in a noisy place. This paper details a method to collect user profile, to notify the user and change these settings according to each user's profile and context using the computing power of smartphones. Examples of automatic adjustments are screen brightness, media volume and ring mode. The experimental results of a controlled experiment indicate that the system is promising because it was able to detect the context and make the necessary adjustments, even before the user's schedule activities.

9:25 Optimising UWB Based Location Tracking in Smartphones Through the Support of 5G

Mythri Hunukumbure (Samsung Electronics, United Kingdom (Great Britain)); Oluwatayo Kolawole (Samsung R&D Institute, United Kingdom (Great Britain)); David M Gutierrez-Estevez (Samsung Electronics, United Kingdom (Great Britain))

This paper is proposing the integrated use of UWB and 5G localizing technologies in the Smartphones to optimize user experience. In use cases where high volume and lower latency are needed, using the NR-sidelink and the newly proposed Multiple QoS class in 5G is shown to be highly effective. The

overall signalling overhead and latency reductions are demonstrated through system level simulations. We propose to group users into clusters, aided by the intrinsic group behaviour in these use cases and then to employ the NR-sidelink for ranging users within a cluster. We provide details of the mobility model and the performance of the user clustering algorithm within this model. We also develop LPP (LTE Positioning Protocol - also adapted for 5G) compliant simulations and use the new Multiple QoS class to show reductions in latency. While the UWB and 5G based localization are currently developing as separate technologies, this paper explores application areas where the integrated use is highly beneficial.

Presenter bio: Dr. Mythri Hunukumbure is a Principal Research Engineer and a Project Lead at Samsung Electronics R&D Institute UK. In an industry career spanning over 15 years, he has contributed to and later led mobile communication research, standardisation and product development activities. Prior to joining Samsung UK, he was with Fujitsu Research Labs Europe. While at Samsung, he has participated in flagship EU projects mmMAGIC, ONE5G and 5G LOCUS as work package leader. Also he is actively contributing to 3GPP RAN1 and SA2 standardisation topics, securing vital IPR.

WNT-I: Wireless Networks (1)

Room: Room: CTA

Chair: Hiraku Okada (Nagoya University, Japan)

9:00 *Constrained Neural Estimation of Bluetooth Direction of Arrival with Non-Uniform Arrays*

Michele Perrone, Danilo Pietro Pau and Nicolo' Ivan Piazzese (STMicroelectronics, Italy)

Bluetooth Low Energy (BLE) 5.1 boosts indoor positioning solutions with its new direction finding features: the HAAT (high accuracy asset tracking) and the BT PIP (Bluetooth public indoor positioning), devised both for the consumer and the industrial field. To achieve efficient and compact solutions, there is a growing interest in the usage of non-uniform antenna arrays, which are much more flexible in terms of layout design compared to uniform arrays, while retaining the same capabilities. Unfortunately, there are only a few direction-finding algorithms that work finely with non-uniform arrays, and the current BLE HAAT or BT PIP solutions are all based on the Multiple Signal Classification algorithm (MUSIC). However, MUSIC requires the calculation of the covariance matrix and a peak-finding procedure in the computed pseudo-spectrum, making it prohibitive to develop real-time estimations on low-cost microcontroller units (MCUs). This paper describes an innovative approach to overcome these limitations. We consider as a study case a BLE HAAT application with a rectangular array, which is comprised of eight antenna elements evenly spaced a square edge. This array is non-uniform due to the lack of the central element. In conjunction to the selected topology, we use a tiny artificial neural network (ANN), which is trained and tested on a dataset specifically devised for this task. Unlike other datasets, it contains not only additive white Gaussian noise (AWGN) but also increasingly strong coherent interference. The proposed ANN is implemented on a low-cost microcontroller unit and is able to estimate, in a few milliseconds, a very precise direction of arrival (DoA) with only one sample per antenna element. Given the same input samples, the proposed solution is three orders of magnitude faster than MUSIC and has a better performance both in terms of azimuth and elevation.

9:04 *Selective Beam Switching System for RFID Based WSN Communication*

Toufiq Aziz and Heung-Gyoon Ryu (Chungbuk National University, Korea (South))

Beam switching is very important for WSN communication by ESPAR antenna for the convenient and low complexity beam forming. Therefore, it is possible to enhance the system performance by reducing the interference which will be easier with the use of an ESPAR antenna. In this paper, we increase the distance from the sensor tag to the RFID reader for the communication quality as well as the calculation of the SIR to enhance the communication strength. So, the communication quality, connectivity as well as SIR can be maximized, moreover, wider sensing and services can be available by this proposed system.

9:08 Evaluation of New CYPHONIC: Overlay Network Protocol Based on Go Language

Taiki Yoshikawa, Hijiri Komura, Chihiro Nishiwaki, Ren Goto, Kazushige Matama and Katsuhiro Naito (Aichi Institute of Technology, Japan)

The Internet of Things (IoT) spreading requires an interconnection scheme to connect to each IoT device over the Internet. However, the internet has several issues about accessible difficulty due to the Network Address Port Translation (NAPT) technology, the interoperability between IPv4 and IPv6, and disconnection due to mobility. As a technique for solving these issues, the authors have developed CYber PHysical Overlay Network over Internet Communication (CYPHONIC) that supports accessibility and seamless mobility over the Internet. Since CYPHONIC nodes typically implement the full IP stack, including IPv4 and IPv6, CYPHONIC supports virtual IPv6 communication over physical IPv4/IPv6 networks. The virtual IPv6 communication provides inter-connectivity among CYPHONIC nodes over the Internet. The conventional implementation for CYPHONIC used ruby language to make a scalable performance. On the contrary, it also suffers from low packet throughput. This paper introduces the detailed implementation of the simple prototype system that supports a primary communication mechanism of CYPHONIC based on Go to increase performance. The developed prototype system consists of cloud service for authentication, CYPHONIC node management, packet relay among CYPHONIC nodes, and client service for CYPHONIC nodes. The evaluation results show that the prototype cloud service can handle increased signaling requests from the CYPHONIC nodes. We also confirmed that CYPHONIC nodes could communicate with each other with sufficient communication quality.

9:12 Cooperative Spectrum Sensing System Using Residual Convolutional Neural Network

Myke D. M. Valadão (Universidade Federal do Amazonas, Brazil); Diego A. Amoedo (Universidade Federal do Amazonas & Agência Nacional de Telecomunicações - Anatel, Brazil); Antonio M. C. Pereira (Federal University of Amazonas, Brazil); Samuel Tavares (Federal University of Uberlândia, Brazil); Rafael S Furtado and Celso Carvalho (Federal University of Amazonas, Brazil); André L. A. Costa (Federal University of Uberlandia, Brazil); Waldir Silva (Universidade Federal do Amazonas, Brazil)

Some bands in the frequency spectrum became overloaded and others underutilized due to considerable increase in demand and user allocation policy. Cognitive radio applies sensing techniques to dynamically allocate secondary users. Cooperative spectrum sensing are currently showing promising results. So, in this work, we propose a cooperative spectrum sensing system based on a residual convolutional neural network architecture. For the proposed method, accuracy was more than 95% for noise power density below -124dBm/Hz , with the cooperation of 10 secondary users.

9:17 A Novel Balanced Routing Protocol for Lifetime Improvement in WSNs

Chih-Min Yu (Yango University, China); Meng-Lin Ku (National Central University, Taiwan)

In this paper, a novel balanced routing protocol with two uncorrelated paths is proposed for improving the imbalanced load around a sink connection area (SCA) and reducing the energy consumption in wireless sensor networks (WSNs). To achieve this, two uncorrelated shortest paths are determined for each node to the sink with the optimal path transmission cycle to avoid unnecessary load congestion in the SCA and all the other intra-layers. The proposed scheme can achieve the even power consumption for each intra-layer in a larger scale network and double the network lifetime, as compared to the traditional shortest path routing.

Presenter bio: Chih-Min Yu was born in Taiwan. He received the B.S. degree in electrical engineering from Chung-Cheng Institute of Technology in 1989, and the M.S. and Ph. D. degrees in telecommunication engineering from National Chiao Tung University, in 1997 and 2006, respectively. In August 2009, he joined the Faculty of Chung-Hua University, Hsinchu, Taiwan, where he is currently an Associate Professor with the Department of Electronics Engineering. Prior to that, he was an Assistant Researcher of the Chung-Shan Institute of Science and Technology, Taiwan, in 1989-2007, and he was an Assistant Professor with the Department of Information and Communication Engineering, Asia University, Taiwan, in 2008-2009. His research interests include the mobile communication, ad hoc networks and wireless sensor networks.

9:21 A Histogram Matching Sampling Technique for Improving the Stability of Adaptive Digital Predistorter

Jijun Ren (Xi'an University of Post & Telecommunications, China); Xing Wang and Qinqin Cheng (Xi'an University of Posts & Telecommunications, China); Qiushuang Song (Xi'an University of Post & Telecommunications, China)

Adaptive digital predistortion (ADPD) can counteract the nonlinear effect of power amplifier (PA). In the updating of ADPD look-up table (LUT), it is difficult to ensure the stability of the whole process due to the change of external environment and the inaccuracy of DPD model. In this letter, a method of histogram matching mask in sample data capture for improving stability of DPD system is presented. The power level, peak value and distribution of sample data is taken into account for estimating the DPD LUTs. Experiment shows that this method can be used to obtain more stability for effective DPD.

9:25 Position Detection for Lost Items Finding System Using LoRa Devices in Large Building

Natsumi Shoji and Kohei Ohno (Meiji University, Japan)

This paper discusses an indoor location finding method using LoRa devices in a large building. To find the position, RSSI from the receiver is measured. The floor number of the item can be detected by measuring the RSSI on each floor, whether the lost item is put outside the room, inside the room, or in a steel box. Moreover, a directional antenna is used to detect the angle of the item.

Saturday, January 8 9:40 - 10:10 (America/New_York)

MDA-II: ML and DL in CE (2)

Room: Room: Ibuka

Chair: Karandeep Singh (Institute for Basic Science, Korea (South))

9:40 *Fault Detection of Electric Motor Coil by YOLOv3 with Spatial Attention*

Mizuki Kato, Yutaro Iwamoto and Yen-Wei Chen (Ritsumeikan University, Japan)

Object detection has been widely applied to the visual inspection of factory products. However, since the detection model needs to be improved depending on the object and the problem setting, it is necessary to fine-tune the parameters of the model. In this paper, we propose an automatic fault detection method based on deep learning for electric motor coils. We introduce the spatial attention mechanism to the object detection method YOLOv3 with the aim of highlighting the location information of the defective part in the image.

9:43 *People Removal Using Edge and Depth Information*

Shunsuke Yae and Masaaki Ikehara (Keio University, Japan)

In this paper, we propose a people removal method from a single image for privacy and other reasons using a three-stage network of depth estimation, semantic segmentation, and inpainting. In this three-stage network, we improve semantic segmentation for detecting people. Traditional methods mainly detect multiple objects, and there is no network specialized for detecting people.

9:47 *Effective Detection of Materials in Construction Drawings Using YOLOv4-Based Small Object Detection Techniques*

Jiwoo Sim (Korea Polytechnic University, Korea (South)); HeeJo Woo (Korea Polytechnic University: Siheung, KR, Korea (South)); Eung Tae Kim (Korea Polytechnic University, Korea (South)); YunHwan Kim (WooSung Steel. Inc, Seoul, KOREA, Korea (South))

Since the quantity surveying of the materials marked on construction drawings is conducted manually, it is very time-consuming and causes problems such as incorrect calculation transactions. So, a fast and accurate AI-based automatic quantity surveying system is required. In order to accurately detect steel materials in construction drawings, we propose data augmentation techniques and spatial attention modules for improving small object detection performance based on YOLOv4. Experimental results show that the proposed method increases the accuracy and precision by 1.8% and 16% respectively compared with the conventional YOLOv4.

9:51 *GAN-Based Semantic-Aware Translation for Day-To-Night Images*

Daiki Shiotsuka and Jinho Lee (The University of Tokyo & Emerging Design and Informatics Course, Graduate School of Interdisciplinary Information Studies, Japan); Yuki Endo (The University of Tokyo, Japan); Ehsan Javanmardi (University of Tokyo, Japan); Kunio Takahashi (Mitsubishi Heavy Industries Machinery Systems, Japan); Kenta Nakao (Mitsubishi Heavy Industries, Japan); Shunsuke Kamijo (The University of Tokyo, Japan)

CNN-based methods require a large amount of data collection and annotation. However, most of the current datasets are built on daytime scenes, and there are few datasets for adverse conditions such as nighttime. Recently, data augmentation by image-to-image translation using Generative Adversarial Networks (GANs) has attracted attention. GANs based image-to-image translation performs well for various image translation tasks. Semantic information may be lost in problems with the significant domain

gap, such as day and night. In this paper, we propose a semantic-aware image translation. This framework preserves semantic consistency by transfer learning a semantic segmentation network to GANs.

9:55 Adaptive Coverage Path Planning Policy for a Cleaning Robot with Deep Reinforcement Learning

Dongki Noh (LG Electronics Inc., Korea (South)); WooJu Lee (Korea Advanced Institute of Science and Technology, Korea (South)); Hyoung-Rock Kim, Il-Soo Cho, In-Bo Shim and SeungMin Baek (LG Electronics Inc., Korea (South))

This paper presents an adaptive policy for coverage path planning for a cleaning robot in 2D environments based on reinforcement learning. We applied an actor-critic model, and a simulator to make a robot learn a path planning policy. In the view of consumer electronics, our objective function is designed to generate the minimum energy path. We used a real cleaning robot called R9 made by LG to evaluate our algorithm. Compared to a rule-based algorithm and other learning-based algorithms, our algorithm is probably more efficient in the view of energy saving.

Presenter bio: Dong-Ki Noh is a Ph.D. student in School of Electrical Engineering, Korea Advanced Institute of Science and Technology from 2020. He received M.S. degree in 2004 from electrical engineering & computer science from Seoul National University, Seoul, Korea. He currently works at Advanced Robotics Lab., LG Electronics Inc.. His research interests are SLAM, Visual Navigation, Deep Learning and Service Robot

9:59 System of Predicting Dementia Using Transformer Based Ensemble Learning

Kazu Nishikawa, Rin Hirakawa, Hideaki Kawano and Yoshihisa Nakatoh (Kyushu Institute of Technology, Japan)

In the previous research of dementia discrimination by voice, a discrimination method using multiple acoustic features by machine learning has been proposed. However, they do not focus on speech analysis in mild dementia patients. Therefore, we proposed a dementia discrimination system based on the analysis of vowel utterance features. The results of the t-test indicated that some cases of dementia appeared in the voice of mild dementia patients. Therefore, we proposed the ensemble discrimination system using a classifier with statistical acoustic features and a Neural Network of transformer models, and the F-score is 0.907, which is the best result.

Presenter bio: ✎ Apr 2016 - Mar 2020 Kyushu Institute of Technology, Japan Bachelor of Electrical and Electronic Engineering ✎ Apr 2020 - current Kyushu Institute of Technology, Graduate School of Engineering, Japan Master of Electrical and Electronic Engineering

10:02 Deep Learning-Based HDR Image Upscaling Approach for 8K UHD Applications

Yixiao Wang and Hamid Reza Tohidypour (University of British Columbia, Canada); Mahsa T Pourazad (TELUS Communications Company, Canada); Panos Nasiopoulos (University of British Columbia, Canada); Victor C.M. Leung (Shenzhen University, China & The University of British Columbia, Canada)

Advances in display technology have led to the introduction of 8K Ultra High Definition (UHD) displays to the consumer market, offering an improved visual experience. However, the lack of 8K High Dynamic Range (HDR) content is a major challenge for the wide adoption. In this paper, we introduce a deep learning approach based on generative adversarial networks to generate 8K UHD HDR content from Full

High Definition and 4K content. Benefiting from a multiple-level residual and dense structure, along with a random down-sampling method, our approach yields natural and visually pleasing 8K UHD HDR content with consistent color performance.

10:06 Domain Adaptive Semantic Segmentation Through Photorealistic Enhancement of Video Game

Kaito Nakajima (Tokushima University, Japan); Takafumi Katayama (University of Tokushima, Japan); Tian Song (University of Tokushima & Synthesis, Japan); Xiantao Jiang (Shanghai Maritime University, China); Takashi Shimamoto (University of Tokushima, Japan)

Unsupervised domain adaptation is considered as an effective technique to reduce the large amount supervised data. In order to solve this problem, unsupervised domain adaptation is considered to be an effective technique. In this work, three types of domain adaptation: image-level domain adaptation, inter-domain adaptation, and intra-domain adaptation are introduced to achieve better semantic segmentation accuracy. The proposed method achieved a mean IoU of 45.0%. Furthermore, by combining the proposed method with intra-domain adaptation, an mean IoU improvement of 1.2% is achieved compared to previous work.

SMC-I: Smart Cities and 5G

Room: Room: TELUS

Chair: Taeyoon Kim (Dankook University, Korea (South))

9:40 Emerging Paradigm of IoT Enabled Smart Villages

Rohani Rohan (KMUTT & School of Information Technology (SIT), Thailand); Debajyoti Pal and Bunthit Watanapa (King Mongkut's University of Technology Thonburi, Thailand); Suree Funilkul (KMUTT, Thailand)

Smart-village is an emerging paradigm that tries to digitize various aspects of rural activities using various IoT technologies. Different activities like smart-agriculture, waste-management, irrigation-management, livestock management, smart energy, smart-healthcare, and smart-education fall under its purview. However, infrastructure and cost are two major barriers towards a smart-village implementation and sustainability, that differentiates it from a smart-city. Considering this we present the current state-of-art of smart-villages by creating a detailed taxonomy. A collaborative edge-computing model is proposed keeping in mind the resource constrains in a smart-village. Finally, the open research issues and challenges are discussed.

Presenter bio: Rohani Rohan was a lecturer at the information department (IS), faculty of computer science, Shaikh Zayed University (SZU), Khost, Afghanistan Currently, he is a research assistant at the school of information technology (SIT), KMUTT, Bangkok Thailand.

9:44 Visual and Location Information Fusion for Hierarchical Place Recognition

Dulmini Hettiarachchi and Shunsuke Kamijo (The University of Tokyo, Japan)

This paper presents a novel hierarchical place recognition system capable of general outdoor place recognition. We achieve this by fusing visual and location information. Our hierarchical approach comprises

of place of interest detection, location-based filtering, image similarity based ranking and information retrieval components. We introduce a new dataset, referred to as Tokyo Outdoor Places, comprising of landmarks, commercial buildings, and business entities for evaluation. Our proposed system achieves 95.69% precision on our new dataset. We believe our system can contribute in achieving smart city goals by providing access to information, enabling locals and tourists to navigate with ease.

9:48 Improvement of Object Segmentation Accuracy in Aerial Images

Sujong Kim (School of Computer Software, Daegu Catholic University, Korea (South)); YunSung Han, Soobin Jeon and Dongmahn Seo (Daegu Catholic University, Korea (South))

With recent advances in UAV technology, research-based on UAV images is underway. UAVs can easily access places that are difficult for people to access and take a wide range of target areas. However, UAV images taken at high altitudes using a drone have object images with a tiny size in the entire background image, resulting in a more significant area error in the area of the detected objects. This paper proposes an accurate area measurement algorithm within an object based on image processing. Also, we evaluated the proposed algorithm by implementing it. The experimental results show that the average duplicate error rate decreased by 14% compared to mask instance segmentation. Finally, the proposed algorithm can more accurately extract small potholes in the images taken at high altitudes.

Presenter bio: Department of Computer Engineering, Kangwon National University. (B.E., 2002.2) Department of Computer & Telecommunication Engineering, Kangwon National University. (M.S., 2004.2) Department of Computer & Telecommunication Engineering, Kangwon National University. (Ph.D., 2010.2) Postdoctoral Research Fellow at Imaging Media Research Center in Korea Institute of Science and Technology (2010.03~2014.02) Currently Assistant Professor at School of Information Technology in Catholic University of Daegu.

9:52 Self-Triggered Consensus Approach to Vehicle Platooning at Intersection

Ayaka Tanaka, Koichi Kobayashi and Yuh Yamashita (Hokkaido University, Japan)

In this paper, a new method of vehicle platooning at an intersection is proposed based on self-triggered pinning consensus control. Using the proposed method, collision avoidance without stopping vehicles is achieved. First, the outline of self-triggered pinning consensus control is explained. Next, the problem setting of vehicle platooning is given. The inter-vehicular distance and the speed of each vehicle are modeled as a linear state equation. Finally, virtual merge and split of vehicle groups are proposed.

9:57 A Method for Detecting Human by 2D-LiDAR

Yuto Nagai and Yuya Sawano (Graduate School of Kanagawa Institute of Technology, Japan); Yoshiaki Terashima (Soka University, Japan); Takayuki Suzuki and Ryozi Kiyohara (Kanagawa Institute of Technology, Japan)

Some robotic carts have been developed. These small robotic carts are suitable for use as transport, guide, delivering and patrol robots. These carts move autonomously using a localization system, obstacle detection, and maps. We focus on a patrol system for detecting suspicious but harmless people such as aged wanderer. We assume that the patrol carts have GNSS for their localization system, LiDAR (Laser imaging Detection And Ranging) for obstacle and human detection, and a BLE device for authorized human detection. In this paper, we describe a method for detection of human by 2D pointcloud data with LiDAR

10:01 Edge Device Based Stress Detection for Older Adults with Cortisol Biomarker

Joseph Clark and Himanshu Thapliyal (University of Tennessee, USA)

Stress impairs human cognition and over long periods of time can cause severe negative health effects for older adults. Real-time stress detection can be a useful tool in stress mitigation strategies, but stress detection is often implemented with machine learning models too large to run on an edge device. This paper presents a stress detection framework for older adults which is designed to be executed with low latency by a wearable device or other embedded system. We use Galvanic Skin Response, Blood Volume Pulse, Interbeat Interval, and skin temperature data with cortisol as a stress biomarker to evaluate the performance of several machine learning models. The best performing model was a radial basis function-based SVC (Support Vector Machine). The model achieved a test data accuracy of 82% and a test data F1-Score of 0.70. Performance data indicates that the framework performs well and could be improved for use on a wearable device.

10:05 Apples vs. Oranges: The QoE Scenario in Consumer IoT Services

Tashfiq Rahman and Debajyoti Pal (King Mongkut's University of Technology Thonburi, Thailand); Suree Funilkul (KMUTT, Thailand); Naphongthawat Photikit (Bank of Thailand, Thailand)

IoT services are being deployed in a variety of contexts ranging from smart-homes, smart-cities, smart-healthcare, smart-transportation to smart-industry. Traditionally, Quality of Experience (QoE) that typically measures the end-users' satisfaction level with a particular service has been associated with multimedia services. In this article we present how IoT services are unique, and why the traditional way of QoE evaluation is not a good approach in this changing scenario. There must be a paradigm shift from a user-centric approach as currently followed, to an approach that combines human to machine (H2M), and machine to machine (M2M) communications. We present a conceptual approach towards such a shift. For the consumer electronics (CE) community this article sheds light to the future research directions in evaluating the QoE for various consumer IoT services.

Presenter bio: The author completed his school education in an International School in Bangladesh. Having studied both Science and Business during high school years, his research interests lie in various fields, ranging from technology to marketing. He was a student of King Mongkut's University of Technology Thonburi in Thailand since August of 2016. He was enrolled at the Computer Science department in the School of Information Technology for his bachelor's degree. He has collaborated actively with researchers in several other disciplines of Computer Science, particularly IoT and its applications on solving daily problems.

WNT-II: Wireless Networks (2)

Room: Room: CTA

Chair: Cihat Cetinkaya (Mugla Sitki Kocman University, Turkey)

9:40 Received Path Power Prediction for Millimeter-Wave Using Machine Learning

Takato Yamazaki, Kohei Shimaoka and Kohei Ohno (Meiji University, Japan); Ulf Johannsen (Eindhoven University of Technology, The Netherlands); Sonia Heemstra de Groot (Eindhoven Technical University, The Netherlands)

This paper discusses the received power prediction of millimeter-wave by machine learning when a user

moves simply like walking straight. In general, a large amount of data is required for the neural network to predict the received power. In this paper, the transfer function of the channel is divided into narrower bandwidths, and the received power obtained from the narrower channel is used for the learning data. The RMSEs are evaluated to show the effectiveness of the proposed prediction scheme.

9:43 A Study on Positioning of Mobile Coordinator in Ad-Hoc Networks

Gai Itoh, Shimon Karasawa and Kohei Ohno (Meiji University, Japan)

This paper discusses the position of the mobile coordinator obtained better communication performance in ad-hoc networks. The mobile base station is necessary when a disaster occurs and fixed base-stations are damaged. In such a situation, organizing Ad-hoc networks using a mobile coordinator like a drone is proposed. The communication performance is different depending on the position of the coordinator. In this paper, communication performances are evaluated by the network simulator. From the results, the coordinator should move to the position to prevent the isolated nodes that the distance of the one hope become closer.

9:47 Adaptive Digital Predistortion of Power Amplifiers Using Sparse Volterra Series Models Based on Compressed-Sensing

Jijun Ren (Xi'an University of Post & Telecommunications, China); Qinqin Cheng and Xinrong Yang (Xi'an University of Posts & Telecommunications, China); Qiushuang Song (Xi'an University of Post & Telecommunications, China)

Adaptive Digital predistortion has become an attractive technique for power amplifier linearization whose limiting factor is its computational complexity. Based on a previous reference algorithm, which consists on applying the orthogonal matching pursuit for the sorting of the model components and a Bayesian information criterion for the selection of the optimum number of components, a new technique to reduce the size of the support set taking into account the structural information within a model is presented. Experimental results show equivalent performance to the pruning with the reference algorithm while further reducing the number of components.

9:51 Chebyshev Functional Link Neural Network Integrating FIR Filter Architecture for Power Amplifier Linearization

Jijun Ren and Qiushuang Song (Xi'an University of Post & Telecommunications, China); Xing Wang and Xinrong Yang (Xi'an University of Posts & Telecommunications, China)

Chebyshev polynomial functional link neural networks (FLNN) integrating FIR filter architecture for power amplifier linearization is proposed. Furthermore, considering the system implementation and resources, we simplify the Chebyshev polynomials in the actual realization on the premise of guaranteeing the fitting accuracy. Experimental results on High-Frequency (HF) Power Amplifier (PA) of actual short-wave communication and the software simulation of dual carrier LTE signal show that more accurate linearization results can be obtained by using the proposed method.

9:55 A Compact Band-Pass Filter for 5G Applications

Van Bui, Sy Vinh Ho, Van Tho Bui and Duc Nhat Nguyen (Viettel High Technology Industries Corporation, Vietnam)

This paper describes a compact cavity band-pass filter for a 5G massive MIMO system. The proposed

design is a seventh order filter with two zero points on either side of the lower and upper pass band, offering a good frequency selectivity from 2496 to 2690 MHz. A novel capacitance structure is also implemented to improve the cross-coupling bandwidth. The band-pass filter has dimension of 90x43x15 mm with the return-loss more than 20 dB, the insertion loss less than 0.3 dB and rejection level of -40 dB and -50 dB at 35 MHz and 80 MHz from the band edges, respectively.

9:59 User Selection of Mobility Control for Throughput Improvement in Ad Hoc Networks

Takumi Anjiki and Tutomu Murase (Nagoya University, Japan)

We propose an optimal user selection method in mobility control to improve QoS in ad hoc networks. In the proposed method, the best user, which is the best node consisting of ad hoc networks, is selected based on physical distances between users in an ad hoc network and on the connection relationships between the users. The method also indicates the best position to move that user to. To reduce the search cost to obtain the best position, the proposed method reduces the areas to be searched by identifying the discrete positions where transmission rates change according to the measurement data model. All the identified positions are examined to determine whether to relay another user to determine the best position. The evaluation results show that this proposed method improved accuracy compared with the exact solution by more than 99.0%. Throughput improvement of 10.3% was achieved compared with the conventional method, which adopts a heuristic approach. Although the proposed method requires more running time than the conventional heuristic approach, it remains within a reasonable time.

Presenter bio: Tutomu Murase was born in Kyoto, Japan in 1961. He received his M.E. degree from Graduate School of Engineering Science, Osaka University, Japan, in 1986. He also received his PhD degree from Graduate School of Information Science and Technology, Osaka University in 2004. He joined NEC Corporation Japan in 1986. He was a visiting professor in Tokyo Institute of Technology in 2012—2014. He is currently a professor in Nagoya University, Japan. He has been engaged in researches on traffic management for high-quality and high-speed internet. His current interests include transport and session layer traffic control, wireless network resource management and network security. He also interested in user cooperative mobility research. He has been serve as TPC for many IEEE conferences and workshops. He has more than 90 registered patents including some international patents. He was a secretary of IEEE Communications Society Japan Chapter. He is a member of IEEE and a fellow of IEICE.

10:02 Deep Reinforcement Learning Based Resource Allocation in Dense Sliced LoRaWAN Networks

Amine Tellache (Ecole Nationale Supérieure d'Informatique Alger & ESI, Algeria); Abdelkader Mekrache (University of Poitiers, France); Abbas Bradai (XLIM Institute, University of Poitiers, France); Ryma Boussaha (National Higher School of Computer Engineering, Algeria); Yannis Pousset (Université de Poitiers & XLIM, France)

Long-Range Wide Area Network (LoRaWAN) is a rapidly expanding communication system for Low Power Wide Area Network (LPWAN) in the Internet of Things (IoTs) deployments. It employs an Adaptive Data Rate (ADR) scheme that optimizes data rate, airtime, and energy consumption. Recently, the use of Network Slicing (NS) in LoRaWAN networks is being widely studied and a hot topic for the latest research in the literature. Network resources must be efficiently assigned to IoT devices in an isolated manner in order to handle and support specific Quality of Service (QoS) requirements for each slice. However, in dense LoRaWAN networks, the ADR scheme is insufficient for efficient resource allocation to meet the QoS requirements of each slice. In this article, we propose a DRL-based approach for intra-slicing resource

allocation in dense LoRaWAN networks. In each slice, we implemented multi-agent DRL that allocates Spreading Factor (SF) and Transmission Power (TP) to IoT devices to meet QoS requirements, i.e. we replaced the conventional ADR scheme with multi-agent DQN with different reward function design for each slice according to QoS requirements. Experimental results realized in real conditions show that our approach outperforms the existing ADR scheme for all the slices.

10:06 Prediction Evaluation for RSSI Data Generated from Leaky Coaxial Cables over Indoor Environment

Pengcheng Hou, Junjie Zhu, Kenta Nagayama, Yafei Hou and Satoshi Denno
(Okayama University, Japan)

Using a probabilistic neural network (PNN) based predictor, this paper investigates the prediction accuracy of the time-series received signal strength indicator (RSSI) data generated over an indoor environment configured by multiple Leaky coaxial cable (LCX). In addition, it also compares the prediction results of RSSI data from the same environment but configured with the conventional monopole antenna. The results indicate that the RSSI data generated by the LCX antenna has better prediction accuracy over multi-path rich environment than that of using the conventional monopole antenna, which can be used for many linear-cell based wireless coverage.

Saturday, January 8 10:20 - 10:50 (America/New_York)

MDA-III: ML and DL in CE (3)

Room: Room: Ibuka

Chair: Karandeep Singh (Institute for Basic Science, Korea (South))

10:20 Efficient Light-Weight Deep Neural Network for Person Detection in Drone Images

Kim Mingi, Heegwang Kim and Yeongheon Mok (Chung-Ang University IPIS, Korea (South)); Joonki Paik (Chung-Ang University, Korea (South))

We propose an efficient light-weight neural network for small object (person) detection in drone images. The proposed method performs light-weight and efficient small object detection by removing the head layers. The feature was extracted by focusing the weight on the small object while performing feature fusion through the Weighting Module. Since the class imbalance problem between the object and the background is more serious in the drone image, the problem is alleviated by using the focal loss. The light-weight, the inference time are faster, and the Average Precision is higher than the original model.

10:24 Low-Light Enhancement Using Retinex-Decomposition Convolutional Neural Networks

JungHoon Sung and Heunseung Lim (Chung-Ang University, Korea (South)); Joongchol Shin (Chung-Ang University, Korea(South), Korea (South)); Sangjae Ahn and Joonki Paik (Chung-Ang University, Korea (South))

This paper proposes a new retinex-decomposition convolutional network (DC-Net) to enhance low-light images based on retinex theory. The proposed method estimates the reflectance and illumination

components using Dc-Net. Bright-Net and Smooth-Net are used for the refined illumination, and Denoise-Net returns the noise-removed reflectance. Finally, A resultant image can be estimated by multiplying the noise removed reflectance map and brightness-improved illumination. The experimental results show that the proposed scheme can provide high-quality images without saturation.

10:28 Deep Guidance Decoder with Semantic Boundary Learning for Boundary-Aware Semantic Segmentation

Qingfeng Liu and Hai Su (Samsung US, USA); Mostafa El-Khamy (Samsung Electronics, USA)

Image semantic segmentation is ubiquitously used in consumer electronics, such as AI Camera, which require high accuracy at the boundaries between semantic classes. To improve the semantic boundary accuracy, we propose low complexity deep-guidance decoder (DGD) networks, trained with a novel semantic boundary learning (SBL) strategy. Our ablation studies on Cityscapes and the ADE20K most-frequent 31 classes, when using different encoders and feature extractors, confirm the effectiveness of our approach. We show that the proposed DGD with SBL significantly improve the mIoU by up to 10.4% relative gain and the mean boundary F1-score (mBF) by up to 38.5%.

10:32 HyperUNet for Medical Hyperspectral Image Segmentation on a Choledochal Database

Gan Zhan (Ritsumeikan University, China)

Microscopy medical hyperspectral images, which are characterized in multiple observation bands under different spectral frequencies, contain profuse spectral information for disease diagnosis. Consequently, an increasing number of deep learning methods have recently been proposed to solve the medical hyperspectral image segmentation task. In this study, we propose a new segmentation network (HyperUNet) as a better version of UNet for medical hyperspectral image segmentation on a choledochal database. Considering the useless spectral information that exists in the hyperspectral image that is irrelevant to our task, HyperUNet first uses the linear transformation block to extract the useful spectral information from the hyperspectral image, and then applies the UNet model to it to capture the tumor area. Finally, when reconstructing the mask, HyperUNet applies the multi-scale loss function in cases of underuse and overuse of low-level detailed features and high-level semantic features. We compare our HyperUNet to other competing methods, and the results show that our HyperUNet is superior.

10:37 A Weakly-Supervised Anomaly Detection Method via Adversarial Training for Medical Images

He Li (Ritsumeikan University, Japan)

Convolutional neural networks have been widely used for anomaly detection, and one of their most common methods is autoencoder. The autoencoder is expected to produce lower reconstruction error for the normal data than the abnormal ones, and the reconstruction error is usually set as a measurement index for discerning anomalies. However, this conception is not always consistent in practice. Sometimes the reconstruction ability of the autoencoder is so well that it can reconstruct anomalies with low error, resulting in losing detection of anomalies. To overcome this drawback, we introduce a novel weakly-supervised learning method, by using the generative adversarial network. The network not only learns the feature distribution of normal samples but also abnormal ones. The autoencoder is employed in the generator network enables the model to map the input image to a lower dimension vector, and then remap back to its reconstructions. The additional encoder discriminator network maps real and generated image

to its latent representation and distinguishes the generated image is true or false. As a result, a larger error index is indicative of an anomaly sample. Experimentation over medical images of a public liver dataset shows the model superiority over previous state-of-the-art approaches.

10:41 DQN Based Exit Selection in Multi-Exit Deep Neural Networks for Applications Targeting Situation Awareness

Abhishek Vashist, Sharan Vidash Vidya Shanmugham and Amlan Ganguly (Rochester Institute of Technology, USA); Sai Manoj Pudukotai Dinakarrao (George Mason University, USA)

Smart infrastructure targeting situation awareness for first responders enables intelligent and faster response time. Such an application requires an edge device to process information. The edge hardware is limited by computation capability for running Deep Neural Networks (DNNs). Multi-exit DNNs are used to provide static exit selection for faster inference. We propose using Deep Q Network (DQN) based technique for dynamic exit selection in multi-exit DNNs. The DQN learns an optimal policy using hardware and multi-exit DNN based state information. Our system achieves performance improvement with 63.5% decrease in inference time, 33% reduction in energy and classifies 2.2x more inputs.

Presenter bio: Abhishek Vashist received the B.Tech. degree from ABES Engineering College, India, in 2014, and the Master's degree in electrical engineering from the Rochester Institute of Technology, Rochester, NY, USA in 2017. He is currently working towards Ph.D. degree at the Department of Computer Engineering, Rochester Institute of Technology. His current research interests include design of localization systems for autonomous vehicles, vehicle-to-vehicle (V2V) communication using millimeter-wave technology and computer architecture.

10:45 Efficient Scale-Recurrent Network Using Generative Adversarial Network for Image Deblurring

Wei-Hsiang Hsu and Chih-Wei Tang (National Central University, Taiwan)

Ubiquitous image blur degrades viewing experiences and performance of video analysis. To be applicable to consumer electronics, the large amount of parameters and high computational load of deblurring network have to be avoided. The existing SRN+ has small amounts of parameters (3.9M) and comparable performance. To improve output quality of a deblurring network (e.g., SRN+) without changing its architecture, this paper proposes the pseudo label based order task for training the discriminator. The proposed funnel soft label further reduces the vanishing gradient problem during training SRN+ (generator), and the adversarial loss combined with weighted scale-level losses improves quality of deblurring. For GoPro dataset, the proposed scheme outperforms the light version of the state-of-the-art MPRNet in PSNR (+1dB) and number of parameters (70%).

VAR-I: VR and AR

Room: Room: TELUS

Chair: Alberto Cannavò (Politecnico di Torino, Italy)

10:20 A Telepresence-Based Remote Learning System

Duc Nguyen (Tohoku Institute of Technology, Japan); Huyen Tran and Truong Cong Thang (The University of Aizu, Japan)

In this paper, we develop a new telepresence-based system for real-time remote learning. By combining

low-latency 360 video/audio communication and Virtual Reality, the proposed system allow students feel like as if they are present in the classroom, regardless of their true locations. Especially, the system allows students to perform in-class activities such as note taking by providing a local view in addition to a remote 360-degree view. The proposed system is expected to improve user engagement and study efficiency.

Presenter bio: His research interest includes multimedia communications, big data processing, transfer learning.

10:25 *Partial Offloading MEC Optimization Scheme Using Deep Reinforcement Learning for XR Real-Time M&S Devices*

Yunyeong Goh, Minsu Choi, Jaewook Jung and Jong-Moon Chung (Yonsei University, Korea (South))

With the advent of 5G, the development of extended reality (XR) technology, which combines augmented reality (AR), virtual reality (VR), and advanced human-computer interaction (HCI) technology, is considered one of the key technologies of future metaverse engineering. Especially, XR real-time modeling and simulation (M&S) devices that can be applied to various fields (e.g., emergency training simulations, etc.) have tasks with large amounts of data to be processed. However, if the XR task is processed only by wireless user equipment (UE), the UE's energy may be quickly depleted, and the quality of service (QoS) may not be satisfied. To solve these problems, this paper proposes a partial offloading optimization scheme through multiple access edge computing (MEC). In addition, deep reinforcement learning (DRL) is used to reflect the dynamic state of the MEC system and to minimize the delay. The simulation results show that the proposed scheme optimizes the delay performance by efficiently offloading the XR tasks.

10:30 *Multipath TCP Control Scheme for Low Latency and High Speed XR Real-Time M&S Devices*

Jaewook Jung, Minsu Choi, Yunyeong Goh and Jong-Moon Chung (Yonsei University, Korea (South))

Advancements in metaverse modeling & simulation (M&S) are becoming possible due to realization of extended reality (XR) systems, which combines mixed reality (MR) with advanced human-computer interaction (HCI) devices. To use these technologies appropriately, high performing system requirements, such as, high data rate and low latency, are required. For this, fifth-generation (5G) New-Radio (NR) technology that achieves high data rate, low latency, and massive connectivity can be applied. Although the mmWave technology adopted in 5G can satisfy high data rates by using high frequencies, it has a disadvantage of easily being vulnerable to blockage. To alleviate this problem, multi-path Transmission Control Protocol (MPTCP) which uses multiple Transmission Control Protocol (TCP) subflows can be used. However, MPTCP has a problem with its reordering delay that occurs due to mixed up packet arrival orders. To overcome this issue, in this paper, extensions to the linked increases algorithm (LIA) scheme are made to form the minimized reordering delay LIA (MRLIA) scheme, which is a new MPTCP congestion control scheme that increases the data rate by minimizing the reordering delay while using network resources fairly. Through simulation, it is confirmed that the proposed method can provide an improved performance compared to existing methods in terms of goodput and latency.

10:35 *Overhead Reduction for Graph-Based Point Cloud Delivery Using Non-Uniform Quantization*

Soushi Ueno (Osaka University, Japan); Takuya Fujihashi (Osaka University & Graduate School of Information Science and Technology, Japan); Toshiaki Koike-

Akino (Mitsubishi Electric Research Laboratories (MERL), USA); Takashi Watanabe (Osaka University, Japan)

Graph-based compression can realize a high-quality delivery of three-dimensional (3D) point cloud data over wireless channels. However, it requires a significant amount of communication overhead in sending a graph Fourier transform (GFT) orthogonal matrix. To reduce the overhead, we integrate two methods: Givens rotation and non-uniform quantization. The Givens rotation transforms the GFT orthogonal matrix into angle parameters, and then they are non-uniformly quantized to maintain high quality at low overheads. We demonstrate that the proposed scheme can reduce a communication overhead by 28.6% and improve a 3D reconstruction quality by up to 3.8dB compared with the conventional schemes.

10:40 Deep 6-DOF Head Motion Prediction for Latency in Lightweight Augmented Reality Glasses

Seongwook Yoon, Heejeong Lim and Jae Hyun Kim (Korea University, Korea (South)); Yun-Tae Kim and Hong-Seok Lee (SAIT, Samsung Electronics, Korea (South)); Sanghoon Sull (Korea University, Korea (South))

Computationally expensive rendering of virtual 3D objects in mixed reality applications of lightweight AR glasses can be performed by a remotely connected external server. However, nonnegligible 6DOF pose error caused by the remote rendering latency results in 3D visual inconsistency which can be hardly removed by 2D image correction using IMU. In this paper, we propose a novel 6DOF pose prediction algorithm based on learnable combination of consistent motion model and deep prediction. We formulate the combination of both as controlled residual learning and model ensemble. We build a dataset and demonstrate that our algorithm provides accurate prediction under 200ms.

10:45 Turn Concrete Jungle into Flower Garden: Transforming Reality Based on Semantic Image Synthesis

Juwon Lee and Jong Gook Ko (ETRI, Korea (South))

In this paper, we present an image manipulation system that enables a user to change the scene of an input image by simple semantic conversion of label, which can "transform" reality. To achieve this, we employed semantic segmentation method and trained a semantic image synthesis model on our landscape dataset of 18 classes. Qualitative results demonstrate the effectiveness of our proposed method.

WNT-III: Wireless Networks (3)

Room: Room: CTA

Chair: Meng-Lin Ku (National Central University, Taiwan)

10:20 A Material Selection Method for High Frequency Connectors

Harish M Navale (TRC Companies, USA); Sedig S Agili (Penn State University, USA); Aldo Morales (Penn State Harrisburg, USA); Anilchandra Attaluri (Pennsylvania State University, Harrisburg, USA)

Manufacturers of a high-frequency connectors consider their electrical performance based on the type of material used, in particular by its relative dielectric constant and loss tangent. In addition, manufacturers have to consider mechanical and molding properties as well as the cost of the material. This paper focuses

on developing an optimal method for selecting a high frequency connector material based on electrical, mechanical, and molding properties. This method relies on modified Ashby plots and current industry standards to obtain an optimal region where possible polymers are placed and thereby a practicing signal integrity engineer can choose an appropriate material for a given application. The modified Ashby plot involve the use of sigmoid functions to modify the electrical properties axis as well normalization of the mechanical properties axis, to generate an optimal region. To verify the above method, a material, satisfying the Ashby plot requirements, is chosen. This material is further electrically characterized using the coaxial airline technique up to a frequency range of 18 GHz. The broadband characterization process involves acquiring the scattering parameters from a vector network analyzer and calculating the electrical properties such as dielectric constant and loss tangent. This method allows the practicing signal integrity engineer to efficiently choose polymers for a variety of connectors used in high frequency consumer electronics application such as USB, HDMI, and Thunderbolt.

Presenter bio: Dr. Morales earned his B.S. in Electronic Engineering, with distinction, from Northern University (now University of Tarapaca), Arica, Chile in 1978. He obtained his M.S. and Ph.D. degrees in Electrical and Computer Engineering, from SUNY-Buffalo, in 1986 and 1990, respectively. His research interests are in signal integrity, mathematical morphology, digital image processing, computer vision, and neural networks. He is currently a Professor of the Electrical Engineering at Penn State Harrisburg, Pennsylvania, USA.

10:25 *Transmission Scheduling for Solar-Powered Wireless Monitoring with Data Immediacy*

Ya-Ju Chien, Yi-Ting Chen, Shih-Cheng Yu and Meng-Lin Ku (National Central University, Taiwan); Chih-Min Yu (Yango University, China)

In this paper, a green wireless environment monitoring system is proposed, in which multiple solar-powered clients with sensor nodes can sense the data from the environments and send them back to a server via time-division multiple access. The age of information (AOI) is considered in the design objective to ensure the immediacy of data. To this end, a Q-learning (QL) approach is proposed to schedule the data transmission of multiple clients based on solar, channel, battery, and buffer conditions. Real experiments are conducted to validate the effectiveness of the proposed system and compare the age of data performance with the conventional round-robin scheduling.

10:30 *Reduce the Dimension of the Predistortion Model Coefficients by Lasso Regression*

Xinrong Yang (Xi'an University of Posts & Telecommunications, China); Jijun Ren (Xi'an University of Post & Telecommunications, China); Xing Wang (Xi'an University of Posts & Telecommunications, China); Qiushuang Song (Xi'an University of Post & Telecommunications, China)

This paper proposes a method of using lasso regression to estimate the parameters of the predistortion model. Lasso regression can quickly and effectively extract important variables from many variables to simplify the model. In this paper, ten-fold cross-validation is used to confirm the method of lasso regression regularization coefficient. Experiments show that the model coefficients are reduced from the original 125 to 28, a 78% reduction, which can reduce the computational complexity.

10:35 Decision Tree Based Small-Signal Modelling of GaN HEMT and CAD Implementation

Saddam Husain, Khamida Begaliyeva and Alisher Aitbayev (Nazarbayev University, Kazakhstan); Muhammad Akmal Chaudhary (Ajman University, Ajman, United Arab Emirates); Mohammad Hashmi (Nazarbayev University, Kazakhstan)

This paper explores the use of Decision Tree algorithm in the development of small signal model of GaN HEMT. In this stage, each measured s-parameters are modelled separately exploiting the bias, frequency and geometry dependence of the device as input predictors. This necessitates the tuning of parameters using Bayesian optimization and Random search algorithms. The outcome in terms of MSE and MAE demonstrates that the Random search algorithm gives a superior agreement with the measured values for the entire frequency range. Subsequently, the developed model is incorporated in the commercial CAD environment and a class-F power amplifier is designed to highlight the seamless integration ability and effectiveness of the developed model.

10:40 A Real-Time Analyzer for Testing DTV Play

Orlewilson Bentes Maia (TPV Technology, Brazil); Eddie B de Lima Filho (TPV & Universidade Federal do Amazonas - UFAM, Brazil); Manoel José de Souza Júnior (TPV Technology, Brazil); Paulo Corrêa (INDT, Brazil); Fabricio Izumi Bandeira (TPV, Brazil); Andre Ricardo Silva Conceição (TPV Vision Innovator, Brazil)

Existing digital TV has been converged to an integrated broadcast-broadband system, which allows execution of hypertext markup language applications and access to broadband content. Due this, tests focused on interactive applications are not enough anymore and can be exhaustive to validate whole network inoperative scenarios, which often leads to long execution times and wrong measures and conclusions. This paper addresses this problem and proposes a real-time analyzer for automatic testing an integrated broadcast-broadband based system, which provides reliable results. Experiments with an implementation based on it showed its efficacy, with testing procedures that are, in average, 66.8% times faster than manual ones.

Presenter bio: Received his B.Sc. degree in computer science from the Centro de Ensino Superior FUCAPI (CESF), Amazonas, Brazil, in 2005. He received an M.Sc. degree in Electrical Engineering from Federal University of Amazonas (UFAM) in 2009. He received his Ph.D. in Electrical Engineering from Federal University of Minas Gerais (UFMG), in 2015. Currently, he is Professor at Martha Falcão Faculty/Wyden, and Researcher at TPV Technology. His research interests include IP television (IPTV), Quality of Service (QoS), Quality of Experience (QoE), Internet of Things (IoT), Embedded Systems, and Education Informatics.

10:45 Evaluation of Wireless Connectivity in an Automated Warehouse at 60 GHz

Rahul Singh Gulia, Sayed Ashraf Mamun, Abhishek Vashist, Amlan Ganguly, Clark Hochgraf, Andres Kwasinski and Michael E Kuhl (Rochester Institute of Technology, USA)

Industry 4.0 Autonomous material handling agents demands high-speed indoor network connectivity in warehouses. Wireless interconnections in the 60GHz bands have been demonstrated to provide multi-Gigabit/second data rates in indoor environments. This paper aims to investigate the network connectivity in the 60GHz millimeter-wave band inside an automated warehouse. The challenges to robust and high-speed network connectivity, especially, at mmWave frequencies stem from lots of non-line-of-sight (nLOS)

paths between transmitter and receivers caused by obstructing structures such as metal shelves, and boxes. The added complexity of dynamic variations in the configuration of the warehouse and the multipath reflections and shadow-fading effects add to the challenges of establishing a stable and reliable yet fast network coverage. In this paper we evaluate the performance of 60GHz wireless network inside a smart warehouse through simulations using Network Simulator-3 (NS-3). We consider a realistic indoor warehouse environment with a large number of metallic shelves and contents with dimensions per material handling standards. Our simulation results show that the performance of the network depends on whether line-of-sight (LOS) and nLOS exists between the agents and Access Point, the presence of reflective environment and the number of autonomous material handling agents (AMHAs) in the warehouse.

Presenter bio: Sayed Ashraf Mamun has received M.Sc. and B.Sc. Engineering degrees from the Department of Electrical and Electronic Engineering at the Bangladesh University of Engineering and Technology, Dhaka. He is currently a Ph.D. candidate in the GCCIS department of Rochester Institute of Technology. His research interests include wireless networks and communications, datacenter communication, and machine learning.

Presenter bio: Abhishek Vashist received the B.Tech. degree from ABES Engineering College, India, in 2014, and the Master's degree in electrical engineering from the Rochester Institute of Technology, Rochester, NY, USA in 2017. He is currently working towards Ph.D. degree at the Department of Computer Engineering, Rochester Institute of Technology. His current research interests include design of localization systems for autonomous vehicles, vehicle-to-vehicle (V2V) communication using millimeter-wave technology and computer architecture.

Presenter bio: Amlan Ganguly is currently an Associate Professor in the Department of Computer Engineering at Rochester Institute of Technology, Rochester, NY, USA. He received his PhD and MS degrees from Washington State University, USA and BTech from Indian Institute of Technology, Kharagpur, India in 2010, 2008 and 2005 respectively. His research interests are in robust and scalable intra-chip and inter-chip interconnection architectures and novel datacenter networks with emerging interconnect technologies. He focuses on using wireless interconnects to reduce energy consumption of data communication in multichip systems such as servers and embedded systems. Dr. Ganguly is a recipient of the United States National Science Foundation (NSF) Faculty Early Career Development (CAREER) Award in 2016 for his research in wireless interconnections for chip-to-chip communications and in datacenter networks. He is an organizing member of several conferences such as IEEE International Green and Sustainable Computing Conference (IGSC) and IEEE Workshop on System Level Interconnection Prediction (SLIP) which is collocated with DAC. He has organized Special Sessions in conferences such as IEEE International Symposium on Network-on-Chip (NOCS) named, "Curbing Energy Cravings in Networks: a Cross-sectional view across the Micro-Macro Boundary" in 2011. He was a participating member of the special session on "Advanced Wireless Networks-on-Chip for Future Manycore Architectures" in NCOS, 2015. He has participated in the DAC Workshop on Diagnostic Services in Network-on-Chips, Test, Debug and On-Line Monitoring in 2008 and 2011. Dr. Ganguly was panelist in a panel discussion on "Wireless in NoCs" in SLIP in 2013. He is the co-author of 15 book chapters and journal articles and about 40 conference or workshop articles. He is a member of IEEE.

Saturday, January 8 11:00 - 11:30 (America/New_York)

K3: Keynote 3: Telus CDO Monty Hamilton

Room: Room: Ibuka

Saturday, January 8 11:30 - 12:00 (America/New_York)

T1: Tutorial 1 Q&A Session

Room: Room: Ibuka

11:30 Tutorial 1

Mark Bocko (University of Rochester, USA)

This is the 1st Tutorial.

Saturday, January 8 12:00 - 12:30 (America/New_York)

T2: Tutorial 2 Q&A Session

Room: Room: Ibuka

12:00 Getting Your Geek on: From Computing Theory to Practice

Milan Vidakovic (University of Novi Sad - Faculty of Technical Sciences, Serbia);

Charlotte Kobert (IEEE CT Society, USA)

Couple of years ago I decided to make a computer from scratch. I had to design everything: instruction set, internal architecture, and interface to peripherals. I used FPGA development board to implement the core of the system. Then I added VGA graphics, UART, keyboard, mouse, SD card and Ethernet connectivity. In parallel, I invented my own assembler, modified GCC to work with my architecture and started making applications. Being able to design every important bit of the system, it was easy to enhance/improve it. Enter the magic world of GCC, assembler, cache, DMA, blitting, graphics acceleration, etc.

Saturday, January 8 12:30 - 14:00 (America/New_York)

IF09: Industry Forum Session 3:

Evolution of Moore's Law for Consumer Electronics

Moderators: Tom Coughlin and Michael Mattioli

Room: Room: Ibuka

It's far from a secret that Moore's Law has been dead for quite some time; clock speeds and transistor density are no longer indicators of a platform's performance. Heterogeneous computing architectures and special purpose hardware have become much more prevalent in recent years. The next several years of security, performance, and power efficiency benefits in consumer products will not come from mere IPC and process technology improvements but, rather, by carefully integrating purpose-built hardware, which results in a highly-optimized system. There are several notable examples of this in recent years (Apple M1, Microsoft Pluton, Apple Afterburner, etc.) - many of them are used in consumer electronics. What was once reserved for the very expensive high-performance computing market (e.g. data center, cloud, etc.) is now readily available to consumers worldwide. This session will look at the current state and projected future of the new class of special purpose hardware in the consumer industry. Here is a list of potential participants: Mark Papermaster, AMD Sam Naffziger, AMD Alan Lee, AMD TBD, Intel TBD, Xilinx

Saturday, January 8 14:00 - 15:30 (America/New_York)

IF00: Industry Forum Session 4:

Product Compliance in Consumer Technology

Moderator: Stefan Mozar

Room: Room: Ibuka

Sunday, January 9

Sunday, January 9 9:00 - 9:30 (America/New_York)

HMI-I: Human-Machine Interaction

Room: Room: CTA

Chair: Kingkarn Sookhanaphibarn (Bangkok University, Thailand)

9:00 Educational Robotics in the Service of the Gestalt Similarity Principle

Aphrodite Sophokleous (Neapolis University Pafos, Cyprus); Angelos Amanatiadis (Democritus University of Thrace, Greece); Socratis Gkelios and Savvas A Chatzichristofis (Neapolis University Pafos, Cyprus)

Several studies have shown that educational activities with robots lead to increased student interest. This paper adopts a content-based image retrieval mechanism to automate the Gestalt similarity testing process and evaluates the impact of the involvement of a humanoid robot. The proposed framework aims to improve participants' visual perception, cultivate their creativity, and improve their visual working memory. During a pilot study, the participants communicate with the proposed framework either by using a tablet or by interacting with a humanoid robot. The experimental results showed that the participation of NAO significantly increased the interest, attention, and commitment of the students.

9:03 How an Educational Robot Should Look like: The Students' Perspective

Georgios Kyprianou (Neapolis University Pafos, Cyprus); Alexandra Karousou (Democritus University of Thrace, Greece); Nikolaos Makris (Democritus University of Thrace, Cyprus); Ilias Sarafis (International Hellenic University, Greece); Savvas A Chatzichristofis (Neapolis University Pafos, Cyprus); Angelos Amanatiadis (Democritus University of Thrace, Greece)

Today, there is a growing demand for educational robots in consumer electronics. This can be observed from the high promotion educational robots get from crowdfunding platforms, where more than 2000 projects have been funded successfully. The main objective of this paper is to investigate the characteristics a robot should have and the way of interaction and socialization with it, as the students are seeking and expecting it. This could provide the attributes and standards of constructing the perfect model for the students to acquire what they are pursuing in a more effective, exciting manner without losing their motivation.

9:06 Local-Sound Visualizations for Presence Control of Telepresence Robots

Takayuki Arakawa (Kyocera Corporation & Future Design Research Laboratory, Japan); Haruya Takase, Hanako Ishida, Takeshi Sugimoto, Seiji Horii, Tsnehiko

Kamachi and Osamu Hoshuyama (Kyocera Corporation, Japan)

We propose two local-sound visualizations for telepresence robots to make presence-control and perception-control easier. One is a visualization of local-sound direction to find local participants. The other is a visualization of spatial spread of remote-operators' voice amplified by the loudspeaker in a local site. To verify the effectiveness of these methods, a remote-controlled robot was developed, 24 subjects played a simple voice game via the robot. Temporal indicators for playing the game and questionnaires confirmed that the two methods contributed to usability, and the former method reduces the time of a remote-operator to discover local participants by half.

9:09 Improving the User Experience for Manual Data Labeling Using a Graph-Based Approach

Bernard Beitz and Robert Roth (University of Wuppertal, Germany); Jutta Häser (Bethlehem University, Palestine); Tobias Wiegand and Reinhard Moeller (University of Wuppertal, Germany)

Even though the ever-increasing demand for large amounts of data makes automated data labeling indispensable in many cases, labels must still be entered manually in various areas. In these cases, an acquisition process that is as simple as possible is essential to ensure high data quality even for complex data sets. We present a graph-based approach that guides a user step-by-step through the process, minimizing the number of possible choices at each step using a defined terminology. A case study demonstrates the capabilities of this approach and statistically evaluates the simplification achieved by this method.

9:12 User-Defined Keyword Spotting Utilizing Speech Synthesis for Low-Resource Wearable Devices

Jaebong Lim and Yunju Baek (Pusan National University, Korea (South))

In this paper, we propose a novel keyword spotting (KWS) system for wearable devices that allows users to add user-defined keywords in quick and easy way. Adding keywords in KWS requires developing a new model to support them, where the model development takes a lot of work and time. To overcome this, we propose an approach that automates the entire development phase of a KWS model for low-resource devices. The proposed system is characterized by automating the data collection step and training step using synthetic speech data. Our implementation and experiments show that the proposed system can automatically develop a user-defined KWS model within a minute.

9:15 Zenbo on Zoom: Evaluating the Human-Robot Interaction User Experience in a Video Conferencing Session

Curtis Gittens (The University of the West Indies, Cave Hill Campus, Barbados);

Damian Garnes (The University of the West Indies Cave Hill Campus, Barbados)

The COVID-19 pandemic has restricted the ability of HRI researchers to undertake face-to-face HRI user studies while obeying existing social and physical distancing mandates. In this pilot study we evaluated the quality of the user experience reported by undergraduate CS/IT students after they had two online interactions with a social robot using the Zoom video conferencing system. Our results showed that there was nothing inherently detrimental to performing HRI user studies online. Indeed, based on these preliminary results, researchers who are conducting HRI user studies online can have more confidence that the online interaction modality does not negatively affect their results.

9:18 Using Maximum Deviation Method and Linguistic TOPSIS to Evaluate Competitive Ability of Line Marketing Platform Supplier

Hsing-Chau Tseng (Chang Jung Christian University, Taiwan)

Line marketing platform is an important mechanism for help factory to sell its product without the expense of middleman. Factory needs to pick up the best line marketing platform supplier. This study designs the framework to evaluate the competitive ability of line marketing platform supplier. In this framework, maximum deviation method is integrated with linguistic TOPSIS to choose the best line marketing platform supplier. A case is implemented for reader understand proposed method. Finally, some conclusion will be discussed as ending.

9:21 V3 - A Gesture Controlled Drone

Harshith N Srivatsa (PES University, India); Dheeraj Kumar N (Pes University, India);

Kushal S L (RV College of Engineering, India)

Absolute freedom of flying has been a long-held dream of Mankind. However, even after decades of technological advancements the joy of flying and experiencing a bird's eye view hasn't been truly fulfilled. This paper reports on the research carried out at The Vimana to develop an integrated product capable of delivering real-time immersive visual experiences of flying with great ease of controls and low cost. The solution is a combination of 3 devices, Vulture - a Ready-to-Fly Drone, Vings - a handheld device with intuitive controls that intelligently maps the motion of the arm to control the drone's motion, and Vision - an ergonomically designed headset to equip a mobile phone with our proprietary application to give live feed from the drone and to track the head movements to control the Gimbal on the drone.

Presenter bio: Experienced technical trainer with a demonstrated history of working within the education management industry. I want to use my knowledge and skills to realize practical exposure and understand the inner workings of the corporate. I would like to learn on the job and grow individually. I have graduated from PES University, Bangalore with Bachelor's degree in Electronics and Communication Engineering. Currently I am working as a Software Engineer at Accenture. LinkedIn Profile: www.linkedin.com/in/ndheerajkumar23101999

Presenter bio: I am Harshith.N.Srivatsa, a B.Tech graduate from PES University Bangalore, Karnataka, India. I have graduated my B.Tech in the year 2021 with a majors degree in Electrical and Electronics Engineering and minor degree in Computer Science and a specialization in Embedded Systems.

9:24 A Methodology for Emulating, Developing, and Testing the Middleware DTV Play in Personal Computers

Bruno Farias (TPV Technology, Brazil); Ivo Machado (TPV, Brazil); Eddie B de Lima Filho (TPV & Universidade Federal do Amazonas - UFAM, Brazil); Cláudio F. M. Pinheiro (TPV Technology & Faculdade Martha Falcão - FMF | Wyden, Brazil); Petrina Kimura (TPV Technology, Brazil); Leonardo Cordeiro (TPV TEchnology, Brazil); Daniel Xavier (TPV, Brazil)

Traditional environments for developing middleware stacks for DTV Play are often based on personal computers, using their available modules and resources. However, as those do not usually represent correctly the digital TV environment found in commercial platforms, the resulting elements may present restrictions, wrong behavior, and bugs related to incorrectly handled scenarios. The present work addresses this problem and proposes an emulation methodology that includes representations of elements specific to DTV platforms, such as tuners and demultiplexers. An evaluation performed with a real implementation

of this scheme showed that it provides software already prepared for final DTV products and shorter development periods.

9:27 *Selecting a Robotic Platform for Education*

Salomi Evripidou (Neapolis University Pafos, Cyprus); Lefteris Doitsidis (Technical Univ of Crete, Greece); George Tsinarakis (Technical University of Crete, Greece); Zinon Zinonos and Savvas A Chatzichristofis (Neapolis University Pafos, Cyprus)

Undoubtedly, the popularity of educational robotic platforms has disrupted the way students are educated while forming an important and promising new market for robotics and consumer electronics companies. Selecting an educational robotic platform is an important task, as it can affect the learning process and the respective learning outcome. To effectively select a robotic kit for a specific activity, several factors should be taken into account. However, choosing a robot for one particular application has become more complicated in recent years because of the increased complexity and the available features and facilities constantly introduced into the robots. Despite the fact that several robot selection methodologies have been established for industrial uses, there has been little study on robot selection for learning purposes. The main objective of this work is to determine the most important parameters for selecting a robotic platform, as they were identified through an extensive literature survey. The work aims to assist consumers in choosing the appropriate educational robots, while supporting manufacturers in designing platforms suitable for education purposes.

MDA-IV: ML and DL in CE (4)

Room: Room: Ibuka

Chair: Ramneek Ramneek (Korea University, Korea (South))

9:00 *Robust Masked Face Recognition via Balanced Feature Matching*

Yu-Chieh Huang, Lin-Hsi Tsao and Homer Chen (National Taiwan University, Taiwan)

Wearing a facial mask has become a must in our daily life due to the global COVID-19 pandemic. However, the performance of conventional face recognition systems severely degrades for faces occluded by masks. How to combat the effect of occlusion on face recognition is an important issue. However, the performance of existing methods developed for masked face recognition unpleasantly degrades when dealing with unmasked faces. To address this issue for real-world applications, where the gallery image or the probe image may be a masked or unmasked face, we propose the concept of balanced facial feature matching and, based on it, design a robust masked face recognition system. The matching is balanced because it is performed on features extracted from corresponding facial regions. The system consists of a classification network and two feature extractors. The classification network classifies an input face image into a masked face or an unmasked face. One feature extractor extracts the feature of a full face, and the other uses a guided perceptual loss to focus the feature extraction on the non-occluded part of the face. The system is tested on both synthetic and real data. The face verification accuracy is improved by 2.4% for the synthetically masked LFW dataset, 1.9% for the MFR2 dataset, and 5.4% for the RMFD dataset. The results further show that the system improves masked face recognition while preserving the performance of unmasked face recognition.

9:04 Object Detection Edge Performance Optimization on FPGA-Based Heterogeneous Multiprocessor Systems

Lit-Yang Liew and Sheng-De Wang (National Taiwan University, Taiwan)

Object detection tasks implemented using complex convolutional neural network (CNN) algorithms are both computational and memory intensive, making them difficult to deploy on CPU-only embedded systems due to their limited edge computing capabilities. Heterogeneous multiprocessor systems come in handy to perform these tasks. These systems usually integrate CPU and other processing units like GPU, DSP and FPGA such that each task is preferably executed by the unit which is able to efficiently perform that task with superior energy efficiency. This paper proposes a workflow with a series of optimization approaches such as model pruning, model quantization and multi-threading design in implementing an object detection task based on YOLOv4-CSP on a FPGA-based heterogeneous multiprocessor system. The YOLOv4-CSP network architecture is the state-of-the-art one-stage detection model. It is widely known for its fast inference time in object detection task. The experiments show that we can achieve a significant edge performance with lesser computing resources to implement object detection with complex CNN algorithms.

9:08 Information Extraction and Analysis on Certificates and Medical Receipts

Tzung-Pei Hong (National University of Kaohsiung, Taiwan); Wei Chou Chen (CoreTech Knowledge Inc., Taiwan); Chih-Hung Wu (National University of Kaohsiung, Taiwan); Bo Wen Xiao, Bing-Yang Chiang and Zhi-Xun Shen (CoreTech Knowledge Inc., Taiwan)

Document digitalization has become a trend in recent years. It provides fast analysis and search because the information in the documents can be easily managed. However, in real applications, while digitalization is in progress, lots of information has not yet been digitalized and only stored on papers. A common demand of analyzing a large amount of documents would be a time-consuming mission because they need massive human labor. Nowadays, some computer vision algorithms have emerged and they can be applied in such a scenario. In this paper, we propose an automatic information extraction and analysis system for madarin documents. It consist of three main steps. Firstly, the text regions in documents under natural scenes are detected. Secondly, these text regions are recognized and converted into digital forms. Finally, heuristic rules are designed and integrated into the system to improve the recognition accuracy. The proposed system is expected to eliminate the time-consuming problem of document information extraction.

9:12 Inclusive Convolutional Neural Network Design Enabling Partially Sighted People to Expand Viewing-Experience on Screens

Jae Sung Park, Cheon Lee, Daesung Lim, Seongwoon Jung, Jiman Kim and Junghwa Choi (Samsung Electronics, Korea (South)); Young-Su Moon (Samsung Advanced Institute of Technology, Samsung Electronics, Korea (South))

A deep neural network-based picture enhancement technique that enables partially sighted people to expand their viewing-experience on smart large TV screens is proposed. Reflecting insights from our previous studies on preferred picture enhancement features for low vision people, a convolutional neural network architecture that can generate visibility-enhanced images on screen is presented. The neural network which has very large scales of convolutional layers is trained to output super-resolved and salient feature-improved images for helping the visually impaired to see more clearly images on screens. Our

experiment result proves that synthesized images by the proposed neural network are expected to give more vivid visual experiences when people with low vision are watching screens. To the best of our knowledge, inclusive neural network design in terms of the picture quality is the first approach which can help the visually impaired to see directly any content itself on screen.

9:17 A Study on the Noise Removal in Road Images Acquired from Black Box Based on Convolutional Neural Networks

JongBae Kim (Sejong Cyber University, Korea (South))

In this paper, we propose a convolutional neural network-based method to remove noise included in road images acquired from a vehicle black-box. In general, various noises are included in a road image acquired from a black-box installed in a vehicle while driving on the road. For example, noise is included in the image due to vehicle exhaust gas, light reflected by objects, fog, sunlight, etc. To remove noise included in the road image, a regression model that estimates the original image from the road image including noise is generated by learning the original road image and the road image to which noise is added using a convolutional neural network. As a result of testing the proposed method on actual road images, an average noise removal rate of about 24% was presented.

9:21 Three-Dimensional Facial Ethnicity Identification Based on Cylindrical Projection and Deep Learning

Takuma Terada and Yen-Wei Chen (Ritsumeikan University, Japan); Ryosuke Kimura (University of the Ryukyus, Japan)

Various applications have been developed in facial research to aid the recognition of personal attributes, analysis of race, and personal authentication for the security industry and other research fields. Because of the wealth of information contained in 3D facial images, 3D face recognition has recently become an active research field. Nevertheless, because of its high dimension, 3D face recognition remains a difficult task. We propose a 3D facial ethnicity identification method on the basis of cylindrical projection and deep learning in this paper. In the proposed method, we first use cylindrical projection to convert a 3D facial image (scanned 3D data) to a 2D grayscale image. The depth information is represented by the grayscale. The transformed 2D image is then fed into a convolutional neural network for ethnicity recognition. The proposed method is alignment-free, and any existing convolutional neural networks developed for 2D image recognition can be used to identify ethnicity. The effectiveness of the proposed method was validated on our private 3D dataset and demonstrated that the proposed method can give promising identification performances between the Mainland Japanese and the Ryukyuan.

9:25 Automatic Segmentation of Infant Brain Ventricles with Hydrocephalus in MRI Based on Deep Multi-Path Learning

Hikari Jinbo, Yutaro Iwamoto and Yen-Wei Chen (Ritsumeikan University, Japan); Masahiro Nonaka (Kansai Medical University, Japan)

Brain ventricles of infants with hydrocephalus is a brain disease in which cerebrospinal fluid accumulates in the ventricles of the brain, causing them to expand abnormally. There is a risk that the ventricles may cause brain damage by compressing other brain tissues. For early detection and postoperative follow-up, it is necessary to extract the ventricles with less burden. Automatic segmentation of infant brain ventricles with hydrocephalus is a challenging task. Especially, the infant brain ventricles with hydrocephalus have complicated and diverse shapes. Therefore, it is difficult to achieve an accurate segmentation with conventional deep learning. In this paper, we propose a deep multi-path learning

approach for accurate segmentation of infant brain ventricles with hydrocephalus. In the proposed method, we constructed three deep learning models for axial plans, sagittal plans and coronal plans, respectively, and integrated the results of the models to form the final segmentation result. The segmentation accuracy was improved from 76.1% to 82.4%.

Presenter bio: Medical image segmentation (i.e., liver segmentation) is an important pre-processing for computeraided diagnosis and computer-aided surgery. Deep learning, which can perform fully automated segmentation, has been popular in the medical field because of its ability to reduce the burden on doctors. However, segmentation is inherently a difficult problem and the accuracy of current deep learning-based segmentation methods remains insufficient. In this work, an interactive network-based segmentation is proposed, which can improve the operation through collaborations with a doctor.

SS-I: Technologies and Services for Private 5G/6G

Room: Room: TELUS

Chair: Jinyoung Han (Sungkyunkwan University, Korea (South))

9:00 Trafficformer: A Transformer-Based Traffic Predictor

Junseo Ko and Jeewoo Yoon (Sungkyunkwan University, Korea (South)); Daejin Choi (Incheon National University, Korea (South)); Eunil Park (Sungkyunkwan University, Korea (South)); Sangheon Pack (Korea University, Korea (South)); Jinyoung Han (Sungkyunkwan University, Korea (South))

In this paper, we propose a deep learning model that can predict future traffic. The proposed Transformer-based model is evaluated using the visit data of popular Wikipedia pages for more than 2 years through multiple accessing devices such as mobile and desktop. The experiment results demonstrate that the proposed model can predict the future traffic with high accuracy.

9:06 A Distributed NWDAF Architecture for Federated Learning in 5G

Youbin Jeon, Hyeonjae Jeong, Sangwon Seo, Taeyun Kim, Haneul Ko and Sangheon Pack (Korea University, Korea (South))

For network automation and intelligence in 5G, the network data analytics function (NWDAF) has been introduced as a new network function. However, the existing centralized NWDAF structure can be overloaded if an amount of analytic data are concentrated. In this paper, we introduce a distributed NWDAF structure tailored for federated learning (FL) in 5G. Leaf NWDAFs create local models and root NWDAF construct a global model by aggregating the local models. This structure can guarantee data privacy since local models are created in NF, and can reduce network resource usage because the global model is created by collecting local models.

9:12 An Implementation Study of Network Data Analytic Function in 5G

Taeyun Kim, Joonwoo Kim, Haneul Ko, Sangwon Seo, Youbin Jeon, Hyeonjae Jeong, Seunghyun Lee and Sangheon Pack (Korea University, Korea (South))

Network automation and intelligence are evolutionary directions in 5G, and network data analytic function (NWDAF) plays a key role to realize this vision. In this work, we present an implementation result of NWDAF in free5GC that is an open software for 3GPP mobile core networks. The implemented NWDAF module consists of 1) model training logical function (MTLF) to train the model and 2) analytics logic function

(AnLF) to provide analytic results based on the trained model. We have verified the operability of NWDAF and released it through Github. Extensive experimental study will be conducted in our future work.

9:18 5G and User Experience: A Bibliometric Approach

Dahye Jeong, Jinyoung Han, Eunil Park and Eun Been Choi (Sungkyunkwan University, Korea (South)); Sangheon Pack (Korea University, Korea (South))

This paper aims to conduct a bibliometric analysis of research at the intersection of 5G and user experience in the last five years. The main purpose of the current study is to provide the current status and trends of this intersection research in one of the academic research databases, that is, Web of Science. From the results of our study of 116 collected articles, published from 2017 to 2021, we found a continuous growth in this area of intersection research. We highlight several leading affiliations, publication venues and supporting agencies and confirm that there are notable interests and improvements in this area.

9:24 Handover Performance of Split RAN-Based Vehicular Networks: A Simulation Study

Daeyoung Jung, Dongju Cha, Dong Kyun Ryoo and Kyeong tak Lee (Korea University, Korea (South)); Junsik Kim (ETRI, Korea (South)); SoonGi Park (Electronics and Telecommunications Research Institute, Korea (South)); Sangheon Pack (Korea University, Korea (South))

Split radio access network (RAN) is a promising technology to achieve seamless coverage and high utilization by deploying a number of distributed units (DUs) and controlling them with a central unit (CU). In this paper, we consider a split RAN-based vehicular network and investigate its handover performance. Specifically, we extended the integrated access and backhaul (IAB) module in the ns-3 mmWave package for split RAN and conducted extensive simulations on the UDP throughput. The simulation results demonstrate that the UDP throughput can be improved by deploying more DUs under the CU for seamless coverage.

Sunday, January 9 9:40 - 10:10 (America/New_York)

MDA-V: ML and DL in CE (5)

Room: Room: Ibuka

Chair: Ramneek Ramneek (Korea University, Korea (South))

9:40 Speaker Authentication Method Using Reservoir Computing for Security System

Yuki Sakaguchi, Rin Hirakawa, Yoshihisa Nakatoh and Hideaki Kawano (Kyushu Institute of Technology, Japan)

In recent years, we have been using biometric authentication systems in various places such as daily life and businesses. However, it's insufficient in hospital and food factory to introduction of the security system of the room access control. This is because they wear gloves, masks and hats in hospitals and factories, so they cannot authenticate faces or fingerprints. To solve this problem, I turned my attention to voice authentication. In this study, I propose a speaker authentication system based on Reservoir Computing. Reservoir computing is a new type of recursive neural network. In this study, we conducted classification experiments on 3, 5, and 10 speakers. The results show that the F-measure is above 0.9 for all the number

of speakers.

9:45 Concept Drift Adaptation for Audio Scene Classification Using High-Level Features

Ibnu Daqiqil Id, Masanobu Abe and Sunao Hara (Okayama University, Japan)

Data used in the model training is assumed to have a similar distribution when the model is applied. However, in some applications, the data distributions may change over time. This condition, known as the concept drift, might decrease the model performance because the model is trained and evaluated in different distributions. To solve this problem in the audio scene classification task, we previously proposed the Combine-merge Gaussian mixture model (CMGMM) algorithm, where Mel-frequency cepstral coefficients (MFCCs) are used as the feature vector. In this paper, in the CMGMM algorithm, we propose to use the Pre-trained audio neural networks (PANNs) to model event audio that exists in the scene. A motivation is, instead of acoustic features, to make the best use of high-level features obtained by a model that trained using a large amount of audio data. The experiment result shows that the proposed method using PANNs improves model accuracy. In the active methods with abrupt and gradual concept drift, it is recommended to use PANNs to have significant accuracy improvement and obtain optimal adaptation results.

Presenter bio: PhD Student of Okayama University, Japan

9:50 Multi-Stream Face Anti-Spoofing System Using 3D Information

Pengchao Deng, Ge Chenyang, Xin Qiao and Hao Wei (Xi'an Jiaotong University, China)

Face anti-spoofing plays a crucial role in face recognition systems widely used in smart devices and security systems. In this paper, We propose a multi-stream fusion system based on a 3D camera by making full use of 3D information for face anti-spoofing. This 3D information is composed of depth maps and Surface Normal Maps (SNM). Detailed discussions about systems are given. Comparison among different modalities and comparison among other methods are provided through several experiments on the public WMCA dataset and our self-build Anti-3D dataset. Due to fewer parameters and less time overhead, We also implement the system on hardware platforms with a 3D camera.

9:55 Distinct Feature Labeling Methods for SVM-Based AMD Automated Detector on 3D OCT Volumes

Yao-Wen Yu (Yuan Ze University, Taoyuan City, Taiwan); Cheng-Hung Lin (Yuan Ze University, Taiwan); Cheng-Kai Lu (Universiti Teknologi PETRONAS, Malaysia); Tzu-Lun Huang and Jia-Kang Wang (Far Eastern Memorial Hospital, Taiwan)

Today's automated detectors of Age-related macular degeneration (AMD) on optical coherence tomography (OCT) volumes using the support vector machine (SVM) are widely researched in the field of ophthalmology. Additionally, an OCT volume is three-dimensional (3D) data composed of several OCT images. Therefore, two feature labeling methods, the slice-chain labeling method and the slice-threshold labeling method, are investigated for the 3D OCT volume in this paper. The two labeling methods are evaluated in this paper because they influence detection accuracy for the SVM-based AMD automated detector and the number of features stored in the memory of SVM hardware. According to the quantization analysis, we can easily compare several types of feature extraction in the local binary patterns (LBP) and linear configuration patterns (LCP) in the data that have to be stored in the RAM. From the experiment

results, the slice-threshold labeling method achieves a high detection accuracy of 96.36% with 35.34% features saved in the memory of SVM hardware compared with the slice-threshold labeling method.

10:00 Emotion Recognition from Raw Speech Signals Using 2D CNN with Deep Metric Learning

Bogdan Mocanu (University Politehnica of Bucharest VAT-RO14814742, Romania);
Ruxandra Tapu (Institut Telecom / Telecom SudParis, France)

In this paper we have introduced a novel emotion recognition framework from raw speech signals. The system is based on ResNet architecture fed with spectrogram inputs. The CNN is further extended with a GhostVLAD feature aggregation layer that extracts a single, fixed size descriptor constructed at the level of the utterance. The system adopts a sentiment metric loss that integrates the relations between various classes of emotions. The experimental evaluation conducted on two publicly available databases: RAVDESS and CREMA-D validates the proposed methodology with average accuracy scores of 82% and 63%, respectively.

Presenter bio: Ruxandra Tapu (M'09) received as valedictorian her B.S. degree in Electronics, Telecommunications and Information Technology from University "Politehnica" of Bucharest, Romania in 2008. In 2012 she received her PhD. in Informatics and Telecommunications from University Paris VI - Pierre et Marie Currie (Paris, France). From 2012 she is a researcher within ARTEMIS department, Institut Mines-Telecom/Telecom Sudparis having as major research interest content-based video indexing and retrieval, pattern recognition and machine learning techniques.

10:05 AI Camera: Real-Time License Plate Number Recognition on Device

Kim Taewan, Chunghun Kang, Yongsung Kim and Seungji Yang (SK Telecom, Korea (South))

Intelligent surveillance cameras with artificial intelligence (AI)-based video analytic function have become pervasive in recent years. They hold the promise of bringing high fidelity, contextually rich sensing into our home town and workplaces as a means of making our life smarter and safer. Despite remarkable and indisputable advances, AI cameras are still limited in the proper convolutional neural networks (CNNs) model, and more importantly, do not easily design a robust system architecture between edge device and (cloud) server for real-world applications. Towards addressing these limitations, we have developed an commercialized AI camera can be installed at any position that we use to recognize the license plate incorporating front-end and back-end intelligence. For intelligent front-end system, we designed three unique CNNs models on AI camera for detecting license plate with its corner points and recognizing the characters and numbers sequentially. To increase the accuracy of AI functions on camera continuously, it is connect to back-end intelligence server where the current models on AI camera is updating with new incoming data in a continual process of adaptation. We conducted a series of experiments, showing high accuracy and versatility of the new architecture, while yielding robust results that can be practically implemented.

Presenter bio: Taewan Kim received the B.S., M.S., and Ph.D. degrees from Yonsei University, Seoul, South Korea, in 2008, 2010, and 2015, respectively, all in electrical and electronic engineering. He is currently with the Vision AI Product CoE, SK Telecom, Seoul. His current research interests include object detection, semi-supervised learning, online learning, generative adversarial network based on machine learning. Dr. Kim received the Samsung Humantech Thesis Prize in 2013. He has participated in the IEEE Standard Working Group for 3D Quality Assessment (IEEE P3333.1).

SPC-I: Security and Privacy

Room: Room: CTA

Chair: Stefan Katzenbeisser (University of Passau, Germany)

9:40 Assessing Network Infrastructure-As-Code Security Using Open Source Software Analysis Techniques Applied to BGP/BIRD

Wahab Almuhtadi (Algonquin College, Canada); Wynn Fenwick (TELUS, Canada); Liam Henley-Vachon and Peter Mitchell (Algonquin College, Canada)

In this paper, the security quality of an open-source software application for IP networks called BIRD is examined. Free and open-source software applications are used in all areas of modern software development. BIRD handles the Border Gateway Protocol (BGP) sessions between many different Autonomous Systems (AS) and is a very popular routing engine used at Internet Exchange Points (IXP's) around the world. It is essential to perform an in-depth analysis when using open-source software to understand risks, develop or improve products to offset the risks of lenient source code acceptance criteria and easier exploit insertion. Testing consists of three different stages: Open Source Intelligence (OSINT) conducted on the contributors to determine intentions for involvement, Static Application Security Testing (SAST) carried out to examine the source code for potential bugs and security risks, and Dynamic Application Security Testing (DAST) dealing with verifying the stability of the program during run-time. Test results and analysis are in section IV.

9:43 Fingerphoto Recognition Using Cross-Reference-Matching Multi-Layer Features

Keiichiro Nakazaki, Naoto Miura, Yusuke Matsuda and Akio Nagasaka (Hitachi, Ltd., Japan)

A fingerphoto-recognition method-which efficiently combines multi-layer biometric features for accurate personal identification even with low-quality images-is proposed. The proposed method extracts both knuckleprint patterns and vein patterns that do not require high-resolution cameras for observation. The distance between one of these patterns and a registered template is calculated in reference to the location-shifting information of the matching using the other pattern. This calculation is performed mutually, and the pair of obtained distance are fused. The experimental results show that the proposed method yields an equal error rate of 1.093%, compared to 4.114% by the conventional method using knuckleprint patterns.

9:47 Innovative Social Cyber Competency Test Method, Using the Application of Neural Network and Artificial Intelligence

Soorena Merat (Silkatech Consulting Engineers Inc. & Silkatech Consulting Engineers Inc., Canada); Wahab Almuhtadi (Algonquin College, Canada)

This present research introduces an innovative approach for testing the issues, regarding social engineering and social risk competency. The method is based on the fussy attention in social media spaces and expectation function via bio-sensory distraction due to the distractive curiosity and irresistible reward-seeking. Group of test participants are employed, and a neural network algorithm is used to artificially map the entire eye movement parameters and distraction tracking. An advanced machine-learning algorithm is also used to convert the model into a functional behavior. The outcome is utilized to predict conditions that may lead to possible correlations with the cyber-attack measures.

9:51 LiDAR Spoofing Attack Detection in Autonomous Vehicles

Khattab M. Ali Alheeti (University of Anbar, Iraq); Abdulkareem Alzahrani (Al Baha University, Saudi Arabia); Duaa Al-Dosary (University of Anbar, Iraq)

Detecting 3D objects is a core task for autonomous vehicles (AVs), as it allows them to drive safely and responsibly. AVs have LiDAR sensors, which can capture 3D data from 360° in various conditions, including harsh weather. However, LiDAR sensors may face a spoofing attack via laser satirizing. This type of attack can mislead AVs by providing them with false information, which can then put passengers, pedestrians, and other vehicles in danger. Therefore, this paper proposes a model utilizing decision trees to protect AVs from such attacks. The performance of the model indicates that it can detect LiDAR spoofing attacks.

9:55 Delegation of Security Functions in Heterogeneous Embedded Systems

Yibo Zhang (International Professional University of Technology in Osaka, Japan)

Various security challenges have been arising with the advent of Internet of Things (IoT) in the past decade. One of the issues is the limited resources for enforcing security functions in heterogeneous embedded IoT systems. This paper aims to cope with this issue by resolving the delegation problems within the scope of systematic security design. Concrete techniques for the delegation of security functions are discussed. Meanwhile, partial delegation and total delegation, and restrictions on the practice of delegation are examined. It also shows that the storage and communication capacities in the system are restriction factors affecting the viability of security function delegation.

9:59 Physical Security Using Machine Learning to Detect Lock Picking at Traffic Cabinets

Hannon Shepard, Michael Young and Billy Kihei (Kennesaw State University, USA)

Traffic systems are filled with essential traffic control equipment and can cause massive infrastructural damage and driver safety if hacked. We explore a machine learning method to detect real-time lock picking to thwart unauthorized access to the electronics. We gather accelerometer and gyroscopic data to train a decision tree model for detecting lock picking. Analysis reveals that a standard deviation feature for only two accelerometer axes is adequate for achieving robust performance. We deployed an real-time decision tree model to an offsite test cabinet that achieves an accuracy of over 95%.

10:02 Identity-Based Authentication Technique for IoT Devices

Brij Gupta (National Institute of Technology Kurukshetra, India); Akshat Gaurav (Ronin Institute, USA); Kwok Tai Chui (The Open University of Hong Kong, Hong Kong); Ching-Hsien Hsu (Asia University, Taiwan)

The Internet of Things (IoT) is a broad term used to describe many types of linked equipment that are both intelligent and interconnected through a network. These Internet of Things devices have become an essential part of our everyday lives. These devices, however, are still in the development stage. Because of their low computing capacity, they are susceptible to various cyberattacks like distributed denial of service (DDoS) attacks and denial of service (DoS) attacks. They disrupt the normal functioning of IoT devices and expose sensitive data; therefore, identifying and mitigating cyber-attacks on IoT devices is a critical area of study. In this regard, we proposed an IoT device-specific unique identity-based authentication method in this paper. Our proposed approach employs lightweight authentication procedures that use the unique IDs of IoT devices to provide identity-based encryption.

10:06 Evaluation on White-Hat Worm Diffusion Method Based on the Evolution of Its Lifespan in Wireless Networks

Mohd Anuaruddin Bin Ahmadon and Shingo Yamaguchi (Yamaguchi University, Japan)

We propose a diffusion method based on the lifespan of white-hat worm that changes according to the network environment, such as distance of nodes and density of the infected network. The main objective is to exterminate malware and to leave no white-hat worm after the extermination. Therefore, we introduce the lifespan and lifespan ratio in our approach based on the network environment. We can control the extermination effect by increasing or decreasing the lifespan ratio. We evaluate our method to show that changing lifespan can improve the result of exterminating malware and cleaning the networks from white-hat botnets.

SS-II: Advanced Image and Signal Processing Technologies and Circuits Design for Smarter Systems

Room: Room: TELUS

Chair: Chih-Peng Fan (National Chung Hsing University, Taiwan)

9:40 Developing Tactile Flashcards from 2D Images

Aaron Raymond A. See (Southern Taiwan University of Science and Technology, Taiwan); Chris Jordan Aliac, Therese Bolabola, Justine Klynt Salgarino, Mark Kenith Simbajon and Avery May Tabanao (Cebu Institute of Technology - University, Philippines)

Education is distinctive for Visually Impaired and Blind students compared to regular students. This research aims to optimize the creation of tactile flashcards. Images gathered are first processed using instance segmentation using Mask R-CNN. Then the PixelLib library was used to implement the model. In this process, the model outputs the segmented object from the image. The output for the first process acts as the input for the second process, the conversion of 2D images to 3D. Subsequently, both the 3D image and Braille text are generated and the resulting output is a STL file that is ready for printing.

9:42 Retinex Based on Weaken Factor with Truncated AGCWD for Backlight Image Enhancement

He-Sheng Chou, Hsiang-Yun Cheng, Jun-Xiang Qiu, Tsun-Huang Chi, Tsung-Yi Chen and Shih-Lun Chen (Chung Yuan Christian University, Taiwan)

This paper proposes a new backlight contrast enhancement algorithm, based on Adaptive Gamma Correction With Weighting Distribution (AGCWD). It is composed of HSV color space, Surrounding luminance blur, MSR-based JND curve weakening factor, and AGCWD. Proposal MSR's surrounding luminance was simulated by Gaussian Filter was replaced with the mean filter to reduce the algorithm complexity. To prevent the areas with high luminance from being overly enhanced by AGCWD and keep the detail of local areas. The proposed algorithm has better performance than other studies in the backlight image. And also reduces the complexity of the MSR's surrounding luminance algorithm.

9:45 AI Crowd Control Detection System Implemented on FPGA Hardware

Development Platform

Chung-Bin Wu (NCHU, Taiwan); Yu-Hu Wu and Yi-Yen Lai (National Chung-Hsing University, Taiwan)

This paper proposes a detection application for crowd control. Detecting objects is mainly to identify pedestrians at close range. The deep learning network uses Yolo-like. And change Yolo-like[1] into a network architecture that only recognizes pedestrians at close distances. The hardware uses Convolution and Detection Layer IP hardware accelerators. And realize the function of Maxpooling and Shortcut on FPGA platform. The FPGA platform is Xilinx Zynq UltraScale+ MPSoC ZCU102 Evaluation Kit. Finally, the FPGA platform uses HDMI to display the recognition results that only detect pedestrians at close distances. Achieve the detection effect of crowd control.

9:48 Boosting Resnet18 for a Smart Glasses Input Module to Control a 3D Printed Prosthetic Arm

Aaron Raymond A. See, Jolo Gerard Miel Tolentino, Bhuvanut Duangasidhorn, Wan-Jung Chang, Yang-Kun Ou and Ming-Che Chen (Southern Taiwan University of Science and Technology, Taiwan)

This research made use of smart glasses to obtain visual input to control a 3D printed prosthetic arm in real time. The system can classify objects and perform the appropriate gesture base from a pre-trained and transfer learned Resnet18 model. The base transfer learning model achieved an accuracy of 87.48% during training and an ~ 80.48% test accuracy from unseen data. After dimension reduction and boosting, the gesture classifier model showed an accuracy of ~ 85.33%. To acknowledge the gesture intent of the amputee, a FSR input is used as a trigger.

9:50 Efficient Convolutional Neural Network Accelerator Based on Systolic Array

Yeong-Kang Lai and Yu-Jen Tsai (National Chung Hsing University, Taiwan)

This paper uses 72 PE as the basis for convolution operations, which can handle 3 x 3 and 1 x 1 filter sizes. Moreover, using the Systolic Array design architecture, the data reuse of this architecture is better than general PE architecture. Systolic Array architecture only needs to access once. This paper integrates Convolution and Max Pooling. This hardware verifies on Xilinx ZCU102 FPGA board. The hardware uses quantized weight parameters, and the hardware arithmetic precision is UINT8. The operation frequency sets at 100 MHz, throughput can reach 14.4 GOPs. The efficiency is 98.90%, the bandwidth is 150.82 MB, and Convolution integrates Max-Pooling to save 31.75% of DRAM access. In the future, the Operation Frequency can increase to more than 200 MHz. The increase in the number of PEs can enhance the efficiency of parallel operations, which can effectively improve the throughput of the hardware.

9:53 Conceptual Evaluation and Comparison of A Data Retaining Multiplexer

Karol Niewiadomski and Dietmar Tutsch (University of Wuppertal, Germany)

Field Programmable Gate Arrays are essential components in applications, which require a certain degree of reconfigurability. This feature is achieved by a sea of configurable logic blocks, which realize the desired boolean functions. These blocks require interconnect lanes to realize more complex functions and to exchange data. In consequence, interconnect logic consumes a comparably large amount of each FPGA type, where multiplexers are an integral part. These components can be realized in different ways

with different advantages and drawbacks. In this paper, selected multiplexer designs are compared to a versatile, newly developed, data retaining and power saving multiplexer design.

Presenter bio: Dr.-Ing. Karol Niewiadomski, age: 38, birthday: January 23, 1982 2002 - 2009: Studies electrical engineering, Ruhr University Bochum Main focus: integrated circuit design Diploma thesis: Investigation of different logic styles on their DPA resistance based on a S-box implementation 2008-2010: Mixed-signal engineering department, Rohde & Schwarze Development of RX/TX IP blocks for various transceivers with VHDL-AMS 2010-2011: Concept engineering, Intel Mobile Communications Virtual prototyping in SystemC 2011-now: Product Manager cyber security Services for semiconductors IP SoC design reviews for various companies (IP- and IC design houses) Training experience (over 8 years) 2015-2019: PhD studies, University of Wuppertal, Chair of automation / computer science, Prof. Dr.-Ing. Dietmar Tutsch PhD thesis: Low-power optimization of selected FPGA blocks Reviewer of various papers and journals Program committee member of ADAPTIVE 2020

9:56 Design of AgileV4 and Its Real-Time Implementation on an Economic Mobile Platform

Kuan Hung Chen and Chun-Wei Su (Feng Chia University, Taiwan)

AI visual algorithms have obtained obvious improvements in detection performance. However, the resulted extremely high computation complexity blocks the progress toward AI hardware design for real-time and portable applications. In this paper, we have developed a dedicated AI detection neural network along with the necessary AI model speedup techniques. For the development goal, we propose our own backbone neural network, which we named it AgileV4. AgileV4 needs only 25% of the weight and 50% of the computation complexity of well-known neural networks to obtain equivalent detection performance. Besides, we introduce a so-called GoP (Group of Pictures) technology to accelerate the computation by removing temporal redundancy. In the GoP mode, the input video frames are classified into I-frames and P-frames. The test with a dedicated hyper-market scenario data illustrates that the presented system can track each object well. Finally, the frame rate can be accelerated to 35.4 frames per second when we deployed AgileV4 along with the GoP mode acceleration on Jetson Nano. Compared with the original existing neural network, the speedup ratio is more than 1200%.

9:58 Super-Resolution of Satellite Images Based on Two-Dimensional RRDB and Edge-Enhanced Generative Adversarial Network

Yu-Zhang Chen and Tsung-Jung Liu (National Chung Hsing University, Taiwan);

Kuan-Hsien Liu (National Taichung University of Science and Technology, Taiwan)

With the increasing demand for high-resolution images, image super-resolution (SR) technology has become one of the focuses in related research fields. Generally speaking, high resolution is usually achieved by increasing the density and accuracy of the sensor. However, such an approach is quite expensive for equipment and design. In particular, increasing the density of satellite sensors must be undertaken great risks. Inspired by EEGAN and based on it, the Ultra-Dense Subnet (UDSN) and Edge Enhanced Network (EEN) were modified. Among them, the UDSN is used for feature extraction and obtains high-resolution results that look clear in the intermediate but are deteriorated by artifacts, and the Edge-Enhanced Subnet (EESN) is used to purify, extract and enhance the image contour and use mask processing to eliminate images contaminated by noise. Finally, the restored intermediate image and the enhanced edge are combined to produce a high-resolution image with high credibility and clear content. We use Kaggle open experimental dataset to test and compare the results among different methods. It proves the performance of the proposed model is better than other SR methods.

10:01 *Image Generation by Residual Block Based Generative Adversarial Networks*

Kuan-Hsien Liu and Chien-Cheng Lin (National Taichung University of Science and Technology, Taiwan); Tsung-Jung Liu (National Chung Hsing University, Taiwan)

Generative adversarial network is a popular deep learning technique for solving artificial intelligence tasks, and it has been widely studied and applied for processing images, voices, texts and so on. Especially, generative adversarial network is adopted in the field of image processing, such as image style transfer, image restoration, image super-resolution and so on. Although generative adversarial networks show remarkable success in image generation, training process is usually unstable and trained models collapse where many of the generated images may contain the same color or texture pattern. In this paper, the network of generator and discriminator are modified, and the residual block is added to the generative adversarial network architecture to learn better image features. To reduce the loss of image feature during training and get more features to stabilize image generation, we use feature matching to minimize feature loss between the real and generated images for stable training. In the experiment, performance improvement can be obtained by adopting our proposed method, which is also better than some state-of-the-art methods.

10:04 *A Low Complexity Monocular Image Matching Scheme for Efficient Indoor Positioning*

Jia-Cheng Wu, Min-Jia Luo and Yin-Tsung Hwang (National Chung Hsing University, Taiwan); Ho-En Liao (Feng Chia University, Taiwan)

An efficient indoor positioning system (IPS) with no hardware deployment costs is presented. Anchor points in the target field are first selected as positioning references. For each anchor point and a wraparound image is captured as a landmark image, which is further divided into overlapped full-HD sized views with a 7.3 degrees angular deviation. By using just one image obtained from a monocular camera, i.e., the positioning image, the IPS matches it with a landmark data base to determine the approximate location and the facing direction of the camera. Color calibration is performed to alleviate the influence of ambient lighting on the images. The image matching is conducted in two phases. A histogram similarity based landmark image screening process is employed to reduce matching efforts by an average of 91%. Feature points are next extracted for the second stage matching. The feature points determined by using the KAZE scheme is scaling and rotation invariant, which can effectively compensate the difference between the positioning image and the landmark image of the nearest anchor point. The closest view of the landmark image also indicates the facing direction of the camera. The experiments conducted on a campus shopping store with 27 anchor points show that the matching is almost error free if the location is within a 60cm vicinity of any anchor point.

Presenter bio: Yin-Tsung Hwang received his PhD degree in EE from the University of Wisconsin, Madison, USA, in 1993. He then returned to Taiwan and became a faculty member of the Department of Electronic Engineering, National Yunlin University of Science & Technology. In 2004, he joined the Department of Electrical Engineering, National Chung Hsing University, and is now a professor. Dr. Hwang served as the director of Meng-Yao Chip Center, National Chung Hsing University, from 2007 to 2010. He also led a nationwide, inter-collegiate talent cultivation program sponsored by MoE for Intelligent IoT from 2017 to 2021. He has been a council member of Taiwan Integrated Circuits Design Association since 2014. His research interests include VLSI designs for wireless base band signal processing, beamforming and radar signal processing, image based indoor positioning schemes, and hardware accelerator for AI applications.

10:07 *3D LiDAR Automatic Driving Environment Detection System Based on*

MobileNetv3-YOLOv4

Ting-Wei Chen, Min-Hua Lu, Wei-Zhe Yan and Yu-Cheng Fan (National Taipei University of Technology, Taiwan)

In this paper, we proposed 3D LiDAR Automatic Driving Environment Detection System Based on MobileNetv3 YOLOv4. In recent years, artificial intelligence and automatic driving technology have developed very rapidly. Automatic driving has the advantages of law abiding and fast response, which can significantly reduce driver and passenger casualties. However, due to the large number of parameters and complexity of most object detection neural networks, the computation time required is huge. To solve this problem, this paper applies the lightweight technique of Mobilenetv3 to significantly improve the original object detection neural network, and finds the region of interest by using point cloud degrounding and clustering algorithms. The data from the region of interest is fed into the Mobilenetv3 YOLOv4 neural network for detection to perform the high accuracy of object detection.

Sunday, January 9 10:20 - 10:50 (America/New_York)

CPE-SEA-I: Consumer Power and Sensor Systems

Room: Room: TELUS

Chair: Lei Shu (Nanjing Agricultural University, China & University of Lincoln, United Kingdom (Great Britain))

10:20 Detection Method for Fire Incident Due to Arc-Fault in Home Appliances

Sittichai Wangwiwattana (Shibaura Institute of Technology, Japan)

The arc fault is well-known causes of electric fire incidents. Generally, the discharge on the tip of plug leads distortion of electrical waveform. One the retailed plug analyze the wave form to detect the arc fault. According to our research, the higher resistance of the contact area on the tip of plug due to oxide copper lead to high temperature area due to Joule's heating.

10:23 Thermoelectric Generator Using Amorphous Ga-Sn-O Thin-Film Device

Mutsumi Kimura, Tatsuya Aramaki, Yoku Ikeguchi, Yuhei Yamamoto, Ryo Ito, Mitsuo Tamura and Tokiyoshi Matsuda (Ryukoku University, Japan); Mutsunori Uenuma (Nara Institute of Science and Technology (NAIST), Japan)

We have developed thermoelectric generators using amorphous Ga-Sn-O (a-GTO) thin-film devices. The Seebeck coefficient and power factor reach 300[uV/K] and 60[uW/mK²] equivalent to amorphous In-Ga-Zn-O (a-IGZO) devices. Amorphous metal-oxide-semiconductor (AOS) devices can be manufactured by thin-film deposition in large areas at low temperature on various substrates, and a-GTO devices are actually manufactured by sputtering at room temperature on a plastic substrate or mist CVD method at atmospheric pressure in this study. The crustal reserves of the a-GTO semiconductor are abundant. Therefore, the manufacturing cost can be extremely low, and they are suitable as power sources in IoT societies.

Presenter bio: Mutsumi Kimura received his B. E. and M. E. degrees in Physical Engineering from Kyoto University in 1989 and 1991, respectively. He joined Matsushita Electric Industrial Co., Ltd. in 1991 and Seiko Epson Corp. in 1995. He received his Ph. D. degree in Electrical and Electric Engineering from Tokyo University of Agriculture and

Technology in 2001. He joined Ryukoku University in 2003. He has been working on TFT characteristic analysis, TFT simulator development, TFT-OLED development and their advanced applications. He is a member of Institute of Electronics, Information and Communication Engineers (EIC), Japan Society of Applied Physics (JSAP) and Society for Information Display (SID). He is also a chair or member of the executive, steering and program committee of AM-FPD, AMD workshop of IDW, and organizing committee of Thin Film Materials and Devices Meeting. He received Outstanding Poster Paper Award of Asia Display / IDW '01, Best Paper Award of AM-LCD '05, Best Paper Award of 4th Thin Film Materials and Devices Meeting, and Outstanding Poster Paper Award of IDW '07.

10:26 Thermal Environment Simulator for BEMS on Double Helix Structure

Toshihiro Mega (Mitsubishi Electric Building Techno-Service Corporation & Kyushu Institute of Technology, Japan); Koudai Murakami (Kyusyu Institute of Technology, Japan); Noriyuki Kushiro (Kyushu Institute of Technology, Japan)

For realizing Building Energy Management System on double helix structure, a thermal environment simulator with multi agent technology was proposed in the paper. All heat sources are modeled as independent agents, and all governing equations for thermal environment was attributed to a simple heat transfer equation. Therefore, the simulator works without Building Information Model and becomes lightweight and fast. The simulator was implemented and validated its accuracy of the simulation through the field. Through the field test, we confirmed that the simulator achieved high accuracy of the simulation.

10:29 Deep Learning Approach for Smart Home Appliances Monitoring and Classification

Jayroop Ramesh, Abdul-Rahman Al-Ali, Ahmad Al Nabulsi, Ahmed Osman and Mostafa Shaaban (American University of Sharjah, United Arab Emirates)

With the global rise in the adoption of smart grids, smart homes and information technology, it is imperative to find approaches to efficiently monitor and manage load profiles across different households. We consider aggregated load profiles during mutual operation, where the rationale is to provide a relatively robust and adaptable deep learning method that can perform appliance classification without any constraints on the consumer behavior. We propose an enhanced real-time single-sensor home appliance classification and monitoring system leveraging convolutional neural networks and transfer learning. The real-time information obtained from smart meters is input into a pre-trained learning model which classifies multiple concurrently active home appliances. The convolutional neural network architectures of VGG16, ResNet50, and the InceptionV3 are trained individually by the transfer-learning paradigm with the image features of V-I trajectories, spectrograms, continuous wavelet transforms, and Fryze decomposed active components respectively. This approach effectively realizes end-to-end learning, and mitigates the need to disaggregate load before the identification process. Experimental results suggest that the utilization of transfer learning improves the multi-label classification performance of aggregate load. This model is made accessible to consumers through a mobile application, which can be used to interface with smart meter data and provide subsequent appliance usage insights. This is one of the first works to employ pre-trained deep learning networks used for image processing for the purposes of high frequency concurrent load classification in the context of an Advanced Metering Infrastructure (AMI).

10:32 A Luminance Control Method for OLED Burn-In Prevention Using User Information

Hong-Kyu Shin, Hea-Bin Yang, Seung-Jin Baek and Sung-Jea Ko (Korea University,

Korea (South))

In this paper, we propose a novel luminance control method utilizing user information (UI) to prevent burn-in in organic light emitting diode (OLED) displays. To control the luminance on a burn-in potential region (BPR), we first calculate the visual angle of each pixel on display utilizing UI and design a visual acuity model based on the cortical magnification theory. Next, we generate a UI-based saliency map by combining the visual acuity model and an image saliency map. Finally, the luminance of the BPR is adjusted based on the UI-based saliency map and the local contrast of the BPR. Experimental results show that the proposed method not only controls the luminance of the BPR to a degree of which users barely notice the change but also greatly extends the lifetime of the OLED.

10:35 YOLO-Based Deep Learning Design for In-Cabin Monitoring System with Fisheye-Lens Camera

Yen-Sok Poon, Chih Chun Lin, Yu-Hsuan Liu and Chih-Peng Fan (National Chung Hsing University, Taiwan)

By using a RGB-format fisheye-lens camera, in this paper, the YOLO-based deep learning models, including YOLOv3-tiny, YOLOv3-tiny-3l, YOLO-fastest, YOLO-fastest-xl, and YOLO-fastest are studied to be detectors. The proposed in-cabin monitoring design detects the normal and distracted driving cases and in-vehicle occupants including back seat passengers and pet dogs. The experimental results show that the YOLO-fastest-three scales model performs the best metrics for F1-Score and mAP, which are 95.89% and 97.16%, respectively. The YOLO-fastest-xl model has the best metric for false negative rate, which is 2.63%. The proposed design executes 30 frames per second with the GPU-based embedded device.

Presenter bio: Chih-Peng Fan received the B.S., M.S., and Ph.D. degrees, all in electrical engineering, from the National Cheng Kung University, Taiwan, R.O.C., in 1991, 1993 and 1998, respectively. During October 1998 to January 2003, he was a design engineer with N100, Computer and Communications Research Laboratories (CCL), Industrial Technology Research Institute (ITRI), Hsinchu, Taiwan. In 2003, he joined the faculty of the Department of Electrical Engineering, National Chung Hsing University, Tai-chung, Taiwan, where he is currently a full Professor. He has published more than 80 technical journals and conference papers. His teaching and research interests include digital video coding, digital image processing, VLSI signal processing, and baseband transceiver design and implementation.

10:38 Refractive Index Measurement Using Self-Interference Incoherent Digital Holography

Youngrok Kim and Sungwoong Park (Kyung Hee University, Korea (South)); Hee-Jin Choi (Sejong University, Korea (South)); Sung-Wook Min (Kyung Hee University, Korea (South))

A Novel method of refractive index evaluation using self-interference incoherent digital holography is proposed. Self-interference digital holography is a powerful phase detecting solution that can record not only the intensity of the image but also phase information under incoherent lighting conditions like LEDs. The proposed system using structured patterns and an autofocus algorithm to evaluate the numerically reconstructed hologram image to find a focused depth plane. The focused depth plane indicates the optical path difference between air and refractive media. To demonstrate a proposal, the experiment is conducted by measuring the refractive index of acryl.

10:41 Single Chip Connected Multi-Axis Servo Drive for Industrial Systems

Jason D Reeder (Texas Instruments, USA); Kedar Chitnis (Texas Instruments India Pvt.

Ltd., India); Mike Hannah (Texas Instruments, Inc., USA); Mihir N Mody (Texas Instruments, India); Reddy Vishwanath Yennacheti (Texas & Texas Instruments, India); Shiju Sivasankaran (Texas Instruments India Pvt. Ltd., India); Frank C Livingston (Texas Instruments Inc., USA); Dhaval Khandla (Texas Instruments, India); Sriramakrishnan Govindarajan (Texas Instruments India Pvt. Ltd., India); Sivaraj R (& Texas Instruments, India); Thomas Leyrer (Texas Instruments, Germany); Prithvi Shankar Y A (Texas Instruments, India); Shailesh Ghotgalkar (Texas Instruments, USA)

Servo motor drives are systems involved in precision motion and position control used in multiple applications in industrial automation, e.g. robotic arm, conveyer belts etc. A typical servo motor drive receives position reference over industrial Ethernet from a motion controller and uses that reference to close the position/speed/torque loops to actuate the drive. The position reference is received over industrial Ethernet at a cyclic rate of 32 KHz i.e. every 31.25usecs and the position/speed/torque loops are closed at a cyclic rate of 100KHz, i.e. every 10usecs. In order to precisely control the servo motor drive, the SW blocks used to close the loops need to be synchronized precisely and with hard real-time limits set by cyclic rate of Ethernet communication and position/speed/torque loops. Additionally, modern servo drive systems need to control multiple servo drives, typically 3-axis servo drive to control a robotic arm in factory automation systems. This paper proposes a single chip solution to handle the industrial Ethernet protocols and multi-axis servo motor drive control software. The proposed solution uses multiple novelties namely, multi-core ARM R5F micro controllers to run the Ethernet and motor control loops, hard real-time offload to dedicated Programmable Real-time Units (PRUs), high precision time-sync to synchronize the SW blocks. The proposed implementation is done on TI AM243x SOC and is able to achieve 3-axis servo motor drive control, using < 10% R5F utilization, < 2MB of internal RAM and time-sync precision of < 20ns. This ensures the servo motor drive operates at the precise position/speed/torque that is desired.

Presenter bio: Mihir Mody is Senior Principal Architect for Automotive Processor Business at Texas Instruments (TI). He has 18+ years of experience in embedded domain, spanning across roadmap definition, algorithm, architecture, HW IP design and software for automotive, mobile and DSP business. He is proven leader and Innovator enabling differentiated solutions for TI. His domains of interests are image processing, computer vision, machine/deep learning, autonomous driving and video coding. He was awarded to the Distinguished Member of technical staff (DMTS) in 2018 for contribution to TI. He holds a Master of Engineering (ME) degree from the Indian Institute of Science (IISc) and a Bachelor of Engineering (BE) from GCOEP. He holds prolific record (100+) in terms of patents, papers, articles, trade-secrets and standardization activities. His Google scholar profile can be accessed at <http://scholar.google.com/citations?user=Wn389rAAAAAJ&hl=en&oi=ao>

10:44 Investigations of the Acoustic Characteristics of Headphone with Hybrid Model

Tzu-Hsuan Lei, Shu-Chien Wu and Yu-Cheng Liu (Feng Chia University, Taiwan)

In the study, a Hybrid Model consisting of T/S parameters and the Finite Element Method is proposed to simulate acoustic radiation characteristics of headphones, with verifications based on comparisons with measurement results. In addition to discussing the predictive ability of this model for the acoustic characteristics of microspeaker, Brüel & Kjør Head & Torso Simulator, artificial ear, and standard IEC 711 coupler were used to simulate and analyze the acoustic characteristics of headphone in the pressure field. Moreover, the impact of the vented rear chamber on acoustic characteristics is discussed and relevant simulation and measurement results are compared. Based on the results, this Hybrid Model accurately predicts acoustic radiation characteristics of microspeakers, including resonance frequency and edge mode frequency characteristics, in addition to the free field performance of headphone front and rear chambers and the pressure field performance of entire headphone on the human head simulator. This predictive ability is especially significant at frequencies below 10 kHz, including the effective elevation of low-

frequency pressure performance of vented rear chamber at under 200 Hz and the changes in pressure valley values at the mid-frequency of around 300 Hz.

10:47 A Digital Speed Profile Generator for Stepper Motor

Daishin Isobe (University of Tsukuba & Digital Control Laboratory, Japan); Shin Kawai and Triet Nguyen-Van (University of Tsukuba, Japan)

Rotation speed and angle characteristics of a stepper motor are subject to speed profiles and frequency of pulses. In recent days, most parts of a stepper motor driver has been digitalized by using digital signal processors (DSP), excepting for the step pulse generation part, which is usually implemented on a separate circuit. This paper presents a method to generate step pulses, which can be implemented by the DSP via Matlab/Simulink, for stepper motor driver. A condition used to discriminate a triangular or trapezoidal pattern drive and a relationship between the sampling period of the DSP and the maximum rotation speed are derived. Simulation and experimental results for a five-phase hybrid stepper motor show that the excitation pulses are generated properly by the proposed method.

MDA-VI: ML and DL in CE (6)

Room: Room: Ibuka

Chair: Ramneek Ramneek (Korea University, Korea (South))

10:20 LogoMix: A Data Augmentation Technique for Object Detection Applied to Logo Recognition

Daniel Fuertes, Carlos R. del-Blanco, Fernando Jaureguizar and Narciso García (Universidad Politécnica de Madrid, Spain)

Automatic logo detection on images is a challenging task in computer vision with many applications in social media platforms. Recent works use generic deep-learning based object detectors, but they require huge databases for optimal recognition performance, which are very costly to obtain, especially in logo detection applications where the number of classes can be very high. For this reason, LogoMix, a new data augmentation method for object detection tasks, is proposed in this paper. It creates new sample images by combining logo entities with different degrees of overlapping. A state-of-the-art object detector trained with LogoMix has been evaluated on two popular logo datasets, QMUL-OpenLogo and FlickrLogos-32, and compared with other state-of-the-art works to prove its high performance.

10:24 Demo-Net: A Low Complexity Convolutional Neural Network for Demosaicking Images

Mert Bektas and Zhao Gao (Loughborough University, United Kingdom (Great Britain)); Eran Edirisinghe (Keele University, United Kingdom (Great Britain)); Alexis Lluís-Gomez (Arm, United Kingdom (Great Britain))

This paper presents a novel Convolutional Neural Network (CNN) and an associated effective training approach that can be used for demosaicking images generated by different Color Filter Array (CFA) patterns, used in imaging sensors. The proposed CNN, Demo-Net, is a low complexity, auto-encoder based generalized CNN architecture, that can specifically take a CFA pattern as an additional input during training, thus creating a trained model for demosaicking images created by the specific CFA. The proposed Demo-Net allows one to create low complexity demosaicking systems that can be effectively deployed in

consumer electronic devices with known sensor specifications.

10:28 *Intents4Bot - A Flexible Architecture to Capture User Intentions from Dialogue Systems*

Felipe Muniz da Silva, Wendley França, Singrid Camelo Palmeira, Catharine Quintans Bezerra, Gildo Macedo Neto, Tales Satiro, Antonio Abreu Neto and Denys Lins (VIRTUS/UFCG, Brazil); Danyllo Albuquerque (Intelligent Software Engineering Group, Brazil); Danilo F S Santos (Federal University of Campina Grande, Brazil)

The capture of user intentions is a cutting edge technique that can significantly contribute to improving the user experience in dialog systems. However, the construction of solutions to capture user intent comes up against a plethora of techniques and frameworks with different purposes and levels of effectiveness. This makes building user intent capture solutions a challenging task. To deal with this problem, this work aims to present a flexible architecture for the development of solutions for capturing user intentions in the context of dialog systems.

10:32 *XNPU - eXtensible Neural Processing Unity from a Programmable Logic Device*

Thiago Cruz, João Pedro Gomes and Hugo Gayoso Medeiros (VIRTUS/UFCG, Brazil); Danyllo Albuquerque (Intelligent Software Engineering Group, Brazil); Gutemberg G. Santos Jr., Angelo Perkusich and Danilo F S Santos (Federal University of Campina Grande, Brazil)

As an emerging field of machine learning, deep learning represents a powerful technique to solve complex learning problems. However, the size of the networks becomes increasingly large due to the demands of the practical applications, which poses a significant challenge to construct high performance implementations of deep learning neural networks. In order to improve the performance as well as to maintain the low power cost, in this paper we design a neural processing unit, which is a scalable accelerator architecture for large-scale deep learning networks using the field-programmable gate array (FPGA) as the hardware prototype.

10:37 *Navigation Robot Training with Deep Q-Learning Monitored by Digital Twin*

Madson Lemos (Cal-comp Institute of Technology, Brazil); Valtemar Cardoso (Instituto Cal-Comp de Tecnologia, Brazil); Mario Otani (Cal-Comp Institute of Technology, Brazil); Rivelino Nunes (Cal-comp Institute of Technology, Brazil); Vandermi Silva (Universidade Federal do Amazonas, Brazil); Vicente F. Lucena, Jr. (Federal University of Amazonas, Brazil)

This paper aims to present the results of a research on the adherence of the Deep Q-learning algorithm applied to the movement and execution of tasks in a vehicular navigation robot, the robot's objective was to transport parts through a delimited environment. a decision system was built based on the Deep Q-learning algorithm with the aid of an artificial neural network that received sensor data as input and enabled autonomous navigation in an environment with different types of obstacles. This article will also present the application process and experiments with the DQN algorithm, finally presenting the results of the learning process and the use of the concept of digital twins to monitor the movement and signals sent by the robot to a Cloud service, which allowed the visualization of navigation through augmented reality.

10:41 3D-To-2D-To-3D Conscious Learning

Juyang Weng (Michigan State University & GENISAMA LLC, USA)

This is a theoretical and algorithmic paper on conscious learning for thoughts and creativity through general-purpose and autonomous imitation of demonstrations. This conscious learning is end-to-end (3D-to-2D-to-3D) and free from annotations of 2D images and 2D motor images, such as a bounding box for a patch to be attended to. The algorithm directly takes that of the Developmental Networks that has been previously published extensively with rich experimental results. Apparently, humans and animals do this type of fully automated learning daily, but it is unclear a robot can do the same or a computational theory can be developed to explain this amazing process in a natural brain. Recently, [8], [16] presented a theory of conscious learning rooted in emergent universal Turing machines. It appeared to be the first algorithmic level theory of holistic consciousness, other than many papers in the literature about piecemeal consciousness. However, [8], [16] proved only conscious learning in motor-imposed training mode, namely 3D-to-2D taught by 2D motor impositions, free from 2D annotations. This paper fills the challenging gap in [8], [16] so the conscious learning is 3D-to-2D-to-3D (end-to-end) without a need for motor-impositions. This new conscious learning methodology is a major departure from traditional AI-handcrafting symbolic labels that tend to be brittle (e.g., for driverless cars) and then "spoon-feeding" pre-collected "big data". The analysis here establishes that autonomous imitations as presented are a general mechanism in learning universal Turing machines. Autonomous imitations drastically reduce the teaching complexity compared to pre-collected "big data", especially because no annotations of training data are needed. When this theory is fully demonstrated in the future, human non-programmers will be able to teach such a new kind of developmental robots through demonstrations. After autonomous practice (trial and error), such robots will gradually become increasingly robust, conscious, and creative while they mentally grow from reflexive infancy to conscious adulthood. This method is technically supported by a new kind of neural networks called Developmental Network-2 (DN-2) [13], [14] as an algorithmic basis, due to its incremental, non-iterative, on-the-fly learning mode along with the optimality (in the sense of maximum likelihood) in learning emergent super Turing machines from the open-ended real physical world. This work is directly related to consumer electronics because it requires large-scale on-the-fly brainoid chips in wearable robots for consumers.

Presenter bio: Juyang (John) Weng received the BS degree from Fudan University, in 1982, M. Sc. and PhD degrees from the University of Illinois at Urbana-Champaign, in 1985 and 1989, respectively, all in computer science. He is a professor emeritus of Computer Science and Engineering, faculty member of the Cognitive Science Program, and faculty member of the Neuroscience Program at Michigan State University, East Lansing. He has published over 300 research articles on related subjects, including vision, audition, touch, autonomous navigation, and natural language understanding. He is an Editor-in-Chief of the International Journal of Humanoid Robotics, the Editor-in-Chief of the Brain-Mind Magazine, and an associate editor of the IEEE Transactions on Autonomous Mental Development (now Cognitive and Developmental Systems). With others' support, he initiated the series of ICDL (conferences), the IEEE Transactions on Autonomous Mental Development, and the startup GENISAMA LLC. He is a Fellow of IEEE.

10:45 Smart Metering System Capable of Anomaly Detection by Bi-Directional LSTM Autoencoder

Sangkeum Lee (ETRI, Korea (South)); Hojun Jin (KAIST, USA); Sarvar Hussain Nengroo (KAIST, Korea (South)); Yoonmee Doh, ChungHo Lee and Tae-Wook Heo (ETRI, Korea (South)); Dongsoo Har (KAIST, Korea (South))

Anomaly detection is concerned with a wide range of applications such as fault detection, system

monitoring, and event detection. Identifying anomalies from metering data obtained from smart metering system is a critical task to enhance reliability, stability, and efficiency of the power system. This paper presents an anomaly detection process to find outliers observed in the smart metering system. In the proposed approach, bi-directional long short-term memory (BiLSTM) based autoencoder is used and finds the anomalous data point. It calculates the reconstruction error through autoencoder with the non-anomalous data, and the outliers to be classified as anomalies are separated from the non-anomalous data by predefined threshold. Anomaly detection method based on the BiLSTM autoencoder is tested with the metering data corresponding to 4 types of energy sources electricity/water/heating/hot water collected from 985 households.

SPC-ENT-I: Security and Entertainment

Room: Room: CTA

Chair: Worawat Choensawat (Bangkok University, Thailand)

10:20 A Low-Power Cryptographic Coprocessor Design for the Internet of Things

Bruno L. M. T. Silva, Fernando S. Sousa, Gutemberg G. Santos Jr. and Danilo F S Santos (Federal University of Campina Grande, Brazil); Marcos Morais (UFCEG, Brazil); Angelo Perkusich (Federal University of Campina Grande, Brazil)

This article presents the design of a low-power cryptographic coprocessor for Internet of Things (IoT) and sensing applications based on the recharacterization of digital cells to operate below nominal voltage. The design is implemented in XFAB 180nm technology with 1V CORE voltage, achieving a 60% reduction in power and 11% in area compared to its implementation at a nominal voltage of 1.8V. This shows the effectiveness of the strategy in power optimization, allowing the use of low cost technologies to develop efficient IoT and Smart Sensors embedded systems.

10:23 Model Verification of Resilient Third-Party Monitoring System Against Cyberattacks

Kousei Sakata, Shintaro Fujita and Kenji Sawada (The University of Electro-Communications, Japan)

Industrial control systems (ICS) are required to be designed and operated safely even when subjected to cyberattacks. Fallback control is necessary for the safe operation of ICS. One of fallback control systems is a resilient third-party monitoring system. This system consists of Programmable Logic Controllers (PLCs) for normal control and for fallback control. The normal PLC controls field devices, and the fallback PLC takes over the control after the normal PLC is attacked. The fallback control of this paper is the control takeover of a robot arm control system. In order to quickly transition to this fallback control, it is necessary to incorporate a supervisor function to manage each PLC function in an integrated manner. This paper aims to propose a modeling method of ICS functions and its analysis method to ensure that the supervisor can work properly under cyberattacks. For modeling, we use UPPAAL and implement the models of each PLC and supervisor on UPPAAL. In order to quantitatively analyze whether the supervisor can really realize the incident response during cyberattacks, we give the specifications necessary for fallback control to the supervisor model using TCTL.

10:26 Anomaly Detection and Anomaly Location Model for Multiple Attacks Using

Finite Automata

Yoshiki Ikeda and Kenji Sawada (The University of Electro-Communications, Japan)

In control systems, the operation of the system after an incident occurs is important. This paper proposes to design a whitelist model that can detect anomalies and identify locations of anomalous actuators using finite automata during multiple actuators attack. By applying this model and comparing the whitelist model with the operation data, the monitoring system detects anomalies and identifies anomaly locations of actuator that deviate from normal operation. We propose to construct a whitelist model focusing on the order of the control system operation using binary search trees, which can grasp the state of the system when anomalies occur. We also apply combinatorial compression based on BDD (Binary Decision Diagram) to the model to speed up querying and identification of abnormalities. Based on the model designed in this study, we aim to construct a secured control system that selects and executes an appropriate fallback operation based on the state of the system when anomaly is detected.

10:29 Design of High-Reliability IoT System Delivery Platform Based on Blockchain and System Prototyping

Hayato Komiya and Hiroshi Yamamoto (Ritsumeikan University, Japan)

In recent years, an IoT (Internet of Things) system that supports human activities based on various types of real-world data (e.g., temperature, location, etc.) has been attracting attention in various fields. The operation of an IoT system is determined based on the real-world data measured and collected by sensor devices placed in various locations in the real world. If the real-world data is tampered within the process of measurement, collection and analysis, the reliability of the IoT system cannot be guaranteed. Therefore, we propose a new blockchain-based service delivery platform to support the development of IoT systems that can guarantee the reliability of both the real-world data and the procedure for analyzing the data. Furthermore, we design and prototype an IoT system based on the proposed platform for evaluating the effectiveness. The prototype system monitors the environmental information of offices and other facilities and analyzes the real-world data to identify risk of coronavirus infection. In the prototype system, the proposed platform provides the user with the function for validating that the analytical result is derived by applying the correct process to the real-world data.

10:32 A Combined Blinding-Shuffling Online Template Attacks Countermeasure Based on Randomized Domain Montgomery Multiplication

Bien-Cuong Nguyen (The University of Electro - Communications, Japan); Cong-Kha Pham (University of Electro-Communications (UEC), Japan)

Online template attacks (OTA), high-efficiency side-channel attacks, are initially presented to attack the elliptic curve scalar. The modular exponentiation is similarly vulnerable to OTA. The correlation between modular multiplication's intermediate products is a crucial leakage of the modular exponent. This paper proposed a practical OTA countermeasure based on randomized domain Montgomery multiplication, which combines blinding and shuffling methods to eliminate the correlation between modular multiplication's inner products without additional computation requirements. The proposed OTA countermeasure is implemented on the Sakura-G board with a suppose that the target board and template board are identical. The experiment results show that the proposed countermeasure is sufficient to protect the modular exponentiation from OTA.

10:35 Toward Collaborative Game Commentating Utilizing Pre-Trained Generative

Language Models

Junjie H. Xu and Hong Huang (University of Tsukuba, Japan); Xiaoling Ling (University of British Columbia, Canada); Pujana Paliyawan (Ritsumeikan University, Japan)

In this paper, we propose a novel task of collaborative game commentating, an artificial intelligence agent capable of collaboratively commentating with a human commentator in Live-Streaming of Esports. To this end, we propose a collaborative game commentating system that employs a pre-trained language model trained using commentaries by professional commentators, along with metadata including title and tags. The conducted experiments show that (1) fine-tuned Text-to-Text Transfer Transformer (T5) model, a state-of-the-art generative language model, could produce more clearer and precise commentary and better recall the words from the reference commentary, as it effectively improves the scores on evaluation metrics that are widely used for concise text generation task after tuning the model. (2) The more information used for the current method fusion of information, the clearer and more precise generated commentary is. However, it performs worse to recall the words from reference commentary.

10:38 Sentence Punctuation for Collaborative Commentary Generation in Esports Live-Streaming

Hong Huang and Junjie H. Xu (University of Tsukuba, Japan); Xiaoling Ling (University of British Columbia, Canada); Pujana Paliyawan (Ritsumeikan University, Japan)

To solve the existing sentence punctuation problem for collaborative commentary generation in Esports live-streaming, this paper presents two strategies for sentence punctuation for text sequences of game commentary, that is, punctuating sentences by two or three text sequence(s) originally punctuated by Youtube to obtain a complete sentence of commentary. We conducted comparative experiments utilizing and fine-tuning a state-of-the-art pre-trained generative language model among two strategies and the baseline to generate collaborative commentary. Both objective evaluations by automatic metrics and subjective analyses showed that our strategy of punctuating sentences by two text sequences outperformed the baseline.

10:41 Web-Based Online Judge System for Online Programming Education

SeokJin Kim, June Hong Park, Soobin Jeon and Dongmahn Seo (Daegu Catholic University, Korea (South))

Due to COVID-19, many educational institutions are using non-face-to-face online education services for programming lectures. However, it is not easy for one person to manage various features, which are scoring the assignment and practice, problem feedback, and so on, in the online programming education service. This paper develops an educational system for programming education using an open source-based online judge system for easy management of instructors. In addition, it defines and implements an academic interface.

Presenter bio: Department of Computer Engineering, Kangwon National University. (B.E., 2002.2) Department of Computer & Telecommunication Engineering, Kangwon National University. (M.S., 2004.2) Department of Computer & Telecommunication Engineering, Kangwon National University. (Ph.D., 2010.2) Postdoctoral Research Fellow at Imaging Media Research Center in Korea Institute of Science and Technology (2010.03~2014.02) Currently Assistant Professor at School of Information Technology in Catholic University of Daegu.

10:44 A Framework for Creating Non-Player Characters That Make Psychologically-Driven Decisions

Shakir Belle (The University of the West Indies Cave Hill Campus, Barbados); Curtis Gittens (The University of the West Indies, Cave Hill Campus, Barbados); Nicholas Graham (Canada)

The behavior of non-player characters (NPCs) affects player immersion and, by extension, engagement. A realistic NPC can provide great satisfaction to the completion of the story a game is attempting to tell; but an unrealistic NPC can spoil the entire experience. Numerous systems have been developed to build NPCs with psychological underpinnings. These tools can be based on one, or some combination of emotion, mood, personality, or memory. This article describes a framework that incorporates these psychological components. This framework can be used to create NPCs that exhibit psychologically-driven behaviors and make decisions based on a combination of their emotions, moods, and personalities.

10:47 Evaluating Electric Guitar Strumming Form as Musically Correct Rhythm and Sharpness Using Wrist-Worn Inertial Motion-Tracking Device

Fumiyoshi Kamo (Tokyo University of Technology & Graduate School of Computer Science, Japan); Soichiro Matsushita (Tokyo University of Technology, Japan)

A wrist-worn inertial motion-tracking device using a commercially available sensor chip has been investigated for a motion evaluation on a chord strumming technique of electric guitar. Several motion parameters such as elbow-swinging angle, wrist-twisting angle, and angular jerk on the wrist-twisting axis were examined for the strumming diagnosis. Three professional guitarists and amateur players having a wide range of playing experience participated in the chord strumming evaluation experiments. As a result, it was found that musically important parameters including playing rhythm deviation and strumming sharpness were able to be estimated without using sound recorders or cameras. A newly developed evaluation algorithm for the strumming sharpness may clearly distinguish the professional and amateur guitarists. In addition, application software for PC enabled the guitar players to compare their performances with those of professional guitarists as well as of themselves in the past. A guitar strumming task finder based on the elbow-swinging angle signal enabled the user to locate a specific timing for evaluation. An experimental guitar lesson class with the easy-to-use motion analysis system showed that both the task annotation and the performance evaluation can be performed without introducing significant cost in terms of time and environmental care.

Presenter bio: Professor, School of Computer Science, Tokyo University of Technology

Sunday, January 9 11:00 - 12:00 (America/New_York)

A1: Awards Ceremony, (1) Ibuka Awards, (2) CTSoc Awards, (3) ICCE 2022 Award

Room: Room: Ibuka

11:00 IEEE Masaru Ibuka Consumer Electronics Award

"In recognition for contributions to the development of image sensors with integrated color filter arrays for digital video and still cameras."

Sunday, January 9 12:00 - 12:30 (America/New_York)

T3: Tutorial 3: Q&A Session

Room: Room: Ibuka

12:00 Tutorial 3

Juyang Weng (Michigan State University & GENISAMA LLC, USA)

This is the 3rd Tutorial.

Sunday, January 9 12:30 - 14:00 (America/New_York)

IF05: Industry Forum Session 5:

Leveraging Intelligent Digital Realities to Reconnect You - Always to the World

Moderators: Tom Coughlin and Kathy Grise

Room: Room: Ibuka

Industry Panel: As a result of the pandemic since early 2020, the entire world has undergone a major physical and virtual transformation. Technology is a key enabler in driving this transformation.

In particular, the IEEE Digital Reality Initiative serves to explore and enable the coming Intelligent Digital Realities through collaboration among technologists, engineers, regulators, practitioners, and ethicists around the world. The Intelligent Digital Transformation is fueled by advances in technology, such as Artificial Intelligence (AI) and Machine Learning (ML), and applications using the copious amounts of continuously generated data. By leveraging these technologies and others developed such as Augmented Reality (AR), Virtual Reality (VR), and Digital Twins, the line between the physical world and the digital world are becoming increasingly less distinct.

Applications are already quickly emerging across the broad fields of gaming, entertainment, medicine, automotive, education, manufacturing, enabling the sharing of services, and more.

Emphasis will be upon presenting practical applications and its implementations of interest to attendees. Subject matter expert speakers will share their observations, experiences on the state-of-the-art and future direction of consumer technologies.

Format: Participate in a live discussion with a panel of industry experts from several distinct fields who will provide their perspectives, observations, and predictions of the future.

Sunday, January 9 14:00 - 15:30 (America/New_York)

IF04: Industry Forum Session 6:

Current and Future Role/Impact of Consumer Technology During

Pandemics Like COVID-19

Moderator: Dr. Himanshu Thapliyal

Room: Room: Ibuka

Consumer technologies-based solutions for sustained health and wellbeing during pandemics like COVID-19 need to be developed that are closely tied to the ground realities, with interdisciplinary expertise of academicians and industry professionals including scientists, engineers, doctors, sociologists, and front-line workers, etc. Panel will discuss current and future role/impact of consumer technology during pandemics like COVID-19 under the following themes: • Consumer technology for smart cities and smart villages during pandemic. • Diagnosis, treatment, and prevention of pandemics like COVID-19. • Improving the health and well-being of the patients, family, and caregivers. • Consumer technologies in education during pandemic. • Security, privacy, and ethical issues in consumer technologies during pandemics. • Novel computing platforms to support pandemic research including but not limited to neuromorphic and quantum computing.

Examples of topics that will be discussed: Audio, as a novel digital phenotype, has been increasingly studied and attracting attention in the community of medicine. Audio-based methods can be feasible develop a non-invasive paradigm to evaluate the subject's health status at anytime and anywhere. In particular, leading scientists in computer audition have made great efforts to find a smart phone app to collect the cough sound and/or speech sound from people in the wild. This will be an interesting story about knowing your COVID-19 test via your sound. Insightful information is the key to making the right decisions. This is especially the case during a pandemic when every decision you make could affect your life. Different from SARS at the beginning of the century, this COVID pandemic is happening at a time when most people on earth have some sort of access to the internet. The abundance of misinformation and disinformation has already shown its influence on people's health as it affects people's decision to take protective measures such as wearing masks and vaccines. Emerging consumer technologies, from wearables to smart assistants, are not immune to dis/misinformation. What if your smart device that is used to determine your health condition cited the wrong information and misdiagnose your situation? How do we develop consumer technologies that are capable of differentiating high-quality information from junk?