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Monday, May 23 9:00 - 18:00

National Conference on Communications 2022

9:00 ***Resolving the Ambiguity in Recognizing Case-Sensitive Characters Gesticulated in Mid-Air Through Post-Decision Support Modules.....1***

Anish Monsley K. and Kuldeep Singh Yadav (NIT Silchar, Assam, India); Rabul Laskar (NIT SILCHAR, India)

Unlike real-world objects which remains the same irrespective of the changes in size on a fixed/varying scale, few English alphabets become identical to each other because of case ambiguity. Recognizing alphabets becomes further complex when different characters are gesticulated with the same pattern or become similar due to the gesticulation style. The generalization ability of deep convolutional neural networks (DCNN) results in misclassifying these characters. To overcome this, we propose a two-stage recognition model that comprises of DCNN and advisor unit (AU) followed by a post-decision support module (P-DSM). It differentiates these similar characters based on actual gesticulated size and extracts features from the 1D, 2D perspective and captures the demographics in the gesticulation. This model is able to discriminate these similar characters with an accuracy of ~92% for the NITS hand gesture database. Experimenting with this on popular handwritten EMNIST database suggests that pre-processing steps followed in it make the characters lose their size information.

9:17 ***Best Arm Identification in Sample-Path Correlated Bandits.....7***

R Sri Prakash (IIT Bombay, India); Nikhil Karamchandani and Sharayu Moharir (Indian Institute of Technology Bombay, India)

We consider the problem of best arm identification in the fixed confidence setting for a variant of the multi-arm bandit problem. In our problem, each arm is associated with two attributes, a known deterministic cost, and an unknown stochastic reward. In addition, it is known that arms with higher costs have higher rewards across every sample path. The net utility of each arm is defined as the difference between its expected reward and cost. We consider two information models, namely, the full information feedback and sequential bandit feedback. We derive a fundamental lower bound on the sample complexity of any policy and also propose policies with provable performance guarantees that exploit the structure of our problem. We supplement our analytical results by comparing the performance of various candidate policies via synthetic and data-driven simulations.

9:34 ***On RIS-Assisted Random Access Systems with Successive Interference Cancellation.....13***

Arzad Kherani (Indian Institute of Technology, Bhilai, India); Thazhathe Veetil Sreejith (IIT Bhillai, India)

We consider a large floor that has RIS elements assisting the transmissions from the different terminal devices towards a common access point located at the center. Showing that the near-field model is the appropriate model for this system, we provide an approach to study the improvement in performance when using RIS in a system that utilizes Successive Interference Cancellation (SIC), along with Random Access, like Slotted ALOHA. Without the use of RIS, the possible spatial region where SIC could have been

used is very small, and introduction of RIS provides a promising improvement. Partial RIS sharing with SIC is seen to offer a significant further improvement in this region. By finding the optimal channel access probabilities by viewing the end-devices as individual players in a game with a common utility function, we see that the overall average system throughput performance improves with RIS assistance.

9:51 ***A Scheduling Approach to Harness Synergy from Two Server Farms.....18***

Vanukuru Hari Rohit (IIT Bombay, India); Vamsi Krishna Velidi (ISRO Satellite Centre, India)

In this paper, we first consider two multi-server M/M/K/FCFS queuing systems, processing two classes of jobs one-on-one respectively. We then operate the two multi-server systems as preemptive resume priority queues (M/M/K/Prio) and route the two classes of jobs to both systems by splitting the Poisson arrivals of each class probabilistically. In each M/M/K/Prio system, own class of jobs are serviced with high priority while class of jobs routed from other system are serviced with low priority. Through numerical computations, we show that for a Pareto set of split probabilities, the probability of wait for service in queues experienced by both classes of jobs in the joint M/M/K/Prio systems, can be less than what they experienced in the original one-on-one M/M/K/FCFS systems. Through Bargaining theory, we capture the agreement of arrival load split between the two systems.

10:08 ***APEX-Net: Automatic Plot Extraction Network.....24***

Aalok Gangopadhyay and Prajwal Kumar Singh (Indian Institute of Technology Gandhinagar, India); Shanmuganathan Raman (Indian Institute of Technology, Gandhinagar, India)

Automatic plot extraction involves understanding and inferring the data distribution and therefore, extracting individual line plots from an image containing multiple 2D line plots. It is an important problem having many real-world applications. The existing methods for addressing this problem involve a significant amount of human intervention. To minimize this intervention, we propose APEX-Net, a deep learning based framework with novel loss functions for solving the plot extraction problem. Further, we introduce APEX-1M - a new large scale dataset that contains both the plot images and the raw data. We demonstrate the performance of APEX-Net on the APEX-1M test set and show that it obtains impressive accuracy. We also show visual results of our network on unseen plot images and demonstrate that it extracts the shape of the plots to a great extent. Finally, we develop a GUI for plot extraction that can benefit the community at large. The dataset and code will be made publicly available.

10:25 ***A Metasurface-Enabled Lens Antenna Demonstrating Electromechanical Beam-Tilting for 5G Applications.....30***

Soumya Chakravarty (Tata Consultancy Services Limited, India); Aman Kumar (TCS Research, India); Tapas Chakravarty (Tata Consultancy Services Limited, India); Arpan Pal (Tata Consultancy Services, India); Rowdra Ghatak (National Institute of Technology Durgapur, India)

In this paper, a probe-fed, transmissive metasurface lens-based antenna system in the sub-6 GHz frequency range for possible fifth-generation (5G) applications is proposed. The design facilitates for gain

enhancement and phase shifter less beam tilting architecture. The structure consists of a probe-fed compact patch antenna, printed on FR4 substrate. The antenna resonates at 5.8 GHz with the -10 dB impedance bandwidth of 210 MHz extending from 5.68 till 5.89 GHz. The maximum realized gain at resonance is 2.6 dBi. The double-sided metasurface, printed on Rogers RT-Duroid 5880 substrate, is placed on top of the antenna with an air gap of 24.5 mm. This arrangement exhibits a maximum transmission gain of 7.98 dBi at resonance, with a gain enhancement of 5.38 dB in conjunction to a impedance bandwidth of 150 MHz from 5.72 - 5.87 GHz. The metasurface is polarization independent. The proposed antenna structure has been simulated for different incidence angles by rotating the metasurface around the antenna by 100 and 200, with the resulting transmitted beam also rotating by the respective angles, thus demonstrating the beam-tilting capability of the system. This beam-tilting is achieved by only mechanically rotating the metasurface. The design has been fabricated and measured, with the experimental results matching with simulated data, with only a variation of less than 1 dB in the gain values and a shift of 50 MHz in the resonance frequency. This is attributed to variation in precise adjustment of the air-gap. The design is scalable and the process of validating the design in Frequency Range (FR2) band (24.25 - 52.6 GHz) is in progress. The proposed antenna-metasurface system is lightweight and low-cost alternative to 5G sub-6 GHz frequency band applications.

Sudhakar Kumawat (Osaka University, Japan); Gagan Kanojia (IIT Gandhinagar, India); Shanmuganathan Raman (Indian Institute of Technology, Gandhinagar, India)

Deep neural networks have enormous representational power which has lead them to overfit on most datasets. Thus, regularizing them is important in order to reduce overfitting and to enhance their generalization capability. This paper studies the operation of channel patch shuffle as a regularization technique in deep convolutional networks. We propose a novel regularization technique called ShuffleBlock where we show that randomly shuffling small patches or blocks between channels significantly improves their performance. The patches to be shuffled are picked from the same spatial locations in the feature maps such that a patch, when transferred from one channel to another acts as a structured noise for the later channel. The ShuffleBlock module is easy to implement and improves the performance of several baseline networks for the task of image classification on CIFAR and ImageNet datasets.

Sonia Gupta (IIT Delhi, India); Monika Agrawal (IIT, India); Desh Deepak (RML Hospital, India)

Millions of people suffer from respiratory illness globally. Early diagnosis of respiratory diseases is hindered because of the lack of cost-effective and simple methods. Spirometry is the pulmonary function test used for diagnosis of obstructive diseases like asthma, chronic obstructive pulmonary disease (COPD) and restrictive diseases like interstitial lung disease (ILD), etc. This test requires repeated manoeuvre, is expensive and is done in laboratory which are not available in resource poor areas. Auscultation is an easy and cost-effective method which can play a vital role in early diagnosis of respiratory diseases. In this paper, a technique is proposed which could classify auscultation sounds into normal, obstructive and restrictive disease category similar to the findings of spirometry. The proposed work uses combination of multivariate variational mode decomposition and dynamic time warping for enhancing multi-channel signal. Further,

pre-trained 3D ResNet18 neural network model is used for classification into three classes. Encouraging results are achieved with accuracy of 94.57%, sensitivity of 100% and specificity of 94.11%.

11:16 ***Analysis of the Matched Filter Detector of the Antenna Index in the Spatial Modulation Systems.....48***

Bibin Baby John and Yash Vasavada (Dhirubhai Ambani Institute of Information and Communication Technology, India)

We analyze the low-complexity matched-filter (MF) based approach for detecting the transmit antenna index in the spatial modulation (SM) or space shift keying (SSK) schemes. The detection metric of the scheme resembles the metric calculated by the maximum ratio combining (MRC) Single Input Multiple Output (SIMO) diversity receiver. While the MRC-based schemes based on this approach have received considerable attention in the literature due to their computational simplicity, a detailed performance analysis is currently lacking. This is because a simple algorithmic formulation of these schemes belies the complexity of a statistical characterization. In the uncorrelated Rayleigh fading MIMO (Multiple Input Multiple Output) channels, the detection metrics are the ratios of the squared magnitudes of the sum of the products of complex normal variates, and the numerator and the denominator of the ratio are correlated. The contribution of this paper is to solve this analysis problem. We present the analytical expression of the performance of the spatial matched filtering MRC detector and validate the analysis by simulation. We offer several insights based on this analysis on the performance of the MRC detectors.

11:33 ***On Study and Analysis of the Impact of the Time Reversal Mirror on Characteristics of the Underwater Acoustic Channel.....54***

Vijay Bhadouria and Ritesh Kumar (Indian Institute of Technology, Delhi, India); Monika Agrawal (IIT, India)

Characterizing the UWA channel is critical for designing a robust communication receiver. Due to the significant delay spread, underwater channels make communication difficult. The time reversal mirror improves the channel characteristics by reducing delay spread and increasing coherence bandwidth. This paper analyses and quantifies a time reversal mirror (TRM) effect on an underwater acoustic channel. The delay spread decreases as the number of receivers increases, but this decrease is asymptotic, meaning that regardless of the receiver geometry, the delay spread converges to a fixed non-zero value. Additionally, this analysis establishes that the TRM effectiveness is dependent on the water column depth and the distance between the transmitter and receiver. TRM effectiveness decreases as the water column depth increases, whereas increasing the distance between the transmitter and receiver increases TRM effectiveness. Additionally, the effect of TRM on the spread of delay is validated in actual sea environment.

11:50 ***Tabla Gharana Recognition from Tabla Solo Recordings.....59***

Gowriprasad R (IIT Madras, India); Vayyavuru Venkatesh (Indian Institute of Technology Hyderabad, India); Kodukula Sri Rama Murty (Indian Institute of Technology, Hyderabad, India)

Tabla is a percussion instrument in North Indian music tradition. Teaching practices and performances of tabla are based on stylistic schools called gharana-s. Gharana-s are characterized by their unique playing

technique, finger posture, improvisations, and compositional patterns (signature patterns). Recognizing the gharana information from a tabla performance is hence helpful to characterize the performance. In this paper, we explore an approach for gharana recognition from solo tabla recordings by searching for the characteristic tabla phrases in these recordings. The tabla phrases are modeled as sequences of strokes, and characteristic phrases from the gharana compositions are chosen as query patterns. The recording is automatically transcribed into a syllable sequence using Hidden Markov Models (HMM). The Rough Longest Common Subsequence (RLCS) approach is used to search for the query pattern instances. A decision rule is proposed to recognize the gharana from the patterns.

Hemant Kumar Rath (Tata Consultancy Services, India); Shameemraj Mohinuddin Nadaf (Tata Consultancy Services Ltd, India); Garima Mishra (TCS (Research and Innovation), India)

Real-time data generation and collection to analyse the network performance is difficult for large-scale networks having limited accessibility. In this paper we propose a framework which can provide a realistic si/e-mulations, and generate synthetic data closer to real-time data that replaces the traditionally used deterministic and probabilistic models. The proposed framework uses an emulation based platform to replicate real network scenarios. The emulator acts as a base layer with necessary APIs to enable customized inclusion of analytics services in a plug-and-play manner through the framework. This framework can be used to acquire data required for different Machine Learning (ML) models in order to reduce costly and time-consuming data collection effort in network analytics.

Shrikant Sharma, Adway Girish, Nikhar P Rakhashia and Vikram M. Gadre (IIT Bombay, India); Ram Bilas Pachori (Indian Institute of Technology Indore, India); P Radhakrishna (LRDE, Defence Research & Development Organization (DRDO), India); Peeyush Sahay (Indian Institute of Technology, Bombay, India); Shaan ul Haque and Aseer Ansari (IIT Bombay, India)

In this paper, we perform a theoretical analysis of an inverse Radon transform-based micro-Doppler parameter estimation algorithm. For a multicomponent micro-Doppler signal, no mathematical expression was proposed in this algorithm to find the number of frequency terms to be dropped for efficient elimination of estimated micro-Doppler components. Hence, we first derive an expression for the number of frequency terms to set to zero for efficient elimination of estimated micro-Doppler components by exploiting standard Bessel function properties. We verify our result through simulations with up to three targets, even in the presence of noise. We also provide an analysis of the limiting performance of the algorithm for two targets as the parameters are made close to each other.

Ajit Kumar (IIT Patna, India); Sudhir Kumar (Indian Institute of Technology Patna,

India)

The nanomachine has a finite processing capability due to size, power, and complexity constraints. To overcome these issues, nanomachine must cooperate to optimize its information exchange operations. Clock synchronization is required for nanomachine cooperation. In Molecular Communication (MC), synchronization is a challenging task due to the random movement of molecules that causes inter-symbol interference (ISI) and non-stationary noise. In this paper, we propose a method for clock synchronization between the transmitter nanomachine (TN) and the receiver nanomachine (RN) based on the molecule's emission time estimation. In the presence of both signal-dependent noise and ISI, clock synchronization is performed using maximum likelihood estimation (MLE). The proposed method takes into account a non-zero emission duration of molecules by the TN. The clock synchronization with rectangular input concentration is realistic for practical applications because the emission duration of molecules can not be zero. The effectiveness of the proposed method is shown by numerical results.

Presenter bio: Ajit Kumar received the M.Tech. degree in communication systems engineering from the Indian Institute of Technology Dhanbad, Dhanbad, India, in 2019. His research interest includes addressing localization and channel estimation challenges in molecular communication nanonetworks. Mr. Kumar received the first prize in poster presentation held at Research Scholars' Day of Indian Institute of Technology Patna.

12:58 *Semantic Segmentation on Low Resolution Cytology Images of Pleural and Peritoneal Effusion.....82*

Shajahan Aboobacker (National Institute of Technology Karnataka, India); Deepu Vijayasenan (NITK, India); Sumam David S. (National Institute of Technology Karnataka, India); Pooja Suresh and Saraswathy Sreeram (Kasturba Medical College Mangalore, Manipal Academy of Higher Education, India); Akash Verma (National Institute of Technology Karnataka, India)

Automation in the detection of malignancy in effusion cytology helps to save time and workload for cytopathologists. Cytopathologists typically consider a low-resolution image to identify the malignant regions. The identified regions are scanned at a higher resolution to confirm malignancy by investigating the cell level behaviour. Scanning and processing time can be saved by zooming only the identified malignant regions instead of entire low-resolution images. This work predicts malignancy in cytology images at a very low resolution (4X). Annotation of cytology images at a very low resolution is challenging due to the blurring of features such as nuclei and texture. We address this issue by upsampling the very low-resolution images using adversarial training. This work develops a semantic segmentation model trained on 10X images and reuse the network to utilize the 4X images. The prediction results of low resolution images improved by 15% in average F-score for adversarial based upsampling compared to a bicubic filter. The high resolution model gives a 95% average F-score for high resolution images.

Presenter bio: Research Scholar at National Institute of Technology Karnataka, Surathkal, India, since 2018. He has six years of teaching experience at various engineering colleges. He graduated from National Institute of Technology Karnataka, Surathkal with an M.Tech degree in Communication Engineering. He graduated from Government Engineering College Wayanad, Kerala with a B.Tech degree in Electronics and Communication Engineering. His research interests include bio-medical image processing and machine learning algorithms.

Slicing (NS) concept to optimally place the VNF instances over Service Function Chains (SFCs) for superior service delivery. Limited network capacity and storage work as a major hindrance towards better Quality-of-Service (QoS), so optimal VNF embedding over SFCs becomes an obligatory aspect. In this work, we have studied the VNF embedding problem (VNF-EP) over SFC instances for Softwarized 5G Networks. We have proposed a novel approach for dynamic VNF sharing over multiple SFCs, considering the flow-requests of SFC for individual Network Slice. The inter-slice co-ordinations are done considering the common service requests among independent and heterogeneous Slices. The mathematical formulation follows a MILP based optimization approach that optimally controls the VNF sharing to increase network efficiency and hardware usage. This flexible and shareable VNF embedding approach (FlexShare-VNF) results in significant energy-efficient service delivery in a low latency environment, and our performance evaluation also supports the claim. This approach will be extremely helpful for smooth network up-gradation in resource-restricted environments for future network advancements.

Presenter bio: Deborsi Basu is pursuing his Ph.D. from G.S Sanyal School of Telecommunication, Indian Institute of Technology, Kharagpur, India with the joint collaboration of Dept. of Electrical Engineering and Computer Science, University of Vanderbilt, Nashville, Tennessee, USA. He has completed his M.Tech from Kalyani Government Engineering College, Kalyani, West Bengal, India in Dept. of ECE in 2018 and B.Tech from Heritage Institute of Technology, Kolkata, West Bengal, India in Dept. of ECE in 2016. He is a Graduate Student Member of IEEE. His current research areas are Software-Defined Networking, Network Function Virtualization, Network Slicing in 5G & NextGen Wireless Communication Networks, OpenFlow, Cloud & Edge Computing etc.

14:06 ***Fingerprint Image-Based Multi-Building 3D Indoor Wi-Fi Localization Using Convolutional Neural Networks.....106***

Amala Sonny (Indian Institute of Technology, Hyderabad, India); Abhinav Kumar (Indian Institute of Technology Hyderabad, India)

Wi-Fi-based indoor localization has gained much attention around the globe due to its widespread reach and availability. Amongst several possible approaches using Wi-Fi signals, fingerprint image-based approach has become popular due to its low hardware requirements. Further, this approach can be used alone or along with other positioning systems for indoor localization. However, a multi-building, multi-floor indoor positioning system with high localization accuracy is required. Motivated by this, we propose a Convolutional Neural Networks (CNN)-based approach. For feature extraction and classification, a multi-output multi-label sequential 2D-CNN classifier is developed and implemented. The system is able to predict the location of the user by combining the classification output from the multi- output model. This approach is verified on the publicly available UJIIndoorLoc database. The system offers an average accuracy of 97%in indoor localization.

14:23 ***Sequential Nonparametric K-Medoid Clustering of Data Streams.....112***

Sreeram C Sreenivasan and Srikrishna Bhashyam (Indian Institute of Technology Madras, India)

We study a sequential nonparametric clustering problem to group a finite set of S data streams into K clusters. The data streams are real-valued i.i.d data sequences generated from unknown continuous distributions. The distributions themselves are organized into clusters according to their proximity to each other based on a certain distance metric. We propose a universal sequential nonparametric clustering test for the case when K is known. We show that the proposed test stops in finite time almost surely and is universally exponentially consistent. We also bound the asymptotic growth rate of the expected stopping time as probability of error goes to zero. Our results generalize earlier work on sequential nonparametric anomaly detection to the more general sequential nonparametric clustering problem, thereby providing a new test for case of anomaly detection where the anomalous data streams can follow distinct probability distributions. Simulations show that our proposed sequential clustering test outperforms corresponding fixed sample size test.

14:40 *Unsupervised Learning of Spatio-Temporal Representation with Multi-Task Learning for Video Retrieval.....118*

Vidit Kumar (Graphic Era Deemed to be University, India)

The majority of videos in the internet lack semantic tags, which makes indexing and retrieval difficult, and necessitates the use of much-needed content-based analysis techniques. Earlier works relies on hand-crafted features, which hardly represents the temporal dynamics. Later, video representations learned through supervised deep learning methods were found to be effective, but at the cost of large labeled dataset. Recently, self-supervised based methods for video representation learning are proposed within the community to harness the freely available unlabeled videos. However, most of these methods are based on single pretext task, which limits the learning of generalizable representations. In this work, we propose to leverage multiple pretext tasks to enhance video representation learning. We jointly optimized the C3D network by exploiting multiple pretext tasks such as: rotation prediction, speed prediction, time direction prediction and instance discrimination. The learned features are then analyzed by nearest neighbour task (video retrieval). Thereafter, the pre-trained model is fine-tuned for the action recognition task. We use the UCF-101 dataset for the experiments and, achieves 28.45% retrieval accuracy (Recall@1), and 68.85% fine-tuned action recognition accuracy, which is better than state-of-the-arts.

14:57 *SVM-D: Efficient SHVC Video Multicast Through D2D Offloading over 5G Cellular Networks.....124*

Pradip Kumar Barik (Pandit Deendayal Energy University); Raja Datta (Indian Institute of Technology Kharagpur, India)

Device-to-Device (D2D) offloading is an emerging technique in 5G where cache-enabled mobile devices receive data from a base station and distribute to the users within its D2D coverage. Storage capacity and battery energy limitation impose additional constraints in implementing such techniques. In this paper, we propose a novel D2D offloading scheme (SVM-D) for multicast transmissions of Scalable High Efficiency Video Coding (SHVC) videos in 5G multimedia mobile wireless networks. Instead of selecting a single cluster head, SVM-D selects multiple users for caching and forwarding scalable video content to the cluster members. A hybrid approach has been adopted for selecting a subset of users as the potential D2D transmitters (cluster heads) depending on their device category, channel quality, and available battery energy. The objective is to reduce the resource utilization at BSs and to increase the cluster lifetime while providing sufficient quality of experience (QoE) to the users. The local servers (i.e., mobile edge computing

servers) performs an on-demand SHVC encoding of multimedia content and distribute it to the users via base stations. We evaluate the performance of SVM-D in terms of its overall resource utilization, average battery lifetime, and average QoE of the cluster users. The comparison is made with conventional unicast and multicast schemes in 5G network with and without D2D offloading scheme (where a single cluster head stores and forwards the data). Simulation results show that SVM-D out performs other popular existing schemes from the literature.

15:14 *Whisper to Neutral Mapping Using i-Vector Space Likelihood and a Cosine Similarity Based Iterative Optimization for Whispered Speaker Verification.....130*

Abinay Reddy Naini (The University of Texas at Dallas, USA); Achuth Rao MV (Indian Institute of Science, India); Prasanta Kumar Ghosh (IISC Bangalore, India)

In this work, we propose an iterative optimization algorithm to learn a feature mapping (FM) from the whispered to neutral speech features. Such an FM can be used to improve the performance of speaker verification (SV) systems when presented with a whispered speech. In one of our previous works, the equal error rate (EER) in an SV task has been shown to improve by ∼24% based on an FM network trained using a cosine similarity-based loss function over that using a mean squared error based objective function. As the mapped whispered features obtained in this manner may not lie in the trained i-vector space, we, in this work, iteratively optimize the i-vector space likelihood (by updating T-matrix) and a cosine similarity based loss function for learning the parameters of the FM network. The proposed iterative optimization improves the EER by ∼26% compared to when the FM network parameters are learned based on only cosine similarity-based loss function without any T- matrix update, which is a special case of the proposed iterative optimization.

15:31 *Performance Analysis of Cooperative Automatic Modulation Classification Using Higher Order Statistics.....136*

Abdul Rahim, V C (Indian Institute of Space Science and Technology, India); Chris Prema (Deemed & Indian Institute of Space Science and Technology, Trivandrum, India)

Over the past few decades, many automatic modulation classification (AMC) algorithms were discussed based on their ability to classify the modulation scheme. However, in practical scenarios, the AMC algorithm should have low complexity, high speed, and better resource utilization. The majority of the current modulation classification methods have inferior performance in low SNRs. In this paper, a cooperative AMC (CAMC) approach using soft decision fusion based on the combination of fourth and sixth order cumulants over additive white Gaussian noise channel and multipath fading channel is proposed. This proposed approach improves the classification accuracy of the modulation schemes at low SNR comparatively.

Presenter bio: I am a research scholar in the department of Avionics, Indian institute of space science and technology, Trivandrum. My area of research is in the efficient wideband spectrum utilization in 5G systems. Currently, I am working on automatic modulation classification techniques.

15:48 ***On the Performance of Cooperative Spectrum Sensing Under Binary Erasure Reporting Channels.....142***

Ashok Parmar (Sardar Vallabhbhai National Institute of Technology Surat, India); Kamal Manharlal Captain, Rahul Kumar and Ankit Chouhan (Sardar Vallabhbhai National Institute of Technology, India)

The spectrum sensing based on single detector suffers from adverse effects such as fading, shadowing and hidden node problems. Cooperative spectrum sensing (CSS) is proposed to overcome these effects by utilizing the spatial diversity among the spatially located cooperating secondary users (CSUs). In traditional centralized CSS, the CSUs share their detection results with the fusion center (FC). Based on the information received from the CSUs, the FC analyze the information and takes the final decision on the occupancy of the primary user (PU) channel. Generally, in literature, the reporting channel between CSUs and the FC is assumed to be error free. However, these reporting channels are wireless channels which undergo fading and shadowing resulting in imperfect channels. In this work, we propose a model based on binary erasure channel (BEC) which is more suitable to model the reporting channel between the CSUs and the FC. We then, analyze the performance of the CSS under imperfect reporting channels. We then analyze the performance of repetition code based algorithm to improve the performance of CSS under imperfect reporting channels. It is found that the repetition code based algorithm significantly improves the performance. Also, by properly choosing the repetition length in the repetition based algorithm, the effects of reporting channel errors can be completely removed.

Presenter bio: Research Scholar

16:05 ***Performance Analysis of RIS Aided IBFD STAR Wireless Networks.....148***

Atiquzzaman Mondal (Indian Institute of Information Technology Guwahati, India); Sudip Biswas (Indian Institute of Information Technology, Guwahati, India)

This paper considers a simultaneous transmission and receive (STAR) communication framework empowered by an in-band full-duplex (IBFD) radio and multiple reconfigurable intelligent surfaces (RISs). We present a mathematical framework for calculating the bit error probability (BEP) of the RIS-aided IBFD STAR communication system. In particular, we first derive the mean and variance of the signal-to-interference-plus-noise ratio followed by its moment generating function, which is used to obtain the BEP. We not only consider the effect of direct line-of-sight self-interference at the IBFD node but also take into consideration the reflected SI, which may arise due to misalignment of some of the RIS elements. Numerical results are presented for BEP and bit error rate (BER) of the STAR system with respect to the number of reflecting elements at the RISs, amount of RSI at the IBFD base station, and modulation orders of uplink and downlink transmission, that explicitly illustrate the feasibility and value of deploying RISs to aid future IBFD STAR communication systems.

16:22 ***Deep Learning-Based Facial Emotion Recognition for Driver Healthcare.....154***

Goutam Kumar Sahoo, Santos Ku Das and Poonam Singh (National Institute of Technology Rourkela, India)

This study proposes deep learning-based facial emotion recognition (FER) for driver health care. The FER system will monitor the emotional state of the driver's face to identify the driver's negligence and provide

immediate assistance for safety. This work uses a transfer learning-based framework to develop an in-vehicle driver assistance system. It implements transfer learning SqueezeNet 1.1 to classify different facial expressions. Data preprocessing techniques such as image resizing and data augmentation have been employed to improve performance. The experimental study uses static facial expressions publicly available on several benchmark databases such as CK+, KDEF, FER2013, and KMU-FED to evaluate the model's performance. The performance comparison shows superiority over the state-of-the-art techniques.

16:39 *Low Complexity Passive Beamforming Algorithms for Intelligent Reflecting Surfaces with Discrete Phase-Shifts over OFDM Systems.....160*

Adit Jain and Rahul D (IIT Guwahati, India); Salil Kashyap (Indian Institute of Technology Guwahati, India); Rimalapudi Sarvendranath (IIT Guwahati)

In recent literature, Intelligent Reflecting Surfaces (IRS) based wireless system design has been a significant point of excitement among the wireless community primarily because of their cost-effective way of passively beamforming a signal and improving performance in various scenarios. We consider the problem of configuring the IRS elements efficiently and effectively for a practical IRS with discrete phase shifts and coupled elements deployed in an Orthogonal Frequency-Division Multiplexing (OFDM) based environment. We propose two near-optimal low complexity extremely scalable heuristic algorithms to design phase shifts at IRS in an OFDM system when the number of bits used to configure the IRS is limited, and the reflected channels via the IRS are spatially correlated. We benchmark the sum data rate performance of our algorithms against the theoretical upper bound and the time performance against the existing Successive Convex Approximation (SCA). Results indicate that 4 bits are sufficient to obtain theoretically optimum sum data rates and that our proposed algorithms obtain a good trade-off between complexity and performance.

16:56 *Feedback Based Compensation of Second Order Modal Dispersion in Principal Mode Based Multiplexed MMF Links.....166*

Komal Ojha and Kumar Appaiah (Indian Institute of Technology Bombay, India)

Multiplexing using principal modes (PMs) of multi mode fibers is known to be effective at enhancing data rates for channel variations that are up to first order in modulation bandwidth . However, for large Ω, the second order group delay terms (dependent on Ω^(2)) diminish the effectiveness of PMs. In this paper, we show that simultaneously feeding back PMs as well as second order group delay matrices permits transmission that overcomes the higher order modal dispersion. In addition, using manifold based quantization of PMs minimizes feedback overheads. Simulations reveal that modal dispersion is effectively eliminated with very little additional feedback overhead.

Presenter bio: PhD Research Scholar at IIT Mumbai.

17:13 *STPGANsFusion: Structure and Texture Preserving Generative Adversarial Networks for Multi-Modal Medical Image Fusion.....172*

Dhruvi Shah, Hareshwar Wani, Manisha Das and Deep Gupta (Visvesvaraya National Institute of Technology, Nagpur, India); Petia Radeva (Universitat de Barcelona & Computer Vision Center, Spain); Ashwini Bakde (All India Institute of Medical Sciences, Nagpur, India)

Medical images from sources having different modalities carry diverse information. The features from these source images are combined into a single image, constituting more information content, beneficial for subsequent medical applications. Recently, deep learning (DL) based networks have demonstrated the ability to produce promising fusion results by integrating the features extraction and preservation task with less manual interventions. However, using a single network for extracting features from multi-modal source images characterizing distinct information results in the loss of crucial diagnostic information. Addressing this problem, we present structure and texture preserving generative adversarial networks based medical image fusion method (STPGANsFusion). Initially, the textural and structural components of the source images are separated using structure gradient and texture decorrelating regularizer (SGTDR) based image decomposition for more complementary information preservation and higher robustness for the model. Next, the fusion of the structure and the texture components is carried out using two GANs consisting of a generator and two discriminators to get fused structure and texture components. The loss function for each GAN is framed as per the characteristic of the component being fused to minimize the loss of complementary information. The fused image is reconstructed and undergoes adaptive mask-based structure enhancement to further boost its contrast and visualization. Substantial experimentation is carried out on a wide variety of neurological images. Visual and qualitative results exhibit notable improvement in the fusion performance of the proposed method in comparison to the state-of-the-art fusion methods.

17:30 *Hybrid Transceiver Design and Optimal Power Allocation in Downlink mmWave Hybrid MIMO Cognitive Radio Systems.....178*

Jitendra Singh, Indranil Chatterjee, Suraj Srivastava and Aditya K Jagannatham (Indian Institute of Technology Kanpur, India)

A hybrid transceiver architecture along with the optimal power allocation is conceived the downlink millimeter wave (mmWave) multi-input multi-output (MIMO) cognitive radio (CR) systems operating in the underlay mode. Towards this, the non-convex objective and constraints of the sum spectral efficiency (SE) maximization problem are simplified by decoupling the hybrid precoder and combiner designs. First, considering the perfect knowledge of the downlink mmWave MIMO channel, we design the combiner at each SU. Subsequently, the front-end digital baseband (BB) precoder and analog-domain RF precoder are designed using the best-approximation problem to the capacity-optimal fully-digital precoder. Moreover, our design also considers the spatial correlation among mmWave MIMO channels, thereby significantly reducing the computational complexity for the analog precoder/combiner design. Furthermore, in order to cancel the MUI, the back-end of the BB precoder has been designed using the low-complexity zero-forcing (ZF) technique. Finally, a closed-form solution to the optimal power allocation problem is derived, which maximizes the overall SE of the downlink mmWave MIMO CR system under the interference power constraint imposed by the primary user (PU). Our simulation findings show an improved SE compared to state-of-the-art approaches while performing close to the ideal fully-digital benchmark.

17:47 *Digital Predistortion for mm-Wave MIMO Phased Arrays.....184*

Varsha Balakumar and Radha Krishna Ganti (Indian Institute of Technology Madras, India)

In this work, we consider the application of digital predistortion for MIMO mm-wave RF beamforming-based subarrays. We propose a single-input single-output (SISO) DPD model as a linearization technique to mitigate the nonlinear behaviour exhibited by the power amplifiers in mm-wave phased arrays. This model

incorporates mutual coupling between the antenna elements. This particular SISO-based model is obtained by transforming a dual-input-based model that accounts for the load-impedance mismatch between the antenna elements. Our proposed SISO-based DPD model can be considered a possible replacement of complex dual-input-based modelling approaches. We provide simulation results of two different array beamforming configurations: A single user beamforming array system (A 64-element antenna array) and a multi-user beamforming array system (4 x 64 elements antenna array).

Presenter bio: I'm a research professional pursuing Master of Science (MS) focused in Communications, Networks and Signal Processing from Indian Institute of Technology, Madras. I'm also an experienced Project Research Associate with a demonstrated history of working in the Indigenous 5G Testbed Project in IITM.

18:04 *Importance of Excitation Source and Sequence Learning Towards Spoken Language Identification Task.....190*

Jagabandhu Mishra and Siddhartha Soma (Indian Institute of Technology Dharwad, India); Mahadeva Prasanna (IIT Dharwad, India)

Spoken LID systems generally capture the long term temporal dynamic information present in the speech signal. To achieve that, sequence modeling techniques are used after the feature extraction process. But, the performance of the spoken LID system degrades in cross channel and noisy scenarios. From the literature, we can observe the benefit of excitation source information in noisy and cross-channel scenarios. Besides that, excitation features are also used as complementary evidence in spoken LID systems with spectral features. Motivated from this, an excitation based feature called integrated residual linear frequency cepstral coefficient (IRLFCC) has been proposed in this work. This work also provides a comparison between various deep learning based sequence modeling architectures towards capturing spoken language specific information. The experiments are performed using OLR2020 dataset. From the experiments, it can be observed that in the cross channel scenario, the proposed best system provides a relative improvement of 70.5% and 57.2% over the baseline in terms of EER_avg and C_avg respectively. Similarly, in the noisy scenario, the proposed best system provides a relative improvement of 37.8% and 45% over the baseline system.

18:21 *Performance Analysis of Vertical Underwater Visible Light Communication System with Cross-QAM.....195*

Chaitanya Chhichhia, Aakarshak Nandwani, Rachna Sharma and Yogesh N Trivedi (Nirma University, India)

In this paper, we consider a vertical Underwater Wireless Visible Light Communication (UWVLC) system, where the source is located at the surface of the sea. The distance between both the source and the destination is divided in certain intervals or layers. We assume turbulence in the underwater channel and the intensity of the turbulence varies between consecutive layers. Further, the turbulence is modelled by log-normal distribution and the statistics of the distribution varies from one layer to another. Thus, we assume cascaded channel with independent but non-identically distributed log-normal distributions. We assume 32-cross quadrature amplitude modulation (XQAM) scheme and derive closed form expression of Average Symbol Error Probability (ASEP). We analyze the ASEP performance of the system for different layers with different intensities of turbulence. As the number of layers or depth increases, the performance degrades. We also present simulation results of ASEP and compare them with their analytical counterparts. A close matching between both validates our analytical approach. Furthermore, we present the

performance with 32-rectangular quadrature amplitude modulation (RQAM) scheme with 16x2 and 8x4 constellations. We observe that the XQAM outperforms the RQAM.

18:38 *Automated Volumetric Examination of Muscle for Sarcopenia Assessment in CT Scan: Generalization of Psoas-Based Approach?.....200*

Pranaya Yellu (Indian Institute of Technology Hyderabad, India); Satyam Singh (India Institute of Technology Hyderabad, India); Swati Joshi (Mahatma Gandhi Medical College and Hospital, India); Rahuldeb Sarkar (Medway NHS Foundation Trust, United Kingdom (Great Britain)); Soumya Jana (Indian Institute of Technology, Hyderabad, India)

Sarcopenia is increasingly identified as a correlate of frailty and ageing and associated with an increased likelihood of falls, fracture, frailty and mortality. The gold standard for the sarcopenia evaluation in computed tomography (CT) scan was psoas muscle area (PMA) measurement. In this paper, we proposed an automated deep learning approach to find the muscle volume and assessed the correlation between PMA and muscle volume in the chest CT scans. This alternate muscle volume metric becomes significant since most chest computed tomography (CT) scans taken to assess lung diseases might not consist of psoas muscle but consists of other muscles, and it would therefore not be possible to assess sarcopenia in chest CT. Our results show a good correlation between the psoas muscle area and the muscle volume produced over specific anatomical landmarks by segmenting the muscle tissue using the 2D U-Net segmentation model, strengthening our proposition. Along with the muscle volume, we have also found the volume of peripheral fat and have shown there exists a correlation between them which could be helpful for nutritional evaluation.

18:55 *Uplink Throughput Enhancement by Employing Transmit-Only AUX Antennas at Nomadic Terminals: A Capacity Analysis.....206*

Anil Kumar (EE, IIT Bombay, India); Sibi Raj B Pillai (IIT Bombay, India)

Employing transmit only AUX antennas is a relatively cheap way of enhancing the communication throughput of lightweight UAVs, nodes in unmanned field expeditions, racing circuits etc, where increased data-rate demands from the nomadic terminals to the base station (BS) may happen intermittently. Asymmetric load demands in the uplink often call for augmented infrastructure at the nomadic terminals or UEs. By omitting multiple receive chains onboard (along with the requirements of oversampling, synchronization and heterodyning), considerable savings in energy, ergonomics and cost is afforded by employing commercially available transmit only AUX antennas, along with the MAIN antenna subsystem possessing its own dedicated receive chain.

The absence of AUX receive chains brings new design challenges, for example, estimating the full channel becomes troublesome at the UE, particularly when the BS has a large number of antennas. On the other hand, the MIMO capacity at high SNRs, effectively the full degrees of freedom, can be achieved even when the channel state information (CSI) is available only at the receiver, for many scattering environments. This motivates us to analyze the situation where the receiving BS has full CSI, however the UE transmitter only knows the CSI from its main antenna system. Channel statistics are assumed to be known at all the terminals. We investigate the uplink ergodic Shannon capacity of the resulting partial CSI MIMO system, and propose transmission schemes which are almost optimal, at all SNRs of interest. Our results show that

even using a single additional AUX can provide 60-70% capacity improvement for a receiver with more than two receive antennas, even at moderate SNRs.

19:12 ***Fractal Based Rectangular DRA for Multi-Band Applications.....212***

Abhijeet Gaonkar, Pragati Patel and Deven Patanvariya (NIT Goa, India)

A multi-band rectangular dielectric resonator antenna (RDRA) is proposed in this study for WiMAX, Wireless Local Area Network (WLAN) applications. The proposed geometry is based on combination of golden ratio and koch snowflake fractal approach. The proposed DRA geometry has been designed using low-cost alumina dielectric material. The DRA is fed by a trapezoidal a conformal strip feed. The proposed triple-band antenna operates at 2.5/3.8/4.9 GHz. The designed triple-band antenna with extremely low-cost and lowprofile is very suitable for multi-band mobile communication systems. The presented dielectric resonator antenna (DRA) is having stable radiation patterns (nearly directional pattern) for each operating band. Additionally, the RDRA achieves an overall total efficiency of more than 90% at the desired frequency bands. The proposed antenna is suitable for different wireless applications such as WLAN (5.2 GHz), WiMAX (2.6/3.5 GHz).

Presenter bio: I am PhD research scholar in NIT goa.My research interests are in microwave and antenna designing. I have completed M.E in industrial automation and RF engineering.I have worked as assistant professor in goa college of engineering for one and half years. My passion is to teach and i believe in hard work.

19:29 ***Novel Wideband Bow Tie Shaped Hemispherical Dielectric Resonator Antenna.....217***

Pragati Patel and Abhijeet Gaonkar (NIT Goa, India); Ayyappan M (National Institute of Technology, Goa, India)

In this paper a novel wideband bow tie shaped Hemispherical Dielectric Resonator Antenna is presented. The simulated results confirms a wide bandwidth of 2:29 GHz (2.69

- 4.98 GHz) (S11 ≤-10 dB is 61% at 3.7 GHz) with an average gain of 5.5 dBi in the operating frequency range. Here, hemispherical DRA is kept complementary to each other to get bow tie shape. It ensures uniform excitation of the mode fields in each DRA element which leads to improvement in bandwidth. The mode investigated is TE111 mode at the first resonant frequency of 3.9 GHz. Further, the effect of increasing the probe length on the resonance and the radiation pattern is also studied. The radiation patterns of antenna are directive in nature and radiation efficiency is more than 95% in the entire band. The presented antenna is suitable for C band, most of L band and WiMAX applications.

Presenter bio: I am PhD research scholar in NIT goa.My research interests are in microwave and antenna designing. I have completed M.E in industrial automation and RF engineering.I have worked as assistant professor in goa college of engineering for one and half years. My passion is to teach and i believe in hard work.

19:46 ***Intelligent On/Off Switching of mmRSUs in Urban Vehicular Networks: A Deep Q-Learning Approach.....221***

Moyukh Laha (IIT Kharagpur, India); Raja Datta (Indian Institute of Technology Kharagpur, India)

In the next generation of vehicular network applications, complex data processing and reliable and quick message transmissions are critical. Traditional cellular macro base stations and IEEE WAVE technology are incapable of supporting such high data speeds and ultra-reliable low latency communication. The combination of 5G RSUs equipped with mmWave beams (mmRSUs) and edge computing methods have been proposed as a possible solution for meeting such service needs. However, since urban vehicle traffic is often predictable, the mmRSUs need not be kept ON all the time to provide services. Instead, the mmRSUs may be dynamically turned ON/OFF depending on current traffic conditions, hence reducing energy consumption without compromising service. We construct the intelligent switching of mmRSUs as an Integer Linear Program to maximize the system's utility by dynamically turning them on/off in order to spend less energy. We propose a strategy based on Deep Q-Learning to accomplish the goal and demonstrate its usefulness in a city with real traffic.

Presenter bio: Mr. Moyukh Laha is an institute research scholar and is currently working towards his Ph.D. in the Department of Electronics and Electrical Communication Engineering (E & ECE) at the Indian Institute of Technology (IIT) Kharagpur. He has completed his B.Tech in Electronics and Communication Engineering (ECE) from Kalyani Govt. Engg. College, West Bengal University of Technology and M.Tech in Radio Physics and Electronics from Institute of Radio Physics and Electronics, University of Calcutta. His research interests include Protocol developments and QoS provisioning in Vehicular Networks, Intelligent Transportation Systems, AI in Wireless networks.

20:03 *Performance Analysis of RIS Assisted RSMA Communication System.....227*

Divyanshu S Shambharkar (Visvesvaraya National Institute of Technology, Nagpur, India); Shivani Dhok and Prabhat Kumar Sharma (Visvesvaraya National Institute of Technology, India)

This paper investigates a reconfigurable intelligent surface (RIS)-aided rate-splitting multiple access (RSMA) communication system. A base-station communicates with cell-edge users using the RSMA protocol with user-dedicated RIS. Using the univariate dimension reduction method, the expressions for the outage probability (OP) are derived considering the optimal and discrete phase-shifts introduced by RIS elements. The inter- dependent constraints of the threshold and the RSMA factors are derived and analyzed. Furthermore, the effects of various factors such as number of RIS elements, number of quantization bits, RSMA factors, threshold, etc. have been discussed and several interesting insights are presented. The derived expressions are validated using the Monte-Carlo simulations.

20:20 *Properties of Maximally Recoverable Product Codes and Higher Order MDS Codes.....233*

D. Shivakrishna and V. Lalitha (IIIT Hyderabad, India)

Product codes are a class of codes which have generator matrices as the tensor product of the component codes and the codeword itself can be represented as an ((m \times n)) array. where the component codes themselves are referred to as the row and column codes. Maximally recoverable product codes are a class of codes which can recover from all information theoretically recoverable erasure patterns, given the (a) column and (b) row constraints imposed by the code. In this work, we derive puncturing and shortening properties of maximally recoverable product codes. We give a sufficient condition to characterize a certain subclass of erasure patterns as correctable and another necessary condition to characterize another subclass of erasure patterns as not correctable. In an earlier work, higher order MDS

codes denoted by MDS(l) have been defined in terms of generic matrices and these codes have been shown to be constituent row codes for maximally recoverable product codes for the case of (a=1). We derive a certain inclusion-exclusion type principle for characterizing the dimension of intersection spaces of generic matrices. Applying this, we formally derive a relation between MDS(3) codes and points/lines of the associated projective space.

20:37 ***Contrastive Learning-Based Domain Adaptation for Semantic Segmentation.....239***

Rishika Bhagwatkar, Saurabh Ravi Kemekar, Vinay K Domatoti, Khursheed Munir Khan and Anamika Singh (Visvesvaraya National Institute of Technology, India)

Semantic segmentation is a crucial algorithm for identifying various objects in the surrounding of an autonomous vehicle. However, due to the limited size of real-world datasets, domain adaptation is employed. Hence, the models are made to adapt to real-world settings while being trained on large-scale synthetic datasets. In domain adaptation, domain-invariant features play a significant role in learning domain agnostic representations for each predefined category. While most of the prior work focuses on decreasing the distance between the domains, the works that utilize contrastive objectives for learning domain-invariant features depend heavily on the augmentations used. In this work, we completely eradicate the requirement of explicit data augmentations. We hypothesize that real-world images and their corresponding synthetic images are different views of the same abstract representation. To enhance the quality of domain-invariant features, we increase the mutual information between the two inputs. We first validate our hypothesis on the classification task using the standard datasets; Office31 and VisDA-2017. Further, we perform quantitative and qualitative analysis on the segmentation task using SYNTHIA, GTA and Cityscapes datasets.

20:54 ***Significance of Prosody Modification in PrivacyPreservation on Speaker Verification.....245***

Ayush Agarwal (Indian Institute of Technology Dharwad, India); Amitabh Swain (IIT Dharwad, India); Jagabandhu Mishra (Indian Institute of Technology Dharwad, India); Mahadeva Prasanna (IIT Dharwad, India)

Privacy is the major concern that comes to the user's mind before sharing their data. There are various methods proposed in literature for providing privacy to speech data. Previous works that have been done to protect the speaker identity were for speech applications like automatic speech recognition (ASR), speech analysis, etc. For these applications the presence of speaker identity is not essential while processing. The objective of this work is to provide privacy to the task in which presence of speaker identity is essential at the time of processing. In this work, privacy is provided to the speaker identity information present in speech signals while performing automatic speaker verification (ASV) tasks. In order to achieve the same, this work proposes a prosody modification based approach. The proposed approach is able to conceal the speaker identity from human perception by changing the pitch of the speech utterances with a pitch modification factor of (\alpha \geq 1). But at the same time the ASV system provides consistent performance irrespective of the change in pitch (i.e. for (\alpha \geq 1)). The same evidence has been shown through experiments in TIMIT and IITG-MV databases. A subjective study has also performed to verify the extent of speaker anonymization with respect to humans. The subjective study evaluates the performance in terms of mean opinion score (MOS). The observed MOS signifies the ability of the proposed approach to conceal the speaker's identity.

21:11 ***Subtitle Synthesis Using Inter and Intra Utterance Prosodic Alignment for Automatic Dubbing.....250***

Pamisetty Giridhar (Indian Institute of Technology Hyderabad, India); Kodukula Sri Rama Murty (Indian Institute of Technology, Hyderabad, India)

Automatic dubbing or machine dubbing is the process of replacing the speech in the source video with the desired language speech, which is synthesized using a text-to-speech synthesis (TTS) system. The synthesized speech should align with the events in the source video to have a realistic experience. Most of the existing prosodic alignment processes operate on the synthesized speech by controlling the speaking rate. In this paper, we propose subtitle synthesis, a unified approach for the prosodic alignment that operates at the feature level. Modifying the prosodic parameters at the feature level will not degrade the naturalness of the synthesized speech. We use both inter and intra utterance alignment in the prosodic alignment process. We should have control over the duration of the phonemes to perform alignment at the feature level to achieve synchronization between the synthesized and the source speech. So, we use the Prosody-TTS system to synthesize the speech, which has the provision to control the duration of phonemes and fundamental frequency (f0) during the synthesis. The subjective evaluation of the translated audiovisual content (lecture videos) resulted in a mean opinion score (MOS) of 4.104 that indicates the effectiveness of the proposed prosodic alignment process.

Presenter bio: I'm Pamisetty Giridhar. Currently doing my Ph.D. in the Electrical Engineering department at the Indian Institute of Technology, Hyderabad. My research interests are end-to-end speech synthesis systems, neural vocoders, etc.

21:28 ***Low-Resource Dialect Identification in Ao Using Noise Robust Mean Hilbert Envelope Coefficients.....256***

Moakala Tzudir and Mrinmoy Bhattacharjee (Indian Institute of Technology Guwahati, India); Priyankoo Sarmah (IIT Guwahati, India); Mahadeva Prasanna (IIT Dharwad, India)

This paper presents an automatic dialect identification system in Ao using a deep Convolutional Neural Network with residual connections. Ao is an under-resourced language belonging to the Tibeto-Burman family in the North-East of India. The three distinct dialects of the language are Chungli, Mongsen and Changki. Ao is a tone language and consists of three tones, viz., high, mid, and low. The recognition of tones is said to be influenced by the production process as well as human perception. In this work, the Mean Hilbert Envelope Coefficients (MHEC) feature is explored to identify the three dialects of Ao as this feature is reported to have information of human auditory nerve responses. Mel Frequency Cepstral Coefficients (MFCC) feature is used as the baseline. In addition, the effect of noise in the dialect identification task at various signal-to-noise ratio scenarios is studied. The experiments show that the MHEC feature provides an improvement of almost 10% average F1-score at high noise cases.

21:45 ***Blind Reconstruction of BCH Encoder over Erroneous Channel Conditions.....262***

Dinesh Ambati (Quantile Analytics Pvt. Ltd, India); Swaminathan Ramabadran (Indian Institute of Technology Indore, India)

Channel coding improves the error performance of digital communication systems. Blind parameter

estimation of channel codes plays an important role in military communication systems. Further, it also provides some additional advantages in adaptive modulation and coding (AMC)-based systems, reconfigurable receiver systems, etc. In this paper, we propose blind estimation algorithms to estimate the codeword length, code dimension, and generator polynomial of Bose-Chaudhuri-Hocquenghem (BCH) codes at the receiver over erroneous channel conditions assuming a non-cooperative scenario. The simulations are carried out on many test cases to validate the proposed blind estimation algorithms and the results are given to testify the algorithms. We infer that the probability of correct estimation of parameters increases with decrease in codeword length. Finally, it is also inferred that the proposed algorithm performs better than the existing algorithms reported in the literature.

22:02 ***Performance Analysis of IRS-Assisted Hybrid FSO/RF Communication System.....268***

Sandesh Sharma (IIT Indore, India); Narendra Vishwakarma and Swaminathan Ramabadran (Indian Institute of Technology Indore, India)

Free space optics (FSO) communication is seen as a cost-effective way to provide higher bandwidth, higher data rates, better link security, higher immunity to interference, etc., compared to radio frequency (RF) communication over short link distances. Despite these advantages, FSO link is severely affected by pointing errors, atmospheric turbulence, and signal loss due to the obstructions caused by buildings, trees, mountains, etc. In this paper, we propose a hybrid communication system model consisting of a FSO subsystem backed by a reliable RF subsystem with the goal to improve the coverage and system reliability. In addition, both the FSO and RF subsystems are assisted by intelligent reflecting surfaces (IRS). Specifically, we carry out the performance analysis of the IRS-assisted hybrid FSO/RF system by deriving approximate closed-form expressions for outage probability, average bit error rate (BER), and ergodic channel capacity assuming intensity modulation/direct detection (IM/DD) technique. The numerical results are shown along with insightful discussions. It is observed from the numerical results that the system performance improves as the number of elements in IRS increases. Further, the IRS-assisted hybrid FSO/RF system performs better in terms of ergodic capacity and average BER than the existing FSO and hybrid FSO/RF systems. Finally, Monte-Carlo simulations are presented to verify the correctness of the analytical results.

22:19 ***Performance Analysis of SWIPT-Enabled Cooperative NOMA System with Partial Relay Selection.....274***

Kalla Satya Ganapathi Kiran (Samsung Semiconductor India Research (SSIR), Bangalore, India); Swaminathan Ramabadran (Indian Institute of Technology Indore, India)

Recently, non-orthogonal multiple access (NOMA) and radio frequency (RF) energy harvesting (EH) techniques are applied in cooperative communication systems for 5G and beyond wireless communications. To exploit the benefits of the aforementioned techniques, we investigate the performance of a simultaneous wireless information and power transfer (SWIPT)-enabled cooperative NOMA system with decode-and-forward (DF) relaying technique. We consider a scenario, where a base station (BS) communicates with two users with the help of one EH relay, which is selected out of multiple relays using partial relay selection (PRS) scheme. The selected relay harvests energy through RF signals received from BS using a time-switching-based relaying (TSR) EH protocol. Furthermore, the relay utilizes the harvested energy from BS to forward the decoded information to the mobile users. The performance of the proposed system model is analyzed by deriving closed-form expressions for outage probability,

ergodic capacity, energy efficiency, and overall system throughput over Rayleigh fading channels. Since perfect channel state information (CSI) and successive interference cancellation (SIC) are not practically possible at the receiver nodes in the proposed system model, we have also considered the effects of imperfect CSI and SIC on the system performance. Finally, Monte-Carlo simulations are presented to verify the correctness of the analytical expressions.

22:36 *Minimally Invasive Microwave Ablation Antenna Designs at 2.45 GHz and 915 MHz.....280*

Aparna Chandran (Visvesvaraya National Institute of Technology Nagpur, India); Bhaskara Naik (Society for Applied Microwave Electronics and Engineering Research(SAMEER), India); Abhay Gandhi (Viswesarayya National Institute of Technology, India); Rajesh Harsh (Society for Applied Microwave Electronics and Engineering Research(SAMEER), India)

The main objective of this paper is to study two types of minimally invasive coaxial antennas for microwave ablation served for the purpose of treatment of liver cancer. Two types of antennas namely dual slot and monopole with slot are designed and simulated in CST at two different frequencies (2.45 GHz and 915 MHz). Return Loss (RL), Voltage Standing Wave Ratio (VSWR), and Specific Absorption Rate (SAR) pattern of both the antennas at two frequencies are analyzed to determine the efficiency of antenna, heating pattern, and distribution of power around the region of the tumor. Simulation results indicate that a dual-slot antenna has higher SAR, lowest backward heating, and better sphericity in ablation pattern compared to a monopole antenna. Also, the antennas operated at 2.45 GHz are more suitable for creating rapid spherical ablation with a larger diameter compared to the antennas operated at 915 MHz . So we can conclude that a dual-slot antenna operated at 2.45 GHz is best suited for microwave ablation.

22:53 *Excitation Epoch and Voicing Detection Using Hilbert Envelope with Single-Pass Processing.....285*

Hirak Dasgupta and Prem C. Pandey (IIT Bombay, India)

A technique is presented for excitation epoch and voicing detection in speech signal using its Hilbert envelope and employing single-pass processing. The excitation epoch detection comprises dynamic range compression for reducing amplitude variability, Hilbert envelope calculation and dynamic peak detection for excitation saliency enhancing, and epoch marking by locating the maximum-sum subarray peaks. The voicing detection is based on thresholding the inter-epoch similarity calculated as the normalized covariance of the adjacent inter-epoch intervals of the Hilbert envelope. The total algorithmic delay is less than 60 ms. The epoch detection and the voicing detection for clean and telephone-quality speech showed a good match with those obtained from the EGG, and the detection performances compared favorably with the earlier techniques.

23:10 *Modelling the Impact of Multiple Pro-Inflammatory Cytokines Using Molecular Communication.....291*

Shivam Nileshbhai Thakker (Ahmedabad University, India); Dhaval Karshanbhai Patel (School of Engineering and Applied Science-Ahmedabad University, India); Kathan S Joshi (Ahmedabad University, India); Miguel López-Benítez (University of Liverpool,

United Kingdom (Great Britain))

Motivated by various health care applications and many other novel fields of Molecular Communication (MC), it has become an important field of research since the last decade. This paper proposes a molecular communication-based model for the spread of the SARS-CoV2 virus in the human body. The virus uses the ACE2 receptor as a gateway to enter the blood vessels, organs and then replicate itself. In response to the infection, the immune system synthesizes pro-inflammatory cytokines such as IL6, IL2, and TNF α. This active bodily response may be further compromised by the generation of anti-inflammatory cytokines such as IL4 and IL10. We also propose a mathematical model using a Markov state transition for a flow-based molecular communication system which contributes to the detection of these pro-inflammatory cytokines level and gives a further inference about the infection in the body by taking multiple cytokines into account

23:27 *Performance Study of Neural Structured Learning Using Riemannian Features for BCI Classification.....297*

Kurusetti Vinay Gupta and Jayasandhya Meenakshinathan (IIT Kanpur, India); Tharun Reddy (IIT Roorkee, India); Laxmidhar Behera (Indian Institute of Technology, Kanpur, India)

Riemannian geometry-based features have been among the most promising electroencephalography(EEG) classification methods in recent years. However, these features can be classified using many machine learning(ML) algorithms. When compared against the standard methods, deep learning-based approaches are successful in classification accuracy and transfer learning. In this paper, we attempt to study Neural structured learning(NSL) to develop robust and regularized neural network models that preserve the similarity structure of the input EEG signals for a more reliable Brain-Computer Interface(BCI) classification. In this study, we have used the state-of-the-art Euclidean Tangent Space features projected from the Riemannian Covariance features of EEG to train the standard feedforward neural nets while incorporating the NSL module. It creates a similarity graph among the input samples and minimizes a graph regularization loss to maintain the neighbor structure. The proposed approach is evaluated on the standard 4-class Dataset 2a from BCI competition 2008. The results show that the proposed model improves accuracy compared to the base model without graph regularization. Surprisingly, it requires very few training samples to achieve almost state-of-the-art accuracy for some subjects using a mere two hidden layered neural network.

23:44 *Automatic Detection of Ocean Eddy Based on Deep Learning Technique with Attention Mechanism.....302*

John Saida Shaik and Samit Ari (NIT Rourkela, India)

Ocean eddies are a common occurrence in ocean water circulation. They have an enormous impact on the marine ecosystem. One of the most active study topics in physical oceanography is ocean eddy detection. Although using deep learning algorithms to detect eddies is a recent trend, it is still in its infancy. In this paper, an attention mechanism-based ocean eddy detection approach using deep learning is proposed. Attention mechanism has spatial and channel attention modules that are cascaded to convolution blocks-based encoder model to simulate spatial and channel semantic interdependencies. In the spatial attention module, the feature at each point is aggregated selectively by the sum of the features at all positions. The channel attention module aggregates related data from all channel maps to selectively highlight interdependent channel maps. The original feature map and the feature map obtained through the

attention mechanism are appended to enhance the feature representation further, resulting in more accurate segmentation results. The findings of the experiments show that adopting an attention-based deep framework improves eddy recognition accuracy significantly.

Presenter bio: This is Shaik John Saida pursuing Ph.D. in the department of Electronics and Communication, NIT Rourkela.

24:01 *Analyzing RMFCC Feature for Dialect Identification in Ao, an Under-Resourced Language……308*

Moakala Tzudir (Indian Institute of Technology Guwahati, India); Shikha Baghel (Indian Institute of Technology, Guwahati, India); Priyankoo Sarmah (IIT Guwahati, India); Mahadeva Prasanna (IIT Dharwad, India)

Ao is a language spoken in Nagaland in the North-East of India. It is a low-resource tone language under the Tibeto-Burman language family. It consists of three tones, namely, high, mid and low. It has three distinct dialects of the language viz. Chungli, Mongsen and Changki. This paper presents an automatic dialect identification in Ao using the excitation source feature. The objective of a dialect identification system is to identify a speech variety within a language. The goal of this study is to determine if the excitation source features such as Residual Mel Frequency Cepstral Coefficient (RMFCC) can be exploited to discriminate the three dialects in Ao automatically. In addition, vocal tract system features, namely Mel Frequency Cepstral Coefficients (MFCC) and Shifted Delta Cepstral (SDC) coefficients, are used as the baseline methods. The RMFCC features are obtained from the Linear Prediction (LP) residual signal, while MFCC features are derived from the smooth spectrum of the speech signal. SDC coefficients are explored to provide additional temporal information. This work is evaluated on trisyllabic words uttered by 36 speakers for the three dialects of Ao. A Gaussian Mixture Model (GMM) based classifier is used for classification. The performance of the system yields a better dialect identification accuracy rate when all three features are combined.

24:18 *Comparative Performance Analysis of Scalp EEG and Ear EEG Based P300 Ambulatory Brain-Computer Interfaces Using Riemannian Geometry and Convolutional Neural Networks……314*

Vartika Gupta and Tushar Kendre (IIT Kanpur, India); Tharun Reddy (IIT Roorkee, India); Vipul Arora (Indian Institute of Technology, Kanpur, India)

Brain-Computer Interfaces (BCI) provide the users to communicate with computers via brain signals. Significant research within the BCI is devoted to ElectroEncephaloGraphy (EEG), which picks, on the scalp, immensely frail electrical currents delineating brain activity. This paper presents a new ambulatory classification method for EEG Event Related Potentials (ERP) for a Practical Brain Computer Interface (BCI). To be more specific, this paper focuses on enhancing the performance of the ERP classification using Ear EEG along with scalp EEG during walking at 1.6m/s. We demonstrate the signal quality of Ear EEG for targets and non-targets. Through a novel estimation of Covariance matrices, this work extends the use of Riemannian Geometry (RG). In addition, the utility of Ear EEG has been justified by the (5%) improvement in ERP detection performance after a novel fusion of Riemannian Geometry attributes from Ear EEG and scalp EEG. Further, we also proposed a fusion of feature attributes of both scalp and Ear EEG obtained from the fully connected layer of trained EEGNet CNN model with autoencoders passed through XGBoost. This

method improved the state of the art by (10%). The proposed methods serve as novel adaptations of RG and CNN methods for mobile EEG in a practical BCI setup. The proposed method was also validated on the track 5 of the International BCI competition and achieved third position in the challenge.

24:35 *Proactive Mobility Management of UEs Using Sequence-To-Sequence Modeling.....320*

Vijaya Parampalli Yajnanarayana (Ericsson Research, India)

Beyond 5G networks will operate at high frequencies with wide bandwidths. This brings both opportunities and challenges. Opportunities include high throughput connectivity with low latency. However, one of the main challenges in these networks is due to the high path loss at operating frequencies, which requires network to be deployed densely to provide coverage. Since these cells have small inter-site-distance (ISD), the dwell-time of the UEs in these cells are small, thus supporting mobility in these types of dense networks is a challenge and require frequent beam or cell reassignments. A pro-active mobility management scheme which exploits the historical trajectories can provide better prediction of cells and beams as UEs move in the coverage area. We propose an AI based method using sequence-to-sequence modeling for the estimation of handover cells/beams along with dwell-time using the trajectory information of the UE. Results indicate that for a dense deployment, an accuracy of more than 90 percent can be achieved for handover cell estimation and very low mean absolute error (MAE) for dwell-time.

Presenter bio: Vijaya Yajnanarayana received the Masters of Science (MS) degree in electrical engineering (EE) from Illinois Institute of Technology, Chicago, USA and Ph.D. in EE from KTH Royal Institute of Technology, Stockholm, Sweden in 2007 and 2017 respectively. From 2001 to 2009, he worked in Motorola. From 2008 to 2009, he served as a senior specialist in Nokia Siemens Networks. From 2009 to 2012, he served as a principal engineer at National Instruments. He is currently working in Ericsson Research as a Master Researcher. In 2021, he was awarded Fred W. Ellersick prize given to the high impact magazine article for previous 3 years by IEEE Communication Society. In 2012, he was awarded 1 Million Swedish Kronor for research through prestigious Program of Excellence Award from KTH Royal Institute of Technology. He is also the recipient of best research paper award, by Motorola GSG technical journal and IEEE ICEMI conference in 2007 and 2011 respectively.

24:52 *Centralized and Distributed Reconfigurable Intelligent Surfaces Assisted NOMA.....326*

M. Hemanta Kumar and Sanjeev Sharma (IIT (BHU) Varanasi, India); Kuntal Deka (IIT Guwahati, India); Thottappan M (IIT (BHU), India)

Reconfigurable intelligent surfaces (RIS) and nonorthogonal multiple access (NOMA) are promising technologies for next-generation wireless networks. RIS can reconfigure wireless channels through passive reflecting elements, and NOMA enhances spectral efficiency (SE) and connectivity. In this paper, a base station (BS) transmits superimposed precoded symbols to near and far users via two different RIS deployment strategies. Initially, a single RIS is deployed at the BS and consists of N passive reflecting elements, referred to as centralized deployment of RIS-assisted NOMA (CDR-NOMA). On the other hand, two RISs having N/2 elements are kept at users and referred to as distributed deployment of RIS-assisted NOMA (DDR-NOMA). We have optimized the phase shift at RIS using the semidefinite relaxation (SDR) technique to maximize the received signal-tonoise ratio (SNR). Simulation results show that the bit error rate (BER) of the CDR-NOMA system is superior to the DDR-NOMA and a conventional RIS-assisted NOMA system. Further, the sumrate of the proposed CDR-NOMA and DDR-NOMA is calculated and it is better than the orthogonal multiple access (OMA). Furthermore, impact of transmitting antennas and reflecting surfaces are studied on the sum-rate and BER performance in the CDR-NOMA and DDR-NOMA.

and Arindam Chakraborty (Saankhya Labs Pvt Ltd, India)

The increased usage of video consumption along with a host of new services such as software download over wireless networks, group communications, and Internet of Things (IoT) applications has created a need for support of multicast broadcast services (MBS) in wireless networks. While the Third Generation Partnership Project (3GPP) is defining its own mechanism for MBS support in 5GS, supplementing the native 5G MBS support with Non-3GPP Broadcast networks (N3BN) may bring additional advantages. A unique characteristic of the 3GPP 5GS architecture is the existence of a converged core, capable of supporting different access technologies, e.g., 3GPP access and non-3GPP access in a uniform manner. The 5GS also supports multiple integration points for non-3GPP access networks, which may be utilized for its (5GS') integration with Non-3GPP Broadcast Networks such as Non-3GPP Satellite access networks and Digital Terrestrial Broadcast networks enabling it to harness them for multicast broadcast service delivery. In this article, we review the upcoming 3GPP 5G MBS standards along with some of its limitations. We also present state of the art standardization initiatives towards convergence of Non-3GPP broadcast networks with the 5G system.

2:00 ***UAV Altitude Optimization for Efficient Energy Harvesting in IoT Networks.....350***

Aditya Singh (IIT KANPUR, India); Surender Redhu (University of Agder & WiSENET Centre, Norway); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

Energy harvesting plays a crucial role in improving the operational lifetime of an IoT network. Moreover, the source and receiver separation dominates the amount of energy harvested in rechargeable IoT networks. In recent, Unmanned Aerial Vehicles (UAVs) have been utilized as RF energy transmitters for energy harvesting IoT networks. In this work, a method is proposed for optimizing the altitude of UAVs for energy-efficient charging of the IoT nodes. The proposed method maximizes the energy usage efficiency of the UAV over the IoT network subject to altitude and energy harvesting constraints. The proposed maximization problem is first transformed into an equivalent convex optimization problem using the First-Order Taylor Series Approximation. A heuristic algorithm based on the sequential convex programming approach is employed to obtain the optimal UAV altitude above the IoT network. The accuracy of the obtained results is evaluated analytically by computing the global optimum of the optimization problem via monotonic transformations. The results motivate the usage of UAV-aided energy harvesting in self-sustaining IoT networks.

2:17 ***Linear Classification on Noisy Hardware.....356***

Prakruthi Pradeep (Carnegie Mellon University, USA); Venkata Sai Chelagamsetty and Avhishek Chatterjee (Indian Institute of Technology Madras, India)

Motivated by the growing interest in machine learning on nanoscale edge devices, we study the effect of hardware noise and quantization errors on the accuracy of inference by linear classifiers. Our experiments on synthetic and real data sets using well accepted models for hardware noise and errors show that they have a significant impact on the accuracy. For mitigating those effects, we propose an easily implementable strategy by combining insights from linear classification, convex analysis and concentration of measure. Evaluations on synthetic and real data sets show that our simple strategy improves the performance significantly. We end with a brief discussion on a few avenues for further explorations.

proposed algorithm dynamically varies OBSS_PD_level based on packet error rates. Via simulations, we show that the proposed dynamic algorithm performs better (in terms of achieving a higher throughput and a lower packet error rate) than a naive method which adopts a constant OBSS_PD_level threshold and the case when the spatial reuse is not adopted. When the spatial reuse is implemented using the proposed algorithm, we also explore the performance of different traffic models served using QoS queues having different priorities and transmission parameters.

Presenter bio: I am an MS student in Indian Institute of Technology, Dharwad. I have completed my B.tech in Electronics and Communications Engineering from NIT Kurukshetra. Currently I am working on IEEE 802.11ax technology.

3:25 *Multi-Task Federated Edge Learning (MTFeeL) with SignSGD.....379*

Sawan Singh Mahara and Shruti Parashuram Maralappanavar (Indian Institute of Technology Dharwad, India); Bharath Bettagere Nagaraja (IIT Dharwad, India)

The paper proposes a novel Federated Learning (FL) algorithm involving signed gradient as feedback to reduce communication overhead. The Multi-task nature of the algorithm provides each device a custom neural network after completion. Towards improving the performance, a weighted average loss across devices is proposed which considers the similarity between their data distributions. A Probably Approximately Correct (PAC) bound on the true loss in terms of the proposed empirical loss is derived. The bound is in terms of (i) Rademacher complexity, (ii) discrepancy, and (iii) penalty term. A distributed algorithm is proposed to find the discrepancy as well as the fine tuned neural network at each node. It is experimentally shown that this proposed method outperforms existing algorithms such as FedSGD, DITTO, FedAvg and locally trained neural network with good generalization on various data sets.

3:42 *On Performance of IoT Devices Utilizing Energy Harvesting and Carrier Sensing in NOMA-HCN.....385*

Abhinav Singh Parihar (Indian Institute of Technology Indore & Nil, India); Pragya Swami and Vimal Bhatia (Indian Institute of Technology Indore, India)

This work proposes a energy harvesting based non-orthogonal multiple access (NOMA) scheme in a heterogeneous cellular network (HCN) to support a ultra-dense network of devices. HCN comprises of macro-cell (MC) tier under-laid by small-cell (SC) tier. The distribution MCs follow the independent Poisson point process model, while the SC tier employs carrier sensing. Carrier sensing reduces interference by allowing only one base station to transmit. The analysis is carried out at SC which pairs two Internet-of-Things (IoT) devices for downlink NOMA transmission. IoT devices have diversified energy profiles and channel conditions which makes them suitable for NOMA pairing. Wireless energy harvesting and cooperative communication is employed at the devices to compensate for the energy constraint while increasing coverage to IoT devices. Unlike previous works, the proposed method employs EH employing interference from small and macro cell tiers rather than just the superimposed signal for EH. Expression of outage probability and system throughput are derived for the proposed NOMA transmission and comparisons are drawn with the HCN that do not employ carrier sensing.

3:59 *Deep Imbalanced Data Learning Approach for Video Anomaly Detection.....391*

Avinash Ratre and Vinod Pankajakshan (Indian Institute of Technology Roorkee,

India)

Surveillance video data often exhibit highly imbalanced data distribution, i.e., majority or normal class instances outnumber the minority or anomalous class instances, which are the point of concern in video anomaly detection (AD). The existing deep learning methods often adopt various ensemble methods consisting of an early or late fusion of the cascade of either deep discriminative or generative learning models. These methods lack the diversity in applying the deep learning algorithms to imbalanced data learning for AD in real-world unlabeled and imbalanced surveillance video data. In this paper, decision level late fusion of two complementary deep learning models is accomplished using a loss function weighted regression model towards imbalanced data learning for video AD. Under the algorithmic level actions, the learning model's architecture consists of two complementary parallel discriminative-generative channels, i.e., a discriminative deep residual network (DRN) channel and a generative deep regression long short-term memory (LSTM) channel. The proposed complementary deep LSTM-DRN-based imbalanced data learning approach improves effectiveness in detecting anomalies compared to state-of-the-art methods.

4:16 ***Performance Analysis of a Relay-Assisted D2D Underlay Cellular Network*****.....397**

Kalpana Dhaka (Indian Institute of Technology Guwahati, India); Mahari Berhe Tsegay (Iitguwahati, India); Ratnajit Bhattacharjee (IIT Guwahati, India)

Device-to-device (D2D) underlay cellular network allows spectrum reuse that improves the spectral efficiency of the network. The challenge in allowing D2D links or relay-assisted D2D links to use the same resources as the traditional cellular down/uplink transmissions is the mutual interference between them. The cellular link contributes majorly to the interference due to the high power transmitted over the link. In this work, we consider interference due to cellular transmission at the relay and destination node of the relay-assisted D2D link are mitigated using decoding matrices obtained using interference alignment techniques. The exact expressions of the end-to-end outage probability and symbol error probability are obtained. The analysis is presented for a general scenario with multiple transmit and receive antennas. Numerical results are plotted to show the impact of the modulation order, interference due to other D2D devices, and power transmitted at the source and relay nodes.

4:33 ***A Fast and Efficient No-Reference Video Quality Assessment Algorithm Using Video Action Recognition Features*****.....402**

Suresh N, Pavan Manesh Mylavarapu and Naga Sailaja Mahankali (IIT Hyderabad, India); Sumohana Channappayya (Indian Institute of Technology Hyderabad, India)

This work addresses the problem of efficient no-reference video quality assessment (NR-VQA). The motivation for this work is that even the best and fastest VQA algorithms do not achieve real-time performance. The speed of quality evaluation is impeded primarily by the spatio-temporal feature extraction stage. This impediment is common to both traditional as well as deep learning models. To address this issue, we explore the efficacy of features used in the action recognition problem for NR-VQA. Specifically, we leverage the efficiency offered by Gate Shift Module (GSM) in extracting spatio-temporal features. A simple yet effective improvement to the GSM model is proposed by adding the self-attention module. We first show that GSM features are indeed effective for NR-VQA. We then demonstrate a speed-up that is at least an order of magnitude faster than the current state-of-the-art VQA algorithms, albeit at the cost of a slight drop in overall performance. We evaluate the efficacy of our algorithm on both Standard Dynamic Range (SDR) and High Dynamic Range (HDR) datasets like KoNViD-1K, LIVE VQC, HDR.

4:50 ***Semantic Masking: A Novel Technique to Mitigate the Class-Imbalance Problem in Real-Time Semantic Segmentation.....407***

Nadeem Atif, Hosur Balaji, Saquib Mazhar and Shaik Rafi Ahamed (Indian Institute of Technology Guwahati, India); Manas Kamal Bhuyan (IIT Guwahati, India)

In the field of computer vision and scene under- standing, semantic segmentation is considered to be one of the most challenging task. This is due to the fact that it has to solve all the three standard vision problems, multi-class classification, object detection and image segmentation. One of the most promising areas of application of semantic segmentation is autonomous driving. The advent of deep-learning and the availability of large-scale datasets has enabled the research com- munity to reach to unprecedented performance heights compared to traditional machine learning algorithms. However, despite all the progress, existing learning methods still face the problem of class-imbalance because of which large classes get more attention and consequently the network becomes biased towards them. The problem of class-imbalance is particularly more prominent in urban road-scene datasets. This is because the layout of the scene captured by the camera mounted on a fixed location, naturally causes certain less important classes to occupy more area in the dataset. Trees, sky and buildings are some of the examples of large classes which frequently occur and occupy large areas despite the fact that they are less important with regards to driving related decision making. To tackle this problem, in this work, we have done the statistical analysis of the famous Cityscapes dataset to uncover the hidden patterns that large and small classes follow. Based on these patterns, we propose a semantic masking technique, that enables our proposed network MaskNet to pay more attention to regions where the smaller classes are more likely to occur. In this way, we see a significant performance increase with regards to smaller classes and the problem of class- imbalance is mitigated to a good extent.

5:07 ***GoPro: A Low Complexity Task Allocation Algorithm for a Mobile Edge Computing System.....413***

Arghyadip Roy (Indian Institute of Technology Guwahati, India); Nilanjan Biswas (Birla Institute of Technology, Mesra, India)

In an Internet of Things (IoT) based network, tasks arriving at individual nodes can be processed in-device or at a local Mobile Edge Computing (MEC) server. In this paper, we focus on the optimal resource allocation problem for tasks arriving in an MEC based IoT network. To address the inherent trade-off between the computation time and the power consumption, we aim to minimize the average power consumption subject to a constraint on the deadline violation probability. The problem is formulated as a Constrained Markov Decision Process (CMDP) problem. To address the high complexities of achieving optimality, we propose a low-complexity heuristic task scheduling scheme. Efficacy of our approach is demonstrated using simulations.

5:24 ***Diversity Combining in a Single-Input-Multiple-Output Molecular Communication System.....419***

Abhishek K Gupta and Nithin V Sabu (Indian Institute of Technology Kanpur, India)

Molecular communication (MC) can enable nanoscale devices to communicate with each other using molecules as information carriers. To enhance the performance of MC, receiver-devices with multiple receiving ports can be utilized to form single-input multiple-output (SIMO) and multiple-input multiple-

output (MIMO) communication links. The receiver ports are analogous to antennas in wireless communication. This paper considers a diffusion-based MC SIMO system with a point transmitter and one receiver system with many receiving ports (RxPs). We first characterize the joint channel between the transmitter and RxPs. We then present the optimal maximum-a-posteriori (MAP) decoding for this system when all ports can share complete information and a central device soft-combines the individual signal values to decode the signal. We then consider a Poisson channel approximation for the channel and show that weighted linear combining is an optimal decoding scheme with weights depending on average channel values. We also study a symmetric SIMO system and investigate the decoding error probability and diversity order for various soft and hard combining schemes.

5:41 ***A Family of Capacity-Achieving Abelian Codes for the Binary Erasure Channel.....425***

Lakshmi Prasad Natarajan (Indian Institute of Technology Hyderabad, India); Prasad Krishnan (IIIT Hyderabad, India)

We identify a large family of abelian codes that achieve the capacity of the binary erasure channel (BEC) under bit-MAP decoding. The codes in this family have rich automorphism groups, their lengths are odd integers, and they can asymptotically (in the block length) achieve any code rate. This family contains codes of prime power block lengths that were originally identified by Berman (1967) and later investigated by Blackmore and Norton (2001), and also contains their generalization to any odd block length. We use Rajan and Siddiqi's (1992) characterization of abelian codes using discrete Fourier transform (DFT) to identify our code family and study their automorphism groups. We then use a result of Kumar, Calderbank and Pfister (2016) that relates the automorphism group of a code to its performance in the BEC to show that this code family achieves BEC capacity.

5:58 ***Analysis of Smart Grid Wide Area Network for Three Hop Mixed PLC/RF/FSO Channel.....431***

Ashish Kumar Padhan (Indian Institute of Technology Bhubaneswar, India); Hemanta Kumar Sahu (Vignan's Institute of Information Technology, India); Pravas Ranjan Sahu (Indian Institute of Technology Bhubaneswar, India); Subhransu Samantaray (Indian Institute of Technology, Bhubaneswar, India)

A three-hop long range communication system with mixed fading for smart grid (SG) wide area network (WAN) is proposed. The three hops proposed here are power line communication (PLC), radio frequency (RF) and free space optical (FSO) in cascade. The smart meter (SM) transfers the data to the access point (AP) through a PLC link. The AP is acting as a decode-and-forward (DF) relay. It retransmits the data to data aggregator unit (DAU) through RF link. The DAU also acts as a DF relay and retransmits the information to meter data management system (MDMS) through FSO link. The PLC, RF, and FSO links are distributed with Log-Normal, Nakagami-m, and Gamma-Gamma distribution, respectively. The modulation scheme considered here is binary phase shift keying (BPSK). A closed form expression for average bit error probability (ABEP) is obtained. Numerical and Monte-Carlo simulation results demonstrate the effect of impulsive noise scenario in the PLC channel, fading severity in Nakagami-m channel, and different FSO parameters in SG communication system.