

Twenty-seventh National Conference on Communications, (NCC 2021)

Jointly Organized by

Indian Institute of Technology Kanpur

&

Indian Institute of Technology Roorkee

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NCC 2021

Technically co-sponsored by IEEE Communication Society







27th National Conference on Communications



Program at-a-glance



	NCC 2021 Program					
27-Jul	Auditorium	На	II A			
0800-1030	Tutorial T1: Streaming Codes	Tutorial T2: Radar Signal Processing				
1030-1040		Break				
1040 1210	Tutorial T3: Model-based deep learning for wireless	The side TA Discharts Task	and any An Eachlan for Truck			
1040-1310	communications	Iutorial 14: Blockchain Tech	inology: An Enabler for Trust			
1310-1340	Tutorial TS: Aprial and Spaceborne	Lunch Break				
1340-1610	Communications: The Journey from 5G to 6G	Tutorial T6: Computing the Discrete Fourier Tr	ansform: From Classical FFTs to Structured FFTs			
1610-1620		Break				
	Tutorial T7: Reconfigurable Intelligent Surfaces:	Tutorial T8: Design Challenges in RF Power Amp	olifiers and Wireless Transmitters for 5G cellular			
1620-1850	From Electromagnetics to Communications	Applic	cations			
1850-1900	Tetraid TO: Advanced Air Machiller	Break	A New Developmin Marchine Intelligence			
1900-2015	Tutorial 19: Advanced Air Mobility	Tutorial 110: Data Analytics on Graphs:	A New Paradigm in Machine Intelligence			
28-Jul	Auditorium	Hall A	Hall B			
0800-0900		Plenary P1: Prof. Shrikanth Narayanan				
0900-1000		Plenary P2: Prof. Urbashi Mitra				
1000-1200		W1: Women in Engineering Workshop				
1200-1210		Break				
1210-1330	Session S1A: Communication Systems	Session S1B: Optical Communications	Session S1C: Speech Processing 1			
1330-1430		Lunch Break				
	Session S2A1: Age of Information					
1430-1550	Session S2A2: Machine Learning for	Session S2R: Ontical Systems	Session S2C: Sneech Processing 2			
1550-1600	communications	Break	Session Sze. Specch Processing 2			
1600-1720	Session S3A: Communication Theory 1	Session S3B: RF & Microwave 1	Session S3C: Video Processing 1			
1720-1730		Break				
1730-1850	Session 4A: Communication Theory 2	Session 4B: RF & Microwave 2	Session 4C: Video Processing 2			
1850-1900		Break				
1900-2000		Plenary P3: Prof. Ian F. Akylidiz				
29-Jul	Auditorium	Hall A	Hall B			
0820-0900	Session 11A: Millimeter Wave Systems	Session 11B: WSN	Session 11C: Radar			
0900-1230		W2: TSDSI Standards Driven Research Workshop				
1230-1240		Break				
1240-1340		Plenary P4: Prof. V. S. Borkar				
1340-1430		Lunch Break				
1430-1550	Session S5A: 5G New Radio	Session S5B: Networking	Session S5C: Image Processing			
1550-1600		Break				
1600-1720	Session S6A: 5G Communications	Session S6B: Antenna Design	Session S6C: Biomedical Image Processing			
1720-1730		Break				
1730-1830		Plenary P5: Prof. Shlomo Shamai (Shitz)				
20. [u]	Auditorium		Hall P			
0800-0900	Additorium	Dienary D6: Drof Balaii Drahbakar				
0800-0900	Tutorial T11: Blockchain protocols made efficient	Session S8A: Channel Canacity & Fixed Point				
0900-1020	and scalable	Analysis	Session S8C: Audio Processing			
1020-1030		Br	eak			
1030-1150		Session S9A: Energy Harvesting	Session S9C: Machine Learning			
1150-1200	Tutorial T12: Reconfigurable Intelligent Surfaces	Br	eak			
	and Holographic Massive MIMO: Vision,		Session S10C1: Clustering			
1200-1320	Fundamentals, and Key Open Problems	Session S10A: Relays	Session S10C2: Detection & Estimation			
1320-1400		Lunch Break				
1400-1430	Industry Talk: Anindya Saha	Service S7A(1)A)/ Communications	Session S7C: Biomedical Signal Processing &			
1430-1450	Sponsor Interaction: SadhKhya Labs	Session STA: UAV COMMUNICATIONS	Networks			
1520-1520	sponsor interaction: Qualcomm					
1600-1640		W3: Applications of Machine Learning Workshop				
1640-1720	Session S12A· RIS	Session S128. Security	Session S12C: DSP Algorithms			
1720-1750	Industry Talk: Samsung	Award Ceremony				
1730-1810	Industry Interaction: Samsung					
1810-1850						
1850-1930		ws: Applications of Machine Learning Workshop				

Tuesday, July 27th, 2021

NCC 2021: 2021 National Conference on Communications (NCC)

T1: Streaming Codes

Session time Tuesday, 08:00 am until 10:30 am Location Auditorium Talk time 150

T2: Radar Signal Processing

Session time Tuesday, 08:00 am until 10:30 am Location Hall A Talk time 150

T3: Model-based deep learning for wireless communications

Session time Tuesday, 10:40 am until 01:10 pm Location Auditorium Talk time 150

T4: Blockchain Technology: An Enabler for Trust

Session time Tuesday, 10:40 am until 01:10 pm Location Hall A Talk time 150

T5: Aerial and Spaceborne Communications: The Journey from 5G to 6G

Session time Tuesday, 01:40 pm until 04:10 pm Location Auditorium Talk time 150

T6: Computing the Discrete Fourier Transform: From Classical FFTs to Structured FFTs

Session time Tuesday, 01:40 pm until 04:10 pm Location Hall A Talk time 150

T7: Reconfigurable Intelligent Surfaces: From Electromagnetics to Communications

Session time Tuesday, 04:20 pm until 06:50 pm Location Auditorium Talk time 150

T8: Design Challenges in RF Power Amplifiers and Wireless Transmitters for 5G cellular Applications

Session time Tuesday, 04:20 pm until 06:50 pm Location Hall A Talk time 150

T9: Journey Towards Realizing the Full Potential of Advanced Air Mobility

Session time Tuesday, 07:00 pm until 08:15 pm Location Auditorium Talk time 75

T10: Data Analytics on Graphs: A New Paradigm in Machine Intelligence

Session time Tuesday, 07:00 pm until 08:15 pm Location Hall A Talk time 75

Wednesday, July 28th, 2021

NCC 2021: 2021 National Conference on Communications (NCC)

P1: Plenary: Human-centered Multimodal Behavioral Machine Intelligence

Session time Wednesday, 08:00 am until 09:00 am Location Auditorium Talk time 60

P2: Plenary: Active Hypothesis Testing for Fast Decision Making with applications to SARS-CoV-2 testing

Session time Wednesday, 09:00 am until 10:00 am Location Auditorium

W1: Women in Engineering

Session time Wednesday, 10:00 am until 12:00 pmLocationAuditoriumTalk time120

S1A: Communication Systems

Session time Wednesday, 12:10 pm until 01:30 pm Location Auditorium Talk time 20 Chaired by

12:10 pm: An All-Digital Wideband OFDM-Based Frequency-Hopping System Using RF Sampling Data Converters

Amit Sravan Bora (National Chiao Tung University, Taiwan); Harishore Singh Tourangbam (National Chiao Tung University, Taiwan); Po-Tsang Huang (National Chiao Tung University, Taiwan)

12:30 pm: Digital Predistortion Resource Optimization for Frequency Hopping Transceiver System

Jaya Mishra (Indian Institute of Technology, Roorkee, India); Girish Chandra Tripathi (Indian Institute of Technology Roorkee, India); Meenakshi Rawat (IIT Roorkee, India)

12:50 pm: Capacity Analysis of Adaptive Combining for Hybrid FSO/RF Satellite Communication System

Narendra Vishwakarma (Indian Institute of Technology Indore, India); Swaminathan Ramabadran (Indian Institute of Technology Indore, India)

01:10 pm: Development of Improved SOQPSK Based Data Transmission over Aeronautical Telemetry Link

Ravindra Mohan Nigam (Aeronautical Development Agency, India); Pyari Mohan Pradhan (IIT Roorkee, India)

S1B: Optical Communication

Session time Wednesday, 12:10 pm until 01:30 pm Location Hall A Talk time 20 Chaired by

12:10 pm: Generation of Optical Frequency Comb Using Cascaded Brillouin Scattering at Low Power Utilizing Pump Recycling Technique in a Single Mode Fiber

Aritra Paul (Indian Institute of Technology Kanpur, India); Pradeep Kumar (Indian Institute of Technology Kanpur, India)

12:30 pm: *Multi-Rate Kalman Filter for Carrier Phase Recovery in 200 Gbps PDM Coherent Optical Receivers*

Wrivu Sanyal (Indian Institute of Technology, Kanpur, India); Srishti Sharma (Indian Institute of Technology, Delhi, India); Pradeep Kumar (Indian Institute of Technology Kanpur, India)

12:50 pm: *Optical Sideband Interference Using Optical IQ and Mach-Zehnder Modulators*

Govind Kumar (Indian Institute of Technology Kanpur, India); Nishant Chandra (Indian Institute of Technology Kanpur, India); Pradeep Kumar (Indian Institute of Technology Kanpur, India)

01:10 pm: *Mode Analysis of AlGaAs Based Hybrid Metal Insulator Plasmonic Waveguide with Nanoscale Confinement*

Santosh Kumar (NIT PATNA, India); Pintu Kumar (National Institute of Technology Patna, India); Rakesh Ranjan (National Institute of Technology Patna, India)

S1C: Speech Processing 1

Session time Wednesday, 12:10 pm until 01:50 pm Location Hall B Talk time 20 Chaired by

12:10 pm: Detection of Speech Overlapped with Low-Energy Music Using Pyknograms

Mrinmoy Bhattacharjee (Indian Institute of Technology Guwahati, India); Mahadeva Prasanna (IIT Dharwad, India); Prithwijit Guha (IIT Guwahati, India)

12:30 pm: A Spectral Variation Function for Variable Time-Scale Modification of Speech

Pramod Haribhau Kachare (IIT Bombay & Ramrao Adik Institute of Technology, India); Prem C. Pandey (IIT Bombay, India)

12:50 pm: *Effect of High-Energy Voiced Speech Segments and Speaker Gender on Shouted Speech Detection*

Shikha Baghel (Indian Institute of Technology, Guwahati, India); Mahadeva Prasanna (IIT Dharwad, India); Prithwijit Guha (IIT Guwahati, India)

01:10 pm: *DNN Based Phrase Boundary Detection Using Knowledge-Based Features and Feature Representations from CNN*

Pavan Kumar J (Indian Institute of Science, India); Chiranjeevi Yarra (International Institute of Information Technology, India); Prasanta Kumar Ghosh (Indian Institute of Science, India)

01:30 pm: Towards a Database for Detection of Multiple Speech Disfluencies in Indian English

Sparsh Garg (International Institute of Information Technology Hyderabad, India); Utkarsh Mehrotra (International Institute of Information Technology Hyderabad, India); Krishna Gurugubelli (IIIT-Hyderabad, India); Anil Kumar Vuppala (International Institute of Information Technology Hyderabad, India)

S2A1: Age of Information

Session time Wednesday, 02:30 pm until 03:10 pm Location Auditorium Talk time20Chaired by

02:30 pm: Age-Of-Information Bandits with Heterogeneous Data Rates

Harsh S Deshpande (IIT Bombay, India); Sucheta Ravikanti (Indian Institute of Technology, Bombay, India); Sharayu Moharir (Indian Institute of Technology Bombay, India)

02:50 pm: On the Age of Information of a Queuing System with Heterogeneous Servers

Anhad Bhati (IIT Bombay, India); Sibi Raj B Pillai (IIT Bombay, India); Rahul Vaze (TIFR Mumbai, India)

S2A2: Machine Learning for Communications

Session timeWednesday, 03:10 pm until 03:50 pmLocationAuditoriumTalk time20Chaired byImage: Chaired by

03:10 pm: Learning to Decode Trellis Coded Modulation

Jayant Sharma (IIIT Hyderabad, India); V. Lalitha (IIIT Hyderabad, India)

03:30 pm: *Auto-SCMA: Learning Codebook for Sparse Code Multiple Access Using Machine Learning*

Ekagra Ranjan (Indian Institute of Technology (IIT) Guwahati, India); Ameya Vikram (Indian Institute of Technology (IIT) Guwahati, India); Alentattil Rajesh (IIT G, India); Prabin Kumar Bora (Indian Institute of Technology Guwahati, India)

S2B: Optical Systems

Session time Wednesday, 02:30 pm until 03:50 pm Location Hall A Talk time 20 Chaired by

02:30 pm: A Penalty-Based Routing and Spectrum Assignment in Fragmented Elastic Optical Network Spectrum

Anjali Sharma (Indian Institute of Technology Kanpur, India); Sobir Ali (Indian Institute of Technology Kanpur, India); Varsha Lohani (IIT Kanpur, India); Yatindra Nath Singh (Indian Institute of Technology Kanpur, India)

02:50 pm: Neural Networks for Predicting Optical Pulse Propagation Through Highly Nonlinear Fibers

Naveenta Gautam (Indian Institute of Technology, India); Amol Choudhary (Indian Institute of Technology (IIT), Delhi, India); Brejesh Lall (Indian Institute of Technology Delhi, India)

03:10 pm: Coupling Length Analysis by Using Three Strips for Compact Design of Photonic Waveguide in Photonic Integrated Circuit

Veer Chandra (National Institute of Technology Patna, India); Santosh Kumar (NIT PATNA, India); Rakesh Ranjan (National Institute of Technology Patna, India)

03:30 pm: Quantized Feedback-Based Space Shift Keying in Visible Light Communication

Sivanjan Rao Chandhu (Indian Institute of Technology, Roorkee, India); Anshul Jaiswal (Indian Institute of Technology Roorkee, India)

S2C: Speech Processing 2

Session time Wednesday, 02:30 pm until 03:50 pm Location Hall B Talk time 20 Chaired by

02:30 pm: Instantaneous Frequency Filter-Bank Features for Low Resource Speech Recognition Using Deep Recurrent Architectures

Shekhar Nayak (Samsung R&D Institute Bangalore & IIT Hyderabad, India); Chintigari Shiva Kumar (IIT Hyderabad, India); Sri Rama Murty Kodukula (Indian Institute of Technology Hyderabad, India)

02:50 pm: CTC-Based End-To-End ASR for the Low Resource Sanskrit Language with Spectrogram Augmentation

Anoop Chandran Savithri (Indian Institute of Science, Bangalore, India); Ramakrishnan Angarai Ganesan (Indian Institute of Science & RaGaVeRa Indic Technologies Pvt Ltd, India)

03:10 pm: Spoken Language Diarization Using an Attention Based Neural Network

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

03:30 pm: Speech-Training Aid with Time-Scaled Audiovisual Feedback of Articulatory Efforts

Pramod Haribhau Kachare (IIT Bombay & Ramrao Adik Institute of Technology, India); Prem C. Pandey (IIT Bombay, India); Vishal Mane (India, India); Hirak Dasgupta (IIT Bombay, India); K. S. Nataraj (Indian Institute of Technology, Bombay, India)

S3A: Communication Theory 1

Session timeWednesday, 04:00 pm until 05:20 pmLocationAuditoriumTalk time20Chaired by

04:00 pm: Channel Estimation and Data Detection of OTFS System in the Presence of Receiver IQ Imbalance

Sapta Girish Babu Neelam (Bharat Electronics Limited & IIT Bhubaneswar, India); Pravas Ranjan Sahu (Indian Institute of Technology Bhubaneswar, India)

04:20 pm: Parametric Estimation of SINR Distribution Using Quantized SINR Samples for Maximizing Average Spectral Efficiency

Karthik Mohan K (IIT Kharagpur, India); Suvra Sekhar Das (Indian Institute of Technology Kharagpur, India)

04:40 pm: Optimal Pilot Design for Data Dependent Superimposed Training Based Channel Estimation in Single/Multi Carrier Block Transmission Systems

Manjeer Majumder (IIT KANPUR, India); Aditya K Jagannatham (Indian Institute of Technology Kanpur, India)

05:00 pm: Superimposed Pilot Based Channel Estimation for MIMO Coded FBMC Systems

Murali Krishna Pavuluri (Indian Institute of Technology Bombay, India); Seeram Ram Prakash Sri Sai (Indian Institute of Technology Bombay, India); Vikram M. Gadre (IIT Bombay, India); Aditya K Jagannatham (Indian Institute of Technology Kanpur, India)

S3B: RF & Microwave 1

Session time Wednesday, 04:00 pm until 05:00 pm Location Hall A Talk time 20 Chaired by

04:00 pm: Wideband Circuit Analog Absorber Using Modified Resistive Cross-Dipoles

Aditya Mandar Jabade (BITS-Pilani, India); Hrishikesh Sonalikar (BITS, Pilani, India)

04:20 pm: Influence of Various Soil Types and Its Properties on Filamentary Planar Coil Based Magnetic Induction Communication System

Swathi Sugumar (SSN College of Engineering, India); Sakthivel Murugan Santhanam (SSN College of Engineering, India)

04:40 pm: Two-Way Array Factor Supported by Thinning Strategy for an Improved Radar Performance

Rathod Rajender (NIT-Rourkela, India); Konidala Subhashini (National Institute Of Technology, India); B Pavan Kumar (APSD Communication Systems Group U R Rao Satellite Centre ISRO, India)

S3C: Video Processing 1

Session time Wednesday, 04:00 pm until 05:20 pm

Location Hall B Talk time 20 Chaired by

04:00 pm: *DeepSCT: Deep Learning Based Self Correcting Object Tracking Mechanism*

Khush Agrawal (Visvesvaraya National Institute of Technology, India); Rohit Lal (Visvesvaraya National Institute of Technology, India); Himanshu Patil (Visvesvaraya National Institute of Technology, India); Surender Kannaiyan (VNIT, Nagpur, India); Deep Gupta (Visvesvaraya National Institute of Technology, Nagpur, India)

04:20 pm: Domain Randomization on Deep Learning Models for Image Dehazing

Abdul Fathaah Shamsuddin (National Institute of Technology Calicut, India); Abhijith P (National Institute of Technology Calicut, India); Deepak Raja Sekar P M (National Institute of Technology Calicut, India); Krupasankari Ragunathan (National Institute of Technology Calicut, India); Praveen Sankaran (National Institute of Technology Calicut, India)

04:40 pm: Deep Video Compression Using Compressed P-Frame Resampling

Abhishek Kumar Sinha (Indian Institute of Space Science and Technology, India); Deepak Mishra (IIST, India)

05:00 pm: Forensics of Decompressed JPEG Color Images Based on Chroma Subsampling

Chothmal Kumawat (IIT Roorkee, India); Vinod Pankajakshan (Indian Institute of Technology Roorkee, India)

S4A: Communication Theory 2

Session time Wednesday, 05:30 pm until 06:30 pm

Location Auditorium

Talk time 20

Chaired by

05:30 pm: Angle of Arrival Distribution for Coherent Scattering from an Undulating Sea Surface

Manishika Rawat (Indian Institute of Technology Delhi, India); Brejesh Lall (Indian Institute of Technology Delhi, India); Seshan Srirangarajan (Indian Institute of Technology Delhi, India)

05:50 pm: *Robust Linear Transceiver Design for Parameter Tracking in IoT Networks*

Mohammad Faisal Ahmed (Cisco Systems (India), India); Kunwar Pritiraj Rajput (Indian Institute of Technology Kanpur, India); Aditya K Jagannatham (Indian Institute of Technology Kanpur, India)

06:10 pm: *Performance of Two Stage Cooperative NOMA Transmission for Full-Efficient Three User Network*

Ankur Bansal (Indian Institute of Technology Jammu, India); Sudhakar Modem (Indian Institute Of Technology, Jammu, India)

S4B: RF & Microwave 2

Session time Wednesday, 05:30 pm until 06:30 pm Location Hall A Talk time 20 Chaired by

05:30 pm: *A Miniaturized Wideband Half Mode Substrate Integrated Waveguide Bandpass Filter for C Band Applications*

Swathy BH (IIITDM Kancheepuram, India); Pallepogu Prasanna Kumar (IIITDM Kancheepuram, India); Prerna Saxena (Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram, India)

05:50 pm: Design of an Elementary Microstrip Power Splitter for Antenna Array

Chanchala Kumari (BIT MESRA RANCHI, India); Neela Chattoraj (Birla Institute of Technology, Mesra Ranchi, India)

06:10 pm: A Miniaturized Interdigital Bandpass Filter for Intentional Electromagnetic Interference Applications

Abirami B (IIITDM Kancheepuram, India); Prerna Saxena (Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram, India); Premkumar K. (Indian Institute of Information Technology, Design and Manufacturing Kancheepuram, India)

S4C: Video Processing 2

Session time Wednesday, 05:30 pm until 06:50 pm Location Hall B Talk time 20 Chaired by

05:30 pm: An Optical Flow Based Approach to Detect Movement Epenthesis in Continuous Fingerspelling of Sign Language

Navneet Nayan (Indian Institute of Technology, Roorkee, India); Pyari Mohan Pradhan (IIT Roorkee, India); Debashis Ghosh (Indian Institute of Technology (IIT) Roorkee, India)

05:50 pm: A Level Set Model Driven by New Signed Pressure Force Function for Image Segmentation

Soumen Biswas (National Institute of Technology Silchar, India); Ranjay Hazra (Nit Silchar, India); Shitala Prasad (Research Scientist, Singapore); Arvind Sirvee (Rajasthan Technical University, Kota, India)

06:10 pm: *Phrase Recognition Using Improved Lip Reading Through Phase-Based Eulerian Video Magnification*

Salam Nandakishor (National Institute of Technology Nagaland, India); Debadatta Pati (National Institute of Technology Nagaland, India)

06:30 pm: Visibility Restoration of Diverse Turbid Underwater Images- Two Step Approach

Mary S Cecilia (Anna University & SSN College of Engineering, India); Sakthivel Murugan Santhanam (SSN College of Engineering, India)

P3: Plenary: TeraHertz Band Communication: An Old Problem Revisited for 6G Wireless Systems

Session time Wednesday, 07:00 pm until 08:00 pm

Location Auditorium

Talk time 60

Thursday, July 29th, 2021

S11A: Millimeter Wave Systems

Session time Thursday, 08:20 am until 09:00 am Location Auditorium Talk time 20 Chaired by

08:20 am: Joint Beamwidth and Number of Concurrent Beams Estimation in Downlink mmWave Communications

Nancy Varshney (IIT Delhi, India); Swades De (Indian Institute of Technology Delhi, India)

08:40 am: A Blind Iterative Hybrid Analog/Digital Beamformer for the Single User mmWave Reception Using a Large Scale Antenna Array

Yash Vasavada (Dhirubhai Ambani Institute of Information and Communication Technology, India); Naitik N Parekh (Dhirubhai Ambani Institute of Information and Communication Technology, India); Aarushi Dhami (Dhirubhai Ambani Institute of Information and Communication Technology, India); Chandra Prakash (Space Applications Centre & ISRO, India)

S11B: WSN

Session time Thursday, 08:20 am until 09:00 am Location Hall A Talk time 20 Chaired by

08:20 am: *Optimal Link Scheduling for Low Latency Data Transfer over Small World WSNs*

Om Jee Pandey (University of Saskatchewan, Canada); Naga Srinivasarao Chilamkurthy (University of SRM AP, India); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

08:40 am: *Efficient Message Dissemination in V2V Network: A Local Centrality-Based Approach*

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

S11C: Radar

Session time Thursday, 08:20 am until 09:00 am Location Hall B Talk time 20 Chaired by

08:20 am: Slotted Aloha for FMCW Radar Multiple Access Networks

Haritha K (Indian Institute of Science, India); Vineeth Bala Sukumaran (Indian Institute of Space Science and Technology, Trivandrum, India); Chandramani Singh (Indian Institute of Science, India)

08:40 am: Analysis of 5G New Radio Waveform as an Illuminator of Opportunity for Passive Bistatic Radar

Purushottama Lingadevaru (National Institute of Technology Karnataka, India); Pardhasaradhi Bethi (National Institute of Technology - Karnataka, India); Pathipati Srihari, Dr (National Institute of Technology Karnataka, India); G. V. k. Sharma (GITAM University, India)

W2: TSDSI: Standards Driven Research

Session time Thursday, 09:00 am until 12:30 pm Location Auditorium Talk time 210

P4: Plenary: Kab Q aur kahaan? (Variations on a theme of Watkins)

Session time Thursday, 12:40 pm until 01:40 pm Location Auditorium Talk time 60

S5A: 5G New Radio

Session time Thursday, 02:30 pm until 03:30 pm Location Auditorium Talk time 20 Chaired by

02:30 pm: Improving the Throughput of a Cellular Network Using Machine Learning - A Case Study of LTE

Prasad Tukaram Gaikwad (IITH, India); SaiDhiraj Amuru (IIT Hyderabad, India); Kiran Kuchi (IIT Hyderabad, India)

02:50 pm: Enhanced Transport Block Processing for 5G NR PUSCH Coverage Enhancement

Koteswara Rao G (Indian Institute of Technology Hyderabad, India); Subhash Kumawat (Indian Institute of Technology Hyderabad, India); SaiDhiraj Amuru (IIT Hyderabad, India); Kiran Kuchi (IIT Hyderabad, India)

03:10 pm: Downlink Resource Allocation for 5G-NR Massive MIMO Systems

Pavan Reddy M (Indian Institute of Technology Hyderabad, India); Mounika Reddy (IIT Hyderabad, India); Abhinav Kumar (Indian Institute of Technology Hyderabad, India); Kiran Kuchi (IIT Hyderabad, India)

S5B: Networking

Session time Thursday, 02:30 pm until 03:50 pm

Location Hall A Talk time 20 Chaired by

02:30 pm: *Multi-Source TCP (MSTCP): A Transport Protocol for Distributed Content Delivery*

Lalhruaizela Chhangte (IITB-Monash Research Academy, India); Pramey Singh (IIT Bombay, India); D. Manjunath (IIT Bombay, India); Nikhil Karamchandani (Indian Institute of Technology Bombay, India)

02:50 pm: On Traffic Classification in Enterprise Wireless Networks

Sipra Behera (Tata Consultancy Services, India); Bighnaraj Panigrahi (Tata Consultancy Services, India); Hemant Kumar Rath (Tata Consultancy Services, India); Jyotirmoy Karjee (Samsung, Bangalore, India)

03:10 pm: A Light-Weight Delay Tolerant Networking Framework for Resource-Constrained Environments

Ajay Salas (Indian Institute of Space Science and Technology, India); Sarath Babu (Indian Institute of Space Science and Technology (IIST), India); Manoj Bs (Indian Institute of Space Science and Technology, India)

03:30 pm: *Differential Scale Based Multi-Objective Task Scheduling and Computational Offloading in Fog Networks*

Mohit Kumar Saxena (Indian Institute of Technology, Patna, India); Sudhir Kumar (Indian Institute of Technology Patna, India)

S5C: Image Processing

Session time Thursday, 02:30 pm until 03:10 pm Location Hall B Talk time 20

02:30 pm: Automated Macular Disease Detection Using Retinal Optical Coherence Tomography Images by Fusion of Deep Learning Networks

Latha V (College of Engineering, Trivandrum, India); Ashok R (College of Engineering, Trivandrum, India); Sreeni K G (College of Engineering, Thiruvananthapuram, INDIA, India)

02:50 pm: Selective Variance Based Kinship Verification in Parent's Childhood and Their Children

Madhu Oruganti (National Institute of Technology RAIPUR, India); Toshanlal Meenpal (NIT Raipur, India); Saikat Majumder (National Institute of Technology Raipur, India)

S6A: 5G Communications

Session time Thursday, 04:00 pm until 05:20 pm Location Auditorium Talk time 20 Chaired by

04:00 pm: Enhanced Precoding Aided Generalized Spatial Modulation for Massive MIMO Systems

Kunnathully Sadanandan Sanila (IIT Goa, India); Neelakandan R (IIT Goa, India)

04:20 pm: K-Preferential Slotted ALOHA for Ultra Reliable Low Latency Communications

Satyam Agarwal (Indian Institute of Technology Ropar, India); Shubham Pandey (Indian Institute of Technology Ropar, India)

04:40 pm: Uplink Channel Impulse Response Based Secondary Carrier Prediction

Prayag Gowgi (Ericsson Research, India); Vijaya Parampalli Yajnanarayana (Ericsson Research, India)

05:00 pm: *Phase Calibration of Multiple Software Defined Radio Transmitters for Beamforming in 5G Communication*

Dusari Nageswara Rao (Indian Institute of Technology, Roorkee, India); Meenakshi Rawat (IIT Roorkee, India)

S6B: Antenna Design

Session time Thursday, 04:00 pm until 05:20 pm Location Hall A Talk time 20 Chaired by

04:00 pm: Design of a Compact TM01-TE11 Mode Converter Using Periodic Iris Loading

Ashish Chittora (BITS-Pilani, K. K. Birla Goa Campus, India)

04:20 pm: Compact and Wideband Circularly Polarized Quadrature Rectangular Dielectric Resonator Antenna

Abhijeet Gaonkar (NIT Goa, India); Pragati Patel (NIT Goa, India)

04:40 pm: A Compact Reconfigurable Slot-Loaded Printed Antenna for Future Wireless Applications

Divyanshu Bhardwaj (Indian Institute of Information Technology Guwahati, India); Anamiya Bhattacharya (Indian Space Research Organization, India); Bidisha DasGupta (Indian Institute of Information Technology, India)

05:00 pm: An H-Plane Multi-Horn Antenna Using Substrate Integrated Waveguide Technique

Anil Nayak, Mr (IIT Roorkee, India); Vinit Yadav (IIT Roorkee, India); Amalendu Patnaik (IIT Roorkee, India)

S6C: Biomedical Image Processing

Session time Thursday, 04:00 pm until 05:20 pm Location Hall B Talk time20Chaired by

04:00 pm: Transfer Learning-Based Automatic Detection of Acute Lymphocytic Leukemia

Pradeep Kumar Das (National Institute of Technology Rourkela, India); Sukadev Meher (National Institute of Technology, Rourkela, India)

04:20 pm: Optimized Bio-Inspired Spiking Neural Models Based Anatomical and Functional Neurological Image Fusion in NSST Domain

Manisha Das (Visvesvaraya National Institute of Technology, Nagpur, India); 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)

04:40 pm: Biomedical Image Retrieval Using Muti-Scale Local Bit-Plane Arbitrary Shaped Patterns

Deepamoni Mahanta (Tezpur University, India); Deepika Hazarika (Tezpur University, India); Vijay Kumar Nath (Tezpur University, India)

05:00 pm: Detection of Myocardial Infarction from 12 Lead ECG Images

Ravi Kumar Sanjay Sane (Indian Institute of Technology Guwahati, India); Pharvesh Salman Choudhary (IIT Guwahati, India); L N Sharma (IIT Guwahati, India); Samarendra Dandapat (Indian Institute of Technology Guwahati, India)

P5: Plenary: The Information Bottleneck: A Unified Information Theoretic View

Session time Thursday, 05:30 pm until 06:30 pmLocationAuditoriumTalk time60

Friday, July 30th, 2021

NCC 2021: 2021 National Conference on Communications (NCC)

P6: Plenary: Timeliness: A New Paradigm for Distributed Computing and Networking

Session time Friday, 08:00 am until 09:00 am Location Auditorium

S8A: Channel Capacity and Fixed Point Analysis

Session time Friday, 09:00 am until 10:20 am Location Hall A Talk time 20 Chaired by

09:00 am: Numerically Computable Lower Bounds on the Capacity of the ..(1,\infty)..-RLL Input-Constrained Binary Erasure Channel

V. Arvind Rameshwar (Indian Institute of Science, Bengaluru, India); Navin Kashyap (Indian Institute of Science, India)

09:20 am: Commitment over Compound Binary Symmetric Channels

Anuj Kumar Yadav (Indian Institute of Technology Patna, India); Manideep Mamindlapally (Indian Institute of Technology Kharagpur, India); Amitalok J. Budkuley (Indian Institute of Technology Kharagpur, India); Manoj Mishra (National Institute of Science Education and Research, Bhubaneswar, Homi Bhabha National Institute, India)

09:40 am: Capacity of Photonic Erasure Channels with Detector Dead Times

Jaswanthi Mandalapu (Indian Institute of Technology, Madras, India); Krishna P Jagannathan (Indian Institute of Technology Madras, India)

10:00 am: The Four Levels of Fixed-Points in Mean-Field Models

Sarath Yasodharan (Indian Institute of Science, India); Rajesh Sundaresan (Indian Institute of Science, India)

S8C: Audio Processing

Session time Friday, 09:00 am until 10:20 am Location Hall B Talk time20Chaired by

09:00 am: *Binaural Reproduction of HOA Signal Using Sparse Multiple Measurement Vector Projections*

Gyanajyoti Routray (Indian Institute of Technology Kanpur, India); Priyadarshini Dwivedi (Indian Institute of Technology, Kanpur, India); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

09:20 am: Robustness and Accuracy of Time Delay Estimation in a Live Room

Yegnanarayana B. (International Institute of Information Technology, Hyderabad, India); HVS Narayana Murthy B (Research Center Imarat, India); J v Satyanarayana (DRDO INDIA, India); Vishala Pannala (International Institute of Information Technology (IIIT), Hyderabad, India); Nivedita Chennupati (International Institute of Information Technology Hyderabad, India)

09:40 am: Learning Based Method for Robust DOA Estimation Using Co-Prime Circular Conformal Microphone Array

Raj Prakash Gohil (Indian Institute of Technology, Kanpur, India); Gyanajyoti Routray (Indian Institute of Technology Kanpur, India); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

10:00 am: Frequency-Anchored Deep Networks for Polyphonic Melody Extraction

Aman Kumar Sharma (IIT Kanpur & Cisco Systems, India); Kavya Ranjan Saxena (IIT, Kanpur, India); Vipul Arora (Indian Institute of Technology, Kanpur, India)

T11: Blockchain protocols made efficient and scalable

Session time Friday, 09:00 am until 10:20 am Location Auditorium Talk time 80

T12: Tutorial 12

Session time Friday, 10:20 am until 01:20 pm Location Auditorium Talk time 180

S9A: Energy Harvesting

Session time Friday, 10:30 am until 11:30 am Location Hall A Talk time 20 Chaired by

10:30 am: Maximizing the Throughput of an Energy Harvesting Transmitter in the Presence of a Jammer with Fixed Energy

Haseen Rahman (Indian Institute of Technology Bombay, India)

10:50 am: Relay-Aided Bidirectional Communications Between Devices in a Hybrid User Scenario for IoT

Shivam Gujral (Indian Institute of Technology Mandi, India)

11:10 am: On Performance of Battery-Assisted SWIPT with Incremental Relaying and Nonlinear Energy Harvesting

Kamal Agrawal (Indian Institute of Technology Delhi, India); Anand Jee (Indian Institute of Technology, Delhi, India); Shankar Prakriya (Indian Institute of Technology, Delhi, India)

S9C: Machine Learning

Session time Friday, 10:30 am until 11:50 am Location Hall B Talk time 20 Chaired by

10:30 am: Attention-Based Phonetic Convolutional Recurrent Neural Networks for Language Identification

Ramesh Gundluru (Indian Institute of Technology, Hyderabad, India); Vayyavuru Venkatesh (Indian Institute of Technology Hyderabad, India); Kodukula Sri Rama Murty (Indian Institute of Technology, Hyderabad, India)

10:50 am: Spatio-Temporal Prediction of Roadside PM2.5 Based on Sparse Mobile Sensing and Traffic Information

Anand Kakarla (Indian Institute Of Technology Hyderabad, India); Venkata Satish Kumar Reddy Munagala (Indian Institute of Technology Hyderabad, India); Tetsuhiro Ishizaka (Nihon University, Japan); Atsushi Fukuda (Nihon University, Japan); Soumya Jana (Indian Institute of Technology, Hyderabad, India)

11:10 am: Early Prediction of Human Action by Deep Reinforcement Learning

Hareesh Devarakonda (IIIT Sricity, India); Snehasis Mukherjee (Shiv Nadar University, India)

11:30 am: A Deep Reinforcement Learning Approach for Shared Caching

Pruthvi Trinadh (Indian Institute of Technology Bhubaneswar, India); Anoop Thomas (Indian Institute of Technology Bhubaneswar, India)

S10A: Relays

Session time Friday, 12:00 pm until 01:20 pm Location Hall A Talk time 20 Chaired by

12:00 pm: Analysis of Multi-Hop Device-To-Device Networks with Half-Duplex Relays

Gourab Ghatak (IIIT Delhi, India)

12:20 pm: Outage Analysis of SWIPT-Enabled Multi-Relay Aided Full Duplex NOMA System Under Partial Relay Selection

Shubham Shinkar (National Institute of Technology Calicut, India); Babu A v (National Institute of Technology Calicut, India)

12:40 pm: *Greedy Successive Relaying for the Multicarrier Diamond Relay Channel*

Antony Mampilly (IIT Madras, India); Srikrishna Bhashyam (Indian Institute of Technology Madras, India)

01:00 pm: On Outage Probability Analysis of Uplink Cooperative VFD-NOMA over Nakagami-m Faded Channels

Justin Jose (Indian Institute of Technology Indore, India); Parvez Shaik (Indian Institute of Technology Indore, India); Shubham Bisen (Indian Institute of Technology Indore, India); Vimal Bhatia (Indian Institute of Technology Indore, India)

S10C1: Clustering

Session time Friday, 12:00 pm until 12:40 pm Location Hall B Talk time 20 Chaired by

12:00 pm: A Novel Clustering Tendency Assessment Algorithm for WSN Generated Spatio-Temporal Data

Kartik Vishal Deshpande (Indian Institute Of Technology, India); Dheeraj Kumar (IIT Roorkee, India)

12:20 pm: *Dimension Reduction and Clustering of Single Cell Calcium Spiking: Comparison of t-SNE and UMAP*

Suman Gare (IIT Hyderabad, India); Soumita Chel (IIT Hyderabad, India); Manohar Kuruba (IIT Hyderabad, India); Soumya Jana (IIT Hyderabad, India); Lopamudra Giri (IIT Hyderabad, India)

S10C2: Detection & Estimation

Session time Friday, 12:40 pm until 01:20 pm Location Hall B Talk time 20 Chaired by

12:40 pm: Safe Sequential Optimization in Switching Environments

Durgesh Kalwar (Indian Institute of Space Science and Technology, India); Vineeth Bala Sukumaran (Indian Institute of Space Science and Technology, Trivandrum, India)

01:00 pm: *Empirical Study of Weight Initializations for COVID-19 Predictions in India*

Meenal Narkhede (College of Engineering, Pune, India); Shubham Mane (College of Engineering, Pune, India); Prashant Bartakke (College of Engineering, Pune, India); M Sutaone (College of Engineering, Pune, India)

S13: Industry Talk: Saankhya Labs

Session time Friday, 02:00 pm until 02:30 pm Location Auditorium Talk time 80

S15A: Industry Interaction: Saankhya Labs

Session time Friday, 02:30 pm until 02:50 pm Location Auditorium Talk time 80

S15B: Industry Interaction: Qualcomm

Session time Friday, 03:00 pm until 03:20 pm Location Auditorium Talk time 80

S7A: UAV Communications

Session time Friday, 02:00 pm until 03:20 pm Location Hall A Talk time 20 Chaired by

02:00 pm: Joint Bandwidth and Position Optimization in UAV Networks Deployed for Disaster Scenarios

Neetu R R (IIIT Delhi, India); Akshita Gupta (Indraprastha Institute of Information Technology, India); Gourab Ghatak (IIIT Delhi, India); Anand Srivastava (Indraprastha Institute of Information Technology Delhi, India); Vivek A Bohara (Indraprastha Institute of Information Technology, Delhi (IIIT-Delhi), India)

02:20 pm: Trajectory Prediction of UAVs for Relay-Assisted D2D Communication Using Machine Learning

Pradip Kumar Barik (Indian Institute of Technology, Kharagpur, India); Ashu Dayal Chaurasiya (Indian Institute of Technology Kharagpur, India); Raja Datta (Indian Institute of Technology Kharagpur, India); Chetna Singhal (Indian Institute of Technology Kharagpur, India)

02:40 pm: *Optimal Deployment Strategy for Relay Based UAV Assisted Cooperative Communication for Emergency Applications*

Nelapati Lava Prasad (Indian Institute of Technology Bhubaneswar, India); Chanakya Ajit Ekbote (Indian Institute of Technology Bhubaneswar, India); Barathram. Ramkumar (Indian Institute of Technology Bhubaneswar, India)

03:00 pm: Optimal Data Transfer in UAV-Assisted Edge-Networks Using 3D Beamforming

Shraddha Tripathi (Indian Institute of Technology Kanpur, India & NCTU Taiwan, Taiwan); Om Jee Pandey (University of Saskatchewan, Canada); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

S7C: Biomedical Signal Processing & Networks

Session time Friday, 02:00 pm until 03:20 pm Location Hall B Talk time 20 Chaired by

02:00 pm: Brain Source Localization with Covariance Fitting Approaches

Anchal Yadav (Indian Institute of Technology Delhi India, India); Prabhu Babu (CARE, Indian Institute of Technology, Delhi, India); Monika Aggarwal (IIT Delhi, India); Shiv Dutt Joshi (Indian Institute of Technology, Delhi, India)

02:20 pm: Performance Analysis of Convolutional Neural Network Based EEG Epileptic Seizure Classification in Presence of Ocular Artifacts

Payal Patel (IIT Bhubaneswar, India); Udit Satija (Indian Institute of Technology (IIT), India)

02:40 pm: Implementation of a Spiking Neuron in CMOS

Iman Burman (Indian Institute of Technology Kharagpur, India); Archita Hore (IIT Kharagpur, India); Ayan Chakraborty (Indian Institute of Technology Khragpur, India); Sharba Bandyopadhyay (IIT Kharagpur, India); Saswat Chakrabarti (G. S. Sanyal School of Telecommunications & Indian Institute of Technology, Kharagpur, India)

03:00 pm: *Heart Rate Estimation from RGB Facial Videos Using Robust Face Demarcation and VMD*

Arya Deo Mehta (National Institute of Technology, Rourkela, India); Hemant Sharma (National Institute of Technology, Rourkela, India)

W3: Applications of Machine Learning

Session time Friday, 03:20 pm until 04:40 pm Location Auditorium Talk time 30

S12A: RIS

Session time Friday, 04:40 pm until 05:20 pm Location Auditorium Talk time 20 Chaired by

04:40 pm: Performance Analysis of RIS Assisted Smart Grid HEMS Using RQAM Modulation

Ashish Kumar Padhan (Indian Institute of Technology Bhubaneswar, India); Pravas Ranjan Sahu (Indian Institute of Technology Bhubaneswar, India); Subhransu Samantaray (Indian Institute of Technology, Bhubaneswar, India)

05:00 pm: *BER Analysis of RIS Assisted Bidirectional Relay System with Physical Layer Network Coding*

Jeba Triphena (Thiagarajar College of Engineering, Madurai, India); Vetrivel Chelian Thirumavalavan (Thiagarajar College of Engineering, Madurai, India); Thiruvengadam S Jayaraman (Thiagarajar College of Engineering, Madurai, India)

S12B: Security

Session time Friday, 04:40 pm until 05:20 pm Location Hall A Talk time 20 Chaired by

04:40 pm: Order Statistics Based Collision Analysis for PUFs

Girish Vaidya (Indian Institute of Science, India); Chandramani Singh (Indian Institute of Science, India); Prabhakar Venkata T. (Indian Institute of Science, India)

05:00 pm: On Physical Layer Security of Correlated Multiantenna Cognitive Radio Receivers

Brijesh Soni (School of Engineering and Applied Science, Ahmedabad University, India); Dhaval Karshanbhai Patel (School of Engineering and Applied Science-Ahmedabad University, India); Sagar Kavaiya (School of Engineering and Applied Science, Ahmedaad University, India); Mazen Omar Hasna (Qatar University, Qatar); Miguel López-Benítez (University of Liverpool, United Kingdom (Great Britain))

S12C: DSP Algorithms

Session time Friday, 04:40 pm until 05:20 pm

Location Hall B Talk time 20 Chaired by

04:40 pm: Fast DFT Computation for Signals with Spectral Support

Charantej Reddy Pochimireddy (IIT Hyderabad, India); Prabhu Tej V s s (Indian Institute of Technology Hyderabad, India); Aditya Siripuram (Indian Institute of Technology Hyderabad, India)

05:00 pm: Improved Hankel Norm Criterion for Interfered Nonlinear Digital Filters Subjected to Hardware Constraints

Srinivasulu Jogi (IIITDM Kancheepuram, India); Priyanka Kokil (Indian Institute of Information Technology Design and Manufacturing, Kancheepuram, India)

S14: Industry Talk: Samsung

Session time Friday, 05:20 pm until 05:50 pm Location Auditorium Talk time 80

S15C: Industry Interaction: Samsung

Session time Friday, 05:50 pm until 06:10 pm Location Auditorium Talk time 80

W3: Applications of Machine Learning

Session time Friday, 06:10 pm until 07:30 pm Location Auditorium



<u>Schedule</u>

Date	India Standard Time	Plenary Speaker	Title of the talk
28 th July 2021	0800-0900 hours	Prof. Shrikanth (Shri) Narayanan	Human-centered Multimodal Behavioral Machine Intelligence
28 th July 2021	0900-1000 hours	Prof. Urbashi Mitra	Active Hypothesis Testing for Fast Decision Making with applications to SARS-CoV-2 testing
28 th July 2021	1900-2000 hours	Prof. Ian F. Akyildiz	TeraHertz Band Communication: An Old Problem Revisited for 6G Wireless Systems
29 th July 2021	1240-1340 hours	Prof. Vivek S. Borkar	Kab Q aur kahaan? (Variations on a theme of Watkins)
29 th July 2021	1730-1830 hours	Prof. Shlomo Shamai (Shitz)	The Information Bottleneck: A Unified Information Theoretic View
30 th July 2021	0800-0900 hours	Prof. Balaji Prabhakar	Timeliness: A New Paradigm for Distributed Computing and Networking



Shrikanth (Shri) Narayanan

P1: Human-centered Multimodal Behavioral Machine Intelligence

by

Prof. Shrikanth (Shri) Narayanan

Date & Time: 28th July 2021 (0800-0900 hours) Indian Standard Time

Location: Auditorium

Abstract:

The convergence of sensing, communication and computing technologies offers tremendous opportunities for continuous information-rich yet unobtrusive multimodal, spatiotemporal characterization of an individual's behavior and state, and of the environment within which they operate. This in turn is enabling hitherto unimagined possibilities for understanding and supporting various aspects of human functioning from health and well-being to job performance.

Recent computational approaches that have leveraged judicious use of both data and knowledge have yielded significant advances in this regard, for example in deriving rich, context-aware information from multimodal signal sources including human speech, language, and videos of behavior. These have been complemented and integrated with data about human brain and body physiology. This talk will focus on some of the advances, opportunities and challenges in gathering such data and creating algorithms for machine processing of such cues. It will highlight some of our ongoing efforts in Behavioral Signal Processing (BSP)—technology and algorithms for quantitatively and objectively understanding typical, atypical and distressed human behavior—with a specific focus on communicative, affective and social behavior. The talk will illustrate behavioral machine intelligence applications that contribute to quantifying higher-level, often subjectively described, human behavior in a domain-sensitive fashion. Examples will be drawn from
health and wellbeing realms such as Autism Spectrum Disorder, Couple therapy, Depression, Suicidality, Addiction ounselling and work place behavior.

Bio:

Shrikanth (Shri) Narayanan is University Professor and Niki & C. L. Max Nikias Chair in Engineering at the University of Southern California, where he is Professor of Electrical & Computer Engineering, Computer Science, Linguistics, Psychology, Neuroscience, Pediatrics, and Otolaryngology-Head & Neck Surgery, Director of the Ming Hsieh Institute and Research Director of the Information Sciences Institute. Prior to USC he was with AT&T Bell Labs and AT&T Research. His research focuses on human-centered information processing and communication technologies. He is a Fellow of the National Academy of Inventors, the Acoustical Society of America, IEEE, ISCA, the American Association for the Advancement of Science (AAAS), the Association for Psychological Science, and the American Institute for Medical and Biological Engineering (AIMBE). He is a recipient of several honors including the 2015 Engineers Council's Distinguished Educator Award, a Mellon award for mentoring excellence, the 2005 and 2009 Best Journal Paper awards from the IEEE Signal Processing Society and serving as its Distinguished Lecturer for 2010-11, a 2018 ISCA CSL Best Journal Paper award, and serving as an ISCA Distinguished Lecturer for 2015-16, Willard R. Zemlin Memorial Lecturer for ASHA in 2017, and the Ten Year Technical Impact Award in 2014 and the Sustained Accomplishment Award in 2020 from ACM ICMI. He has published over 900 papers and has been granted seventeen U.S. patents. His research and inventions have led to technology commercialization including through startups he co-founded: Behavioral Signals Technologies focused on the telecommunication services and AI based conversational assistance industry and Lyssn focused on mental health care delivery, treatment and quality assurance.



P2: Active Hypothesis Testing for Fast Decision Making with applications to SARS-CoV-2 testing

by

Prof. Urbashi Mitra

Date & Time: 28th July 2021 (0900-1000 hours) Indian Standard Time

Location: Auditorium

Abstract:

Many modern (machine) learning strategies depend on the intelligent acquisition of informative samples. Such sampling methods can be viewed as an instantiation of the exploration-exploitation problem. Initially, one is unclear about the state of the environment and the goal is to take observations that refine the understanding of the state. If one has a series of "experiments" (or queries), each of which provide information about the state, an important question is how to design that sequence of experiments to enable a decision about the environmental state as quickly as possible. Exploration-exploitation problems abound in applications such as anomaly detection, target localization, dynamical system tracking, medical diagnosis, wireless body area sensor networks etc. The problem of experiment design for classification (hypothesis testing) has been persistently studied since the 1940s. Then and now, there has been an emphasis on the design of asymptotically optimal methods. Herein, we will provide new analysis which enables the design of strategies for the finite sample regime. In key cases, our methods are also asymptotically optimal, but provide significantly improved finite sample performance. We specialize our analysis to the problem of anomaly detection for which we can determine asymptotically tight upper and lower bounds on the misclassification error and provide an experiment design strategy with excellent finite sample performance. We further consider the application of our approach to group-testing, wherein different experiments

call for the pooling of samples which can dramatically reduce the number of experiments needed. Finally, we consider the problem of testing of populations to provide good spatial estimates of the incidence of an anomaly, such as SARS-CoV-2 positivity. We have preliminary analysis of SARS-CoV-2 serological tests based on randomized testing undertaken by a colleague at USC's School of Public Policy. Our proposed strategy suggests that uniform allocation for randomized testing over heterogeneous regions may not yield the best estimates of positivity rates and offers a method by which active hypothesis testing can be used to improve such estimates.

Bio:

Urbashi Mitra received the B.S. and the M.S. degrees from the University of California at Berkeley and her Ph.D. from Princeton University. Dr. Mitra is currently the Gordon S. Marshall Professor in Engineering at the University of Southern California with appointments in Electrical & Computer Engineering and Computer Science. She was the inaugural Editor-in-Chief for the IEEE Transactions on Molecular, Biological and Multi-scale Communications. She has been a member of the IEEE Information Theory Society's Board of Governors (2002-2007, 2012-2017), the IEEE Communications Society's Boad of Governors (2018-2020), the IEEE Signal Processing Society's Technical Committee on Signal Processing for Communications and Networks (2012-2016), the IEEE Signal Processing Society's Awards Board (2017-2018), and the Chair/Vice-Chair of the IEEE Communication Theory Technical Committee (2017-2020). Dr. Mitra is a Fellow of the IEEE. She is the recipient of: the 2021 USC Viterbi School of Engineering Senior Research Award, the 2017 IEEE Women in Communications Engineering Technical Achievement Award, a 2015 UK Royal Academy of Engineering Distinguished Visiting Professorship, a 2015 US Fulbright Scholar Award, a 2015-2016 UK Leverhulme Trust Visiting Professorship, IEEE Communications Society Distinguished Lecturer, 2012 Globecom Signal Processing for Communications Symposium Best Paper Award, 2012 US National Academy of Engineering Lillian Gilbreth Lectureship, the 2009 DCOSS Applications & Systems Best Paper Award, 2001 Okawa Foundation Award, 2000 Ohio State University's College of Engineering Lumley Award for Research, and a 1996 National Science Foundation CAREER Award. She has been an Associate Editor for the following IEEE publications: Transactions on Signal Processing, Transactions on Information Theory, Journal of Oceanic Engineering, and Transactions on Communications. Dr. Mitra has held visiting appointments at: King's College, London, Imperial College, the Delft University of Technology, Stanford University, Rice University, and the Eurecom Institute. Her research interests are in: wireless communications, communication and sensor networks, biological communication systems, detection and estimation and the interface of communication, sensing and control.



P3: TeraHertz Band Communication: An Old Problem Revisited for 6G Wireless Systems

by

Prof. Ian F. Akyildiz

Date & Time: 28th July 2021 (1900-2000 hours) Indian Standard Time

Location: Auditorium

Abstract:

The ever-increasing requirement on wireless data rates has been motivating technological innovations on wireless communications in both academia and industry. Among emerging research and development trends in wireless communications, Terahertz Band (0.1-10 THz) communication has been envisioned as one of the key enabling technologies in the next decade. With the ultra-wide available spectrum resources, THz band can provide terabits per second (Tbps) links for a plethora of applications. With many proposed 6G wireless systems research directions, it is evident that the TeraHertz Band communication is increasingly becoming a major key technology for 6G systems. Recently, many researchers jumped on the bandwagon to make their contributions as if the THz problem just arose couple years ago. This talk will cover all our research activities on THz within the last 15 years. First the theoretical foundations of ultra-broadband communications in the THz band is laid out for wireless environments in order to bring the Tbps links one-step closer to reality. In particular, the channel model is presented along many physical and link layer solutions for TeraHertz band. The very large available bandwidth in this ultra-broadband frequency range comes at the cost of a very high propagation loss, which combined with the low power of mm-wave and THz-band transceivers, limits the communication distance. To overcome

this distance problem which is the grand challenge in this area, multipath effects, distance adaptive modulation, ultra-massive MIMO communication and reconfigurable intelligent surfaces are introduced. The concept of ultramassive MIMO (UM MIMO) overcomes the transmission distance limitation, based on the use of the very large antenna arrays with thousands of antenna elements. The dynamic operation modes that include beamforming, spatial multiplexing and a combination of both, as well as the multi-band UM MIMO for THz mobile channels and multihop links will be analyzed. The second concept, the intelligent surfaces, yet another worldwide research activity, will be presented, in particular, our own design from VISORSURF project (visorsurf.eu) is introduced as a class of planar meta-materials as well as graphene material that can interact with impinging electromagnetic waves in a controlled manner. They can effectively re-engineer electromagnetic waves, including steering toward any desired direction, full absorption, polarization manipulation, and more. Moreover, the use of TeraHertz band in outdoor and mobile environments is discussed and the research challenges are pointed out. The last part of the talk will be based on the CubeSats where intersatellite links will operate in Thz Bands and the communication between ground and space segments will be realized through integrated ultrabroadband hybrid front-end that is capable of sensing and communication from the RF to the THz bands. Many research directions and challenges will be discussed.

Bio:

Ian F. Akyildiz received his BS, MS, and PhD degrees in Electrical and Computer Engineering from the University of Erlangen-Nürnberg, Germany, in 1978, 1981 and 1984, respectively. He is the Ken Byers Chair Professor Emeritus in Telecommunications, Past Chair of the Telecom group at the ECE and the Director of the Broadband Wireless Networking Laboratory between (1985-2020) at the Georgia Institute of Technology. Since 1989, he is the President and CTO of the Truva Inc.. He also serves on the Advisory Board of the Technology Innovation Institute (TII) in Abu Dhabi, United Arab Emirates since June 1, 2020. Dr. Akvildiz is the Megagrant Research Leader and Advisor to the Director of the Institute for Information Transmission Problems at the Russian Academy of Sciences, in Moscow, Russia, since May 2018. Dr. Akyildiz is an Adjunct Professor with University of Helsinki, Finland since May 2021. He is also a Visiting Professor with Department of Electrical Engineering at University of Iceland since September 2020. Dr. Akvildiz had many international affiliations during his career. He established many research centers in Spain, South Africa, Finland, Saudi Arabia, Germany, Russia, India, Cyprus, etc. He is the Founder and Editor in Chief of the newly established of the ITU (International Telecommunication Union) Journal on Future and Evolving Technologies (ITU-J FET) since August 2020, and is the Editor-in-Chief Emeritus of Computer Networks Journal (Elsevier) (1999- 2019), the founding Editor-in-Chief Emeritus of the Ad Hoc Networks Journal (Elsevier) (2003-2019), the founding Editor-in-Chief Emeritus of the Physical Communication (PHYCOM) Journal (Elsevier) (2008-2017), and the founding Editor-in-Chief Emeritus of the Nano Communication Networks (NANOCOMNET) Journal (Elsevier) (2010-2017). Dr.

Akyildiz co-launched many international conferences (ACM MobiCom, ACM SenSys, IEEE BlackSeaCom, ACM NanoCom, BalkanCom conferences the last 3 decades. He is an IEEE Fellow (1996) and ACM Fellow (1997) and received numerous awards from IEEE and ACM and other professional organizations, including Humboldt Award from Germany. His current research interests are in 6G/7G Wireless Systems, TeraHertz Communication, Reconfigurable Intelligent Surfaces, Nanonetworks, Internet of Space Things/CUBESATs, Internet of BioNanoThings, Molecular Communication and Underwater Communication. According to Google Scholar as of July 2021, his H-index is 130 and the total number of citations to his papers is 128+K. His worldwide ranking is 51 and the USA ranking is 34.



P4: Kab Q aur kahaan? (Variations on a theme of Watkins)

by

Prof. Vivek S. Borkar

Date & Time: 29th July 2021 (1240-1340 hours) Indian Standard Time

Location: Auditorium

Abstract:

In this talk, I shall describe Watkins' Q-learning algorithm viewed as a stochastic approximation based numerical scheme for a Markov decision process, and try to bring out the underlying intuition. In the later part of the talk, I shall describe two variants that I have been involved in: Q-learning in a prospect theoretic framework (joint work with Siddharth Chandak), and a variation of Deep Q-Network (DQN) reinforcement learning called `Full Gradient DQN' or FG-DQN (joint work with Konstantin Avrachenkov, Harsh Dolhare and Kishor Patil).

Bio:

Prof. V. S. Borkar obtained his B.Tech. in electrical engg. From IIT Bombay in 1976, M.S. in systems and control engg. In 1977 from Case Western Reserve Uni., and Ph.D. from Uni. Of California at Berkeley in 1980. He has held positions in the TIFR Centre for Applicable Mathematics and Indian Institute of Science in Bengaluru, and in the Tata Institute of Fundamental Research and IIT Bombay in Mumbai. He is now an Emeritus Fellow in the latter. He is a fellow of the science and engineering academies in India and of IEEE, AMS and TWAS. He is a recipient of the S. S. Bhatnagar award in engineering sciences. His research interests are in stochastic optimization and control – theory, algorithms and applications.



Shlomo Shamai (Shitz)

P5: The Information Bottleneck: A Unified Information Theoretic View

bv

Prof. Shlomo Shamai (Shitz)

Date & Time: 29th July 2021 (1730-1830 hours) Indian Standard Time

Location: Auditorium

Abstract:

This presentation focuses on connections between relatively recent notions and variants of the Information Bottleneck and classical information theoretic frameworks, such as: Remote Source-Coding; Information Combining; Common Reconstruction; The Wyner-Ahlswede-Korner Problem; The Efficiency of Investment Information; CEO Source Coding under Log-Loss, Hypothesis Testing Error Exponent and others.

We overview the uplink Cloud Radio Access Networks (CRAN) with oblivious processing, which is an attractive model for future wireless systems and highlight the basic connections to distributed Gaussian information bottleneck framework. For this setting, the optimal trade-offs between rates (i.e. complexity) and information (i.e. accuracy) in the discrete and vector Gaussian schemes is determined, taking an information-estimation viewpoint. Further, the performance cost of the simple 'oblivious' universal processing in CRAN systems is exemplified via novel bounding techniques.

The concluding overview and outlook addresses in a unified way the dual problem of the privacy funnel and recent observations on the additive noise channels with a helper. Connections to the finite block length bottleneck features (related to the Courtade-Kumar conjecture) and entropy complexity measures (rather than mutual information) are shortly discussed. Some challenging problems are mentioned such as the characterization of the optimal power limited inputs ('features') maximizing the 'relevance' for the Gaussian information bottleneck, under `complexity' constraints.

The talk is based mainly on joint work with A. Zaidi, I.E. Auguerri, G. Caire, O. Simeone and S-H. Park. The research of S. Shamai is supported by the European Union's Horizon 2020 Research and Innovation Programme: No. 694630.

Bio:

Shlomo Shamai (Shitz) is with the Viterbi Department of Electrical and Computer Engineering, Technion---Israel Institute of Technology, where he is now a Technion Distinguished Professor, and holds the William Fondiller Chair of Telecommunications.

He is an IEEE Life Fellow, an URSI Fellow, a member of the Israeli Academy of Sciences and Humanities and a foreign member of the US National Academy of Engineering. He is the recipient of the 2011 Claude E. Shannon Award, the 2014 Rothschild Prize in Mathematics/Computer Sciences and Engineering, the 2017 IEEE Richard W. Hamming Medal. He is also a co-recipient of the 2018 Third Bell Labs Prize for Shaping the Future of Information and Communications Technology and other awards and recognitions. He is the recipient of numerous technical and paper awards and recognitions of the IEEE, Information Theory, Communications and Signal Processing Societies as well as EURASIP.



P6: Timeliness: A New Paradigm for Distributed Computing and Networking

by

Prof. Balaji Prabhakar

Date & Time: 30th July 2021 (0800-0900 hours) Indian Standard Time

Location: Auditorium

Abstract:

The first two decades of this century (2000--2019) have seen the emergence of Virtualization and Big Data technologies as the bedrock of Cloud Computing. As businesses and real-world operations, ranging from retail, eCommerce, entertainment, gaming, mobile banking, financial trading and autonomous vehicles, begin to operate in the cloud, "Timeliness" is becoming this decade's first-class primitive for the Cloud. Deadlines, bounded delays, "jitter-free" performance, and "simultaneous message delivery" are just some of the requirements for supporting this new class of time-sensitive applications.

But, "Don't Trust The Clock" has been a fundamental dogma of Distributed Systems. This is because it has been believed that it is hard, if not impossible, to accurately synchronize clocks across random, jittery packet switched networks.

In this talk we describe Huygens---a software-based system which provides highly-accurate network clock synchronization at scale (to 1000s of machines spread out across large geographical distances) without any special hardware/clocks or other infrastructure upgrades. We demonstrate how this system enables financial trading in jitter-prone public clouds, provides very accurate logging and monitoring of events, and solves other notable problems in Distributed Systems (e.g., providing consistency in databases, novel congestion control mechanisms, consensus protocols, event ordering in distributed ledgers, etc).

Bio:

Balaji Prabhakar is VMWare Founders Professor of Computer Science at Stanford University. He is a faculty member in the Departments of Electrical Engineering and Computer Science and, by courtesy, in the Graduate School of Business. His research interests are in computer networks---notably, in data center networks and cloud computing platforms. Additionally, he has worked on Societal Networks, where he has developed "nudge engines" to incentivize commuters to travel in off-peak times so that congestion, fuel, and pollution costs are reduced. He is a Fellow of the Sloan Foundation, the IEEE and the ACM. He was the inaugural recipient of the IEEE Innovation in Societal Infrastructure Award for his work on Societal Networks, and a recipient of the IEEE Koji Kobayashi Award for his work on Data Centers and Cloud Computing. In addition, he has received the Erlang Prize from INFORMS and the Rollo David Prize for his contributions to Stochastic Networks and Probability.



T1: Streaming Codes	T2: Radar Signal Processing
27 th July 2021 (0800-1030 hours)	27 th July 2021 (0800-1030 hours)
Sponsor Video: Qualcomm	
(1030-1040 hours)	
T3: Model-based deep learning for wireless communications	T4: Blockchain Technology: An Enabler for Trust
27 th July 2021 (1040-1310 hours)	27 th July 2021 (1040-1310 hours)
Lunch Break	
(1310-1340 hours)	
T5: Aerial and Spaceborne	T6: Computing the Discrete
Communications: The Journey	Fourier Transform: From Classical
from 5G to 6G	FFTs to Structured FFTs
27 th July 2021 (1340-1610 hours)	27 th July 2021 (1340-1610 hours)
Sponsor Video: Saankhya Labs	
(1610-1620 hours)	
	T8: Design Challenges in RF
T7: Reconfigurable Intelligent	Power Amplifiers and Wireless
Surfaces: From Electromagnetics	Transmitters for 5G cellular
to Communications	Applications
27 th July 2021 (1620-1850 hours)	27 th July 2021 (1620-1850 hours)
Sponsor Video: Amazon, Texas Instruments, Keysight, Agmatel,	
Tejas Networks	
(1850-1900 hours)	
19: Journey Towards Realizing	M10. Data Analytica an Oranta A
the Full Potential of Advanced Air	Tiu: Data Analytics on Graphs: A
MODILITY	New Paradigm in Machine
	Intemgence
27 th July 2021 (1900-2015 hours)	27 th July 2021 (1900-2015 hours)
T11: Blockchain protocols made efficient and scalable	
30 th July 2021 (0900-1015 hours)	
T12: Peconfigurable Intelligent Surfaces and Holographic Massive	
MIMO: Vision, Fundamentals, and Key Open Problems	
20th July 2021 (1020 1220 hours)	
30th July 2021 (1020-1320 hours)	

Tutorial Schedule



T1: Streaming Codes

by

P. Vijay Kumar, Nikhil Krishnan, Myna Vajha, Vinayak Ramkumar

Date & Time: 27th July 2021 (0800-1030 hours) Indian Standard Time

Location: Auditorium

Abstract:

Streaming codes are relevant to the 5G objective of achieving ultra-reliable, low-latency communication (URLLC) and address the need for an errorcorrection scheme at the packet level, that ensures reliability in the face of dropped or lost packets.

The streaming codes discussed here may be viewed at the packet level as convolutional codes, but which are yet built out of scalar block codes by employing a diagonal-embedding technique.

A sliding-window channel model is adopted as a tractable approximation to the two-state Gilbert Elliott channel, which is capable of causing both random and burst erasures. Rate bounds and efficient code constructions will be presented, as well as an experimental demonstration that includes adaptation to a time-varying channel.

Bio:

P. Vijay Kumar received the B.Tech. and M.Tech. degrees from IIT Kharagpur and IIT Kanpur respectively, and the Ph.D. degree from USC. From 1983-2003, he was on the faculty of the EE-Systems Department at USC. Since 2003, he has been on the faculty of IISc, Bengaluru. His current research interests include codes for distributed storage, low-latency communication and low-correlation sequences. He is a recipient of the 1995 IEEE Information Theory (IT) Society's Prize-Paper award and the IEEE Data Storage Best Paper Award of 2011/2012. A pseudorandom sequence family designed in a 1996 paper co-authored by him formed the short scrambling code of the 3G WCDMA cellular standard. He was a plenary speaker at ISIT 2014 and is currently chair of the IT Society Conference Committee. He is a

Fellow of the INAE, IAS, and INSA Indian academies, a JCB National Fellow as well as a Fellow of IEEE.

Nikhil Krishnan received his B.Tech. (Electronics and Communication Engineering) degree from Amrita School of Engineering, Amritapuri Campus, Kerala in 2011. He received both his M.E. (Telecommunications) and Ph.D. (Electrical Communication Engineering) degrees from Indian Institute of Science (IISc), Bangalore, in 2013 and 2019, respectively. He was a postdoctoral fellow at the Department of Electrical & Computer Engineering, University of Toronto from November 2019 to June 2021. Since July 2021, he is working as an Assistant Professor in IIIT Bangalore. His research interests include coded computation, streaming codes and distributed storage.

Myna Vajha received Bachelors degree in ECE from IIT Kharagpur, in 2011, and Masters from EE Department, University of Southern California (USC), in 2013. She has recently obtained her a Ph.D. from ECE Department, Indian Institute of Science. She currently works at Qualcomm Research, Bangalore. Her research interests include coding theory and information theory, with applications to distributed storage systems, low latency streaming and privacy.

Vinayak Ramkumar received his B. Tech. in Electronics and Communication Engineering from National Institute of technology, Calicut, in 2015 and M. Sc. (Engg) from the Department of Electrical Communication Engineering, Indian Institute of Science (IISc), Bangalore, in 2017. He is currently a Ph.D. student at the Department of Electrical Communication Engineering, IISc. His research interests include streaming codes, codes for distributed storage and coded PIR.



T2: Radar Signal Processing

by

Shobha Sundar Ram

Date & Time: 27th July 2021 (0800-1030 hours) Indian Standard Time

Location: Hall A

Abstract:

The tutorial is intended for bachelors, masters and doctoral students who may be interested in pursuing research in radar signal processing specifically in context to automotive radars. The tutorial will be divided into five sections. In the first section, an introduction to radar systems will be presented including concepts pertaining to the transmitter, receiver, targets, clutter and noise encountered in automotive radar scenarios. This will be followed by the second section, where the radar signal models for simple and extended targets will be discussed in detail. The third part of the tutorial will delve into the specifics of radar waveforms and the corresponding signal processing algorithms - matched filtering for range estimation, Doppler processing and Fourier based azimuth and elevation estimation. The following part of the tutorial will cover the fundamentals of radar detection with a focus on the ubiquitous Neyman-Pearson detection rule, the likelihood ratio test and the constant false alarm rate detection. In the final section, advanced concepts related to the use of modern machine learning and deep learning algorithms on automotive radar data for varied applications such as pedestrian detection, object classification and parking assistance will be presented. Throughout the tutorial, MATLAB based software demos will be presented to supplement the theoretical concepts.

Bio:

Shobha Sundar Ram is Associate Professor, Dept. of Electronics and Communications Engineering, Indraprastha Institute of Information Technology, Delhi. She did her Bachelor of Technology in ECE from the University of Madras,

India in 2004 and then her Master of Science and Ph.D. in electrical engineering from the University of Texas at Austin, USA in 2006 and 2009 respectively. Before joining IIIT Delhi, she worked as a research and development electrical engineer at Baker Hughes Inc. USA. She is engaged in research and education principally in the areas of radar signal processing and electromagnetic sensor design and odelling. She is a Senior Member of IEEE, an active member of the Aerospace and Electronics Systems Society and an Associate Editor for the IEEE Transactions on Aerospace and Electronics Systems.



T3: Model-based deep learning for wireless communications

by

Nir Shlezinger

Date & Time: 27th July 2021 (1040-1310 hours) Indian Standard Time

Location: Auditorium

Abstract:

Recent years have witnessed a dramatically growing interest in machine learning (ML) methods. These data-driven trainable structures have demonstrated an unprecedented empirical success in various applications, including computer vision and speech processing. The benefits of ML-driven techniques over traditional model-based approaches are twofold: First, ML methods are independent of the underlying stochastic model, and thus can operate efficiently in scenarios where this model is unknown, or its parameters cannot be accurately estimated; Second, when the underlying model is extremely complex, ML algorithms have demonstrated the ability to extract and disentangle the meaningful semantic information from the observed data. Nonetheless, not every problem can and should be solved using deep neural networks (DNNs). In fact, in scenarios for which modelbased algorithms exist and are computationally feasible, these analytical methods are typically preferable over ML schemes due to their theoretical performance guarantees and possible proven optimality. A notable application area where model-based schemes are typically preferable, and whose characteristics are fundamentally different from conventional deep learning applications, is wireless communications. In this talk, I will present methods for combining DNNs with traditional model-based algorithms. We will show hybrid model-based/data-driven implementations which arise from classical methods in wireless communications, and demonstrate how fundamental

classic techniques can be implemented without knowledge of the underlying statistical model, while achieving improved robustness to uncertainty.

Bio:

Nir Shlezinger is an assistant professor in the School of Electrical and Computer Engineering in Ben-Gurion University, Israel. He received his B.Sc., M.Sc., and Ph.D. degrees in 2011, 2013, and 2017, respectively, from Ben-Gurion University, Israel, all in electrical and computer engineering. From 2017 to 2019 he was a postdoctoral researcher in the Technion, and from 2019 to 2020 he was a postdoctoral researcher in Weizmann Institute of Science, where he was awarded the FGS prize for outstanding achievements in postdoctoral research. His research interests lie in the intersection of signal processing, machine learning, communications, and information theory.



Sandeep K. Shukla

T4: Blockchain Technology: An Enabler for Trust

by

Sandeep K. Shukla

Date & Time: 27th July 2021 (1040-1310 hours) Indian Standard Time

Location: Hall A

Abstract:

Since its introduction in 2008 in the form of the Bitcoin blockchain, blockchain technology has been known more as a cryptocurrency enabler than its actual foundations as a platform for enabling trust. The idea of cryptocurrency blockchain was anonymous transactions, mining of currency in the digital platform itself, and to provide trust through transparency of a public, distributed and replicated ledger of all transactions which are cryptographically signed. The use of cryptographic signature, and use of has functions to link blocks of transactions provided the defense against forgery, and attack on integrity of the digital records of transaction. The permanence of the records is ensured by crowd sourcing computational power of a large number of participants making it almost impossible to change the history of transactions unless 51% of computational power is procured by a single participant or a group of colluding participants.

Blockchain 2.0 ushered in the concept of smart contracts – thereby enabling more automation of digital transactions, and also the ability to tokenize noncurrency assets. However, with the programmability in a Turing complete language, came the possibility of bugs in smart contracts and thereby security vulnerabilities. A number of cyber attacks followed and in several cases, insider attack on crypto-exchanges led to huge losses to account holders. On top of all these, the pseudo-anonymity offered by the crypto-currency blockchains made it a favorite medium of transaction for criminals – starting from the Silk Road to today's ransomware gangs. We also find malicious usage of the cryptocurrency platforms for illegal gambling, phishing, money laundering and various other crimes.

While all these led to suspicion about cryptocurrency among regulators and law enforcement, technologists discovered that the trust offered by blockchain technology itself has very many transformative potential. With the advent of Blockchain 3.0 with the introduction of Hyperledger and similar distributed ledger technology platforms, we started seeing use of blockchain platforms for supply chain provenance, renewable energy billing, land registry systems, voting systems, agri-market transactions, and more recently NFTs.

In this tutorial, we first introduce the concept of blockchain and its underlying technologies including public key crypto systems, hashing, distributed computing,. Fault-tolerant consensus, byzantine algorithms, public-vs private ledgers, permissioned vs permission-less ledgers etc. We then gently introduce why non-currency usage of blockchain can enhance trust in data integrity in many applications which are today implemented in centralized system – leading to trust deficit among the users of the systems – such as land record registration system, supply chain integrity, DND system by mobile operators, or even DNS system.

We will expose the audience to various applications of permissioned private blockchains in creating trust mechanism in such applications. Finally, we will touch on certain security issues for these applications.

Bio:

Sandeep K. Shukla is a program director of C3i Hub, a joint coordinator for C3i Center, a joint coordinator for the national blockchain project, as well as a professor of Computer Science at IIT Kanpur. He is an ACM distinguished scientist and a Fellow of IEEE.



T5: Aerial and Spaceborne Communications:

The Journey from 5G to 6G

by

Giovanni Geraci

Date & Time: 27th July 2021 (1340-1610 hours) Indian Standard Time

Location: Auditorium

Abstract:

Barely seen in action movies until a decade ago, the progressive blending of UAVs into our daily lives will greatly impact labor and leisure activities alike. Most stakeholders regard reliable connectivity as a must-have for the UAV ecosystem to thrive, and the wireless research community has been rolling up its sleeves to drive a native and long-lasting support for UAVs in 5G and beyond. Moving up, the recent introduction of more affordable insertions into the low orbit is luring new players to the space race, making a marriage between the satellite and cellular industries more likely than ever. In this talk, we will navigate from 5G to 6G use cases, requirements, and enablers involving aerial and spaceborne communications, also acting as a catalyst for much-needed new research.

Bio:

Giovanni Geraci is an Assistant Professor at University Pompeu Fabra in Barcelona and the coordinator of the Telecommunications Engineering program. He was previously a Research Scientist with Nokia Bell Labs and holds a Ph.D. from the UNSW Sydney. He serves as a Distinguished Lecturer of the IEEE ComSoc & VTS and as an Editor for the IEEE Transactions on Wireless Communications and IEEE Communications Letters. Giovanni is a co-Editor of the book "UAV Communications for 5G and Beyond" by Wiley—IEEE Press and he received the IEEE ComSoc Outstanding Young Researcher Award for Europe, Middle East, and Africa.



T6: Computing the Discrete Fourier Transform: From Classical FFTs to Structured FFTs

by

Aditya Siripuram

Date & Time: 27th July 2021 (1340-1610 hours) Indian Standard Time

Location: Hall A

Abstract:

The importance and ubiquity of the Discrete Fourier Transform (DFT) cannot be overstated. Algorithms to compute the DFT (collectively referred to as the Fast Fourier Transform or FFT) have a long history, starting probably in the 19th century itself. The goal of this tutorial is to give a brief overview of the development of FFT. The tutorial will be in three parts. In the first part, we review the classical approach to the FFT, including the Cooley-Tukey algorithm, Prime-factor algorithm and Rader's FFT.

With the ever-increasing data sizes that we operate with, there is a need to reduce the complexity beyond what a classical FFT provides. In addition, even though data sizes are increasing, they also have underlying structure, thus providing algorithm designers with opportunities to exploit this structure for faster computation. Recent research on the FFT operates at the intersection of these two notions: the focus is on speeding up the DFT computation for a structured (or restrictive) class of signals. The most popular structural model is spectral sparsity: where we assume the signal has very few non-zero frequency coefficients. In the second part of the tutorial, we discuss the key ideas behind sparse FFT algorithms. Our coverage here will be more illustrative than exhaustive. While many of these sparse FFT algorithms are randomized, we also discuss some deterministic algorithms for sparse FFT.

In the final portion of the talk, we attempt to go beyond sparsity. In particular, we may try to find the DFT when more structural information on the spectral support is available. We briefly discuss some work on finding the DFT of block-sparse signals, and conclude with some of our recent work that tries to make some progress towards structured FFTs.

Bio:

Aditya Siripuram received his B.Tech and M.Tech degrees in Electrical Engineering from the Indian Institute of Technology, Bombay in 2009. He completed PhD from Stanford University in 2017 and was a recipient of the Stanford Graduate Fellowship. He is currently a faculty member in the Department of Electrical Engineering at IIT Hyderabad. He is interested broadly in the theory of signal processing and machine learning; particularly in sampling, Fourier analysis and graph signal processing.



Marco Di Renzo

T7: Reconfigurable Intelligent Surfaces: From Electromagnetics to Communications

by

Marco Di Renzo

Date & Time: 27th July 2021 (1620-1850 hours) Indian Standard Time

Location: Auditorium

Abstract:

A reconfigurable intelligent surface (RIS) is an emerging technology that enables the control of the electromagnetic waves. An RIS is a thin sheet of electromagnetic material, which is made of many nearly passive scattering elements that are controlled through low cost and low power electronic circuits. By appropriately configuring the electronic circuits, different wave transformations can be realized. Recent research works have shown that RISs whose geometric size is sufficiently large can outperform other technologies, e.g., relays, at a reduced hardware and signal processing complexity, and can enhance the reliability of wireless links by reducing the fading severity. In addition, the achievable performance of RIS-assisted systems has been proved to be robust to various hardware impairments, e.g., the phase noise, which may further reduce the implementation cost. To quantify the performance gains offered by RISs in wireless networks, realistic communication models need to be employed. In this talk, we offer a critical appraisal of the communication models currently employed for analyzing the ultimate performance limits and for optimizing RIS-assisted wireless networks. Furthermore, we introduce a new tractable, electromagnetic-compliant, and circuit-based communication model for RIS-assisted transmission and discuss its applications to the modeling and optimization of wireless systems.

Bio:

Marco Di Renzo (Fellow, IEEE) received the Laurea (cum laude) and Ph.D. degrees in electrical engineering from the University of L'Aquila, Italy, in 2003 and 2007, respectively, and the Habilitation à Diriger des Recherches (Doctor of Science) degree from University Paris-Sud (now Paris-Saclay University), France, in 2013. Since 2010, he has been with the French National Center for Scientific Research (CNRS), where he is a CNRS Research Director (CNRS Professor) with the Laboratory of Signals and Systems (L2S) of Paris-Saclay University - CNRS and CentraleSupelec, Paris, France. In Paris-Saclay University, he serves as the Coordinator of the Communications and Networks Research Area of the Laboratory of Excellence DigiCosme, and as a Member of the Admission and Evaluation Committee of the Ph.D. School on Information and Communication Technologies. He is the Editor-in-Chief of IEEE Communications Letters and a Distinguished Speaker of the IEEE Vehicular Technology Society. In 2017-2020, he was a Distinguished Lecturer of the IEEE Vehicular Technology Society and IEEE Communications Society. He has received several research distinctions, which include the SEE-IEEE Alain Glavieux Award, the IEEE Jack Neubauer Memorial Best Systems Paper Award, the Royal Academy of Engineering Distinguished Visiting Fellowship, the Nokia Foundation Visiting Professorship, the Fulbright Fellowship, and the 2021 EURASIP Journal on Wireless Communications and Networking Best Paper Award. He is a Fellow of the UK Institution of Engineering and Technology (IET), an Ordinary Member of the European Academy of Sciences and Arts (EASA), and an Ordinary Member of the Academia Europaea (AE).



T8: Design Challenges in RF Power Amplifiers and Wireless Transmitters for 5G cellular Applications

by

Karun Rawat

Date & Time: 27th July 2021 (1620-1850 hours) Indian Standard Time

Location: Hall A

Abstract:

This talk discusses various aspects of wireless transmitters and the radio frequency (RF) power amplifier (PA) design for 5G cellular applications.

The wireless transmitters and RF PA design require several new considerations to be useful for New Generation Radio Access Network (NG-RAN) in 5 G applications. The wireless transmitter design must strive for spectrum and energy efficiency to provide linear power amplification of high crest factor signals with the least consumption of power. Maintaining good linearity can meet the spectrum efficiency requirements but requires special RF power amplification schemes to guarantee low power consumption. For example, linearization schemes such as digital predistortion require load modulation based power amplifier (PA) (Doherty PA or Chireix Outphasing PA etc.) for handling high crest factor signals with good power efficiency. Alternatively, delta-sigma modulation-based transmitters can exhibit good performance in terms of error vector magnitude (EVM), where high-efficiency switch-mode Pas can be used along with RF filters for suppressing out-of-band quantization noise.

Apart from the various transmitter and PA architectures, it is essential to enhance the bandwidth of the design to co-op with wideband modulated signals anticipated in 5G communication. In general, switch-mode Pas are a popular choice for systems where high efficiency is required. However, these Pas are inherently narrow bands. Moreover, it is difficult to obtain a feasible design space that led to realizable loads resulting in high-efficiency operation over a wide bandwidth. In case load-pull is used, it is difficult to find this appropriate set of loads that can be realizable with a matching network. A continuum of class such as Class B/J and continuous Class F, Class E Pas provide many useful solutions which can be represented by a drain voltage waveform set at each frequency of operation over the band. In such a case, high efficiency is maintained over a wide bandwidth. This waveform engineering is performed by selecting an appropriate set of fundamental and harmonic loads at the intrinsic current generator plane of the transistor.

The talk will discuss the design aspects of wireless transmitters and RF PA design while discussing various challenges in transmitter architecture, device selection, circuit design, odelling, etc.

Bio:

Karun Rawat has received his PhD. Degree in electrical engineering from University of Calgary, Canada in 2012, where he worked as a student research assistant and later Post-doctoral research fellow under the research grant of iCORE and CRC chair, Alberta, Canada. He is currently Associate Professor & Outstanding young faculty in the department of Electronics and Communication at Indian Institute of Technology (I.I.T) Roorkee, India. Prior to this, he was Assistant Professor in I.I.T Delhi from 2013-2014 and scientist in the Indian Space Research Organization, from 2003–2007.

Dr. Rawat is Senior member of IEEE since 2012 and member of IEEE MTT Microwave High-Power Techniques Committee (MTT-12). His current research interests are in the areas of RF power amplifier and transceiver design, digital transmitters, nonlinear device odelling, RF linear and nonlinear measurements and characterization, RF CMOS and GaN MMIC designs. His research has resulted in more than 70 publications in journals and conferences, three patents (applied), two state of art books and a book chapter. He has given several technical talks in reputed IEEE conferences including workshops in power amplifiers at IEEE ARFTG 2016 (USA), IEEE APMC 2015 (China), IEEE ImaRC 2014-2015 (India), IEEE IMS 2018 (USA), IEEE EuMW 2018 (Spain) etc. He has been organizer of NVNA forum in IEEE IMS (USA), 2018 and 2019. He has several invited papers in reputed conferences such as IEEE European Microwave Conference in Germany, International Symposium on Circuit and System, USA, IEEE International Wireless Symposium, China etc.

Dr. Rawat has received several awards including young scientist from national academy of science India and Scopus, outstanding young faculty award by I.I.T-Roorkee and research production award for three consecutive years from University of Calgary. He also received best design prize in 3rd Annual Smart Radio Challenge in 2010.

Dr. Rawat has also been associated with advisory committee of several RF industries, national laboratories and universities for brainstorming and research initiatives. He is founding director and chairman of start-up "Linearized Amplifier Technologies and Services Private Limited" which develops indigenous linearized power amplifiers for telecom and defense applications.



Kamesh Namuduri

T9: Journey Towards Realizing the Full Potential of Advanced Air Mobility

by

Kamesh Namuduri

Date & Time: 27th July 2021 (1900-2015 hours) Indian Standard Time

Location: Auditorium

Abstract:

The flying taxi business is projected to be a \$5 Billion/year market. The industry is moving fast to realize this potential, with both established and startup companies competing as well as collaborating in this race. Airline companies including Boeing, Airbus, and Bell, are building the electrical Vertical Takeoff and Landing (eVTOL) aircrafts. Uber is collaborating with NASA to plan flying taxi service in Dallas by 2023. The big question that we need to address is "Are we ready for the big challenges that come with unmanned air transportation?" Just to give a perspective, think about self-driving cars. When, where, and how did we begin this journey and where are we now in this journey? What are you likely see first – A fully autonomous self-driving car in an urban area or an unmanned air taxi? In this presentation, we will discuss the critical aspects of unmanned air transportation: (1) Technology Readiness (2) Safety, Security, Regulations and Standardization Efforts and (3) Privacy, Ethics and Community Acceptance.

We begin this discussion with a review of the technology capability levels as discussed in NASA's UTM initiative, which gives an idea of where the industry is today from a technology perspective. The capabilities that the industry is expected to demonstrate in the UTM project, including Beyond Visual Line of Sight (BVLOS) communications, navigation in GPS-denied areas, and Remote Identification of aircraft with applications to law enforcement and public safety, wild fire management, and package deliveries, give an idea of where we are today in terms of technology readiness. In another related activity, NASA has just began a grand challenge on Urban Air Mobility. This will also be discussed.

Second, safety should be an important goal of Unmanned Air Transportation. While the industry mastered safety of manned aviation, the path to mastery was slow and steady. Is Unmanned Air Transportation as safe as manned aviation? Are there regulations to guarantee the desired levels of human safety? What needs to be done now to make unmanned aviation as safe as it needs to be? How are regulatory and standards organizations working towards achieving this goal?

The third topic is community acceptance. Community engagement at local and regional levels is also critical for the success of unmanned air transportation. How do we engage communities in this fast-paced evolution of unmanned air transportation? Community engagement includes education and training geared towards future workforce as well as town-hall meetings to inform the communities about changes that are coming to their communities and help prepare them for these changes. Their participation and inputs are very critical to the success of new endeavors that cities and municipalities are going to engage in.

We wrap up this discussion with a summary of our expectations from the industry perspective. Safety and trust can only be achieved through the whole community approach. Government-public-private partnership is the key to the success of safe and trusted unmanned transportation.

Bio:

Kamesh Namuduri is a Professor of Electrical Engineering and the director of Autonomous Systems Laboratory at the University of North Texas (UNT). He received his B.S. degree in Electronics and Communication Engineering from Osmania University, India, in 1984, M.S. degree in Computer Science from University of Hyderabad in 1986, and Ph.D. degree in Computer Science and Engineering from University of South Florida in 1992. Over the past eleven years, his research is focused on aerial networking and communications. He is serving as the chair for two Standards Working Groups (IEEE 1920.1: Aerial Communications and Networking and IEEE P1920.2: Vehicle-to-Vehicle Communications for Unmanned Aircraft Systems).

He is serving as the Chair for the IEEE Vehicular Technology Society's Ad Hoc Committee on Drones, as the Vice Chair for "Aerial Communications", an emerging technology initiative of the IEEE Communication Society, and as an Expert Adviser on UAVs, COM/Access Core Standards Committee, IEEE Communications Society. He is a co-editor for the book titled "UAV Networks and Communications" published by the Cambridge University Press in 2017. He is leading the Smart and Connected Community project on "Deployable Communication Systems" in collaboration with the government, public, and private organizations. This living laboratory project was demonstrated thrice during the Global City Teams Challenge hosted jointly by the National Institute of Standards and Technology and US Ignite in 2015, 2016, 2017, and 2018. He contributed to the development of research agenda, requirements and

blueprints highly deployable communications systems led by the National Institute of Standards and Technology and National Public Safety Telecommunications Council. In 2020, Namuduri successfully led a team of seven organizations including three universities and four start-up companies engaging as an airspace partner in the Advanced Air Mobility, National Campaign Developmental Test project directed by NASA. He is working on a new book titled "Unmannered Air Transportation: Bringing Principles to Practice", which is expected to be published by the Oxford University Press in 2022.



T10: Data Analytics on Graphs: A New Paradigm in Machine Intelligence

by

Danilo P. Mandic

Date & Time: 27th July 2021 (1900-2015 hours) Indian Standard Time

Location: Hall A

Abstract:

The current availability of powerful computers and huge data sets is creating new opportunities in computational mathematics to bring together concepts and tools from graph theory, machine learning and signal processing, creating Data Analytics on Graphs. In discrete mathematics, a graph is merely a collection of points (nodes) and lines connecting some or all of them. The power of such graphs lies in the fact that the nodes can represent entities as diverse as the users of social networks or financial market data, and that these can be transformed into signals which can be analyzed using data analytics tools. In this talk, we aim to provide a comprehensive introduction to generating advanced data analytics on graphs that allows us to move beyond the standard regular sampling in time and space to facilitate modelling in many important areas, including communication networks, computer science, linguistics, social sciences, biology, physics, chemistry, transport, town planning, financial systems, personal health and many others. Graph topologies will be revisited from a modern data analytics point of view, and we will then proceed to establish a taxonomy of graph networks. With this as a basis, we show how the spectral analysis of graphs leads to even the most challenging machine learning tasks, such as clustering, being performed in an intuitive and physically meaningful way. Unique aspects of graph data analytics will be outlined, such as their benefits for processing data acquired on irregular domains, their ability to finely-tune statistical learning procedures through local information processing, the concepts of random signals on graphs and graph shifts, learning of graph topology from data observed on graphs, and confluence with deep neural networks, multiway tensor networks and Big Data. Extensive examples are included to render the concepts more concrete and to facilitate a greater understanding of the underlying principles.

Bio:

Danilo P. Mandic is a Professor in signal processing with Imperial College London, UK, and has been working in the areas of adaptive signal processing and bioengineering. He is a Fellow of the IEEE and member of the Board of Governors of International Neural Networks Society (INNS). He has more than 300 publications in journals and conferences. Prof Mandic has received the 2019 Dennis Gabor Award by the International Neural Networks Society (for outstanding achievements in neural engineering), and the President Award for Excellence in Postgraduate Supervision at Imperial. He has authored research monographs "Recurrent Neural Networks for Prediction", Wiley 2001, "Complex Valued Nonlinear Adaptive Filters: Noncircularity, Widely Linear and Neural Models", Wiley 2009, and "Tensor Networks for Dimensionality Reduction and Large Scale Optimisation", Now Publishers, 2017. He is a 2018 recipient of the Best Paper Award in IEEE Signal Processing Magazine, for his paper "Tensor Decompositions for Signal Processing Applications". His work related to this talk is a series of three articles entitled "Data Analytics on Graphs", published in Foundations and Trends in Machine Learning", December 2020.



T11: Blockchain protocols made efficient and scalable

by

Sreeram Kannan

Date & Time: 30th July 2021 (0900-1015 hours) Indian Standard Time

Location: Auditorium

Abstract:

Blockchain protocols such as Bitcoin have created the possibility of highly decentralized computing. However, existing blockchain protocols suffer from various problems: (1) energy inefficiency, (2) large confirmation latency (order of hours), and (3) lack of scalability (performance does not improve as more nodes are added to the system). In this mini-tutorial, we highlight how to solve these bottlenecks. We highlight the modeling of blockchain using tree-processes, which have both a randomized component as well as an adversarial component. We then use this abstraction to prove sharp phase-transitions of these processes yielding security theorems for the corresponding blockchain protocols. We then show how to use this abstraction to achieve (1) energy efficiency and (2) optimal confirmation latency. Finally, we show that (3) the scalability bottleneck of blockchains can be solved using an interesting connection to the classical result of Blackwell in dynamic game theory.

Bio:

Sreeram Kannan is an assistant professor at the University of Washington, Seattle, where he runs the information theory lab focussing on information theory and its applications in communication networks, machine learning and blockchain systems. He was a postdoctoral scholar at the University of California, Berkeley and a visiting postdoc at Stanford University between 2012-2014 before which he received his Ph.D. in Electrical and Computer Engineering and M.S. in Mathematics from the University of Illinois Urbana Champaign. He is a speaker in the 2021 National

Academy of Engineering Frontiers-of-Engineering US-Japan meeting, a recipient of the 2019 UW ECE Outstanding Teaching Award, 2018 Amazon Catalyst award, 2017 NSF Faculty Early CAREER award, the 2015 Washington Research Foundation Early Career Faculty award, and the Van Valkenburg outstanding graduate research award from UIUC.



T12: Reconfigurable Intelligent Surfaces and Holographic Massive MIMO: Vision, Fundamentals, and Key Open Problems

by

Emil Björnson

Date & Time: 30th July 2021 (1020-1320 hours) Indian Standard Time

Location: Auditorium

Abstract:

Wireless connectivity is becoming as essential as electricity in our modern world. Although we would like to deliver wireless broadband services everywhere, the underlying physics makes it inherently complicated: the signal power vanishes very quickly with the propagation distance and is absorbed or scattered when interacting with objects in the way. Even when we have a "strong" signal, only one in a million parts of the signal energy is being received, thus, there is a huge room for improvements!

What if we could tune the propagation environment to our needs? This is the main goal of reconfigurable intelligent surfaces, which is an emerging concept for beyond-5G communications. The idea is to support the transmission from a source to a destination by deploying so-called metasurfaces that can reconfigure how incident signal waves are scattered and absorbed. These surfaces can be electronically configured to interact with the wireless signals as if they had different shapes. For example, it can be configured to behave as a parabolic reflector that is perfectly rotated to gather signal energy and re-radiate it as a beam focused on the receiver, and a few milliseconds later it can take a different virtual shape for another use case. This feature makes use of a new design dimension: we can not only optimize the transmitter and receiver but also control the channel properties. This can be a game-changer when communicating at mmWave and THz frequencies, where the traditional propagation conditions are particularly troublesome and can benefit from new
well-optimized propagation paths, and to manage interference in the spatial domain in dense deployments.

This might sound like science fiction but is theoretically possible. In this tutorial, you will first learn about the visions for the technology, which includes both passive surfaces known as "reconfigurable intelligent surfaces" and the active counterpart known as "Holographic Massive MIMO". The core difference is whether the surface is co-located with transmitter/receiver or deployed in between. The fundamental models and behaviors will then be presented using signals-and-system theory, which leads to more familiar and intuitive derivations for communication engineers than previous examples based on electromagnetic theory. The tutorial will focus on the impact that these technologies have on delay spread, frequency selectivity, channel modeling, beamwidth, and near/far-field propagation properties. The system operation related to channel estimation and optimization of the surfacedescribing parameters will be covered for different use cases. The tutorial will culminate in the description of two major open problems that need to be tackled by the research community if this exciting new technology should have a role to play in 6G.

Bio:

Emil Björnson received the M.S. degree in Engineering Mathematics from Lund University, Sweden, in 2007. He received the Ph.D. degree in Telecommunications from KTH Royal Institute of Technology, Sweden, in 2011. From 2012 to mid-2014, he was a joint postdoc at the Alcatel-Lucent Chair on Flexible Radio, SUPELEC, France, and at KTH. He joined Linköping University, Sweden, in 2014 and is currently Associate Professor and Docent at the Division of Communication Systems. He teaches Master level courses on communications and is responsible for the Master programme in Communication Systems.





Technology Frontiers: Designing 5G chips in New Technology nodes

by

Mamta Bansal

Date & Time: 28th July 2021 (1030-1100 hours) Indian Standard Time

Location: Auditorium

Abstract:

5G wireless innovation is transforming how the world connects, computes and communicates. A walk through the Technology and Innovations in development of leading 5G SoCs. New architecture trends are driving methodologies and design flow changes. We discuss the trends and opportunities of practical research in Concept to Silicon design solutions.

Bio:

Mamta Bansal is Sr. Director of Engineering at Qualcomm Technologies Inc., where she leads the Global CAD chip Implementation solutions at Qualcomm Technologies Inc. She has over 25 years of experience in the semiconductor industry. Mamta joined Qualcomm in 2010 and has lead worldwide engineering teams responsible for RTL2GDS design flow for Qualcomm SoCs in cutting-edge advance process nodes. Prior, she held IP design manager, technology access manager and Director- EDA positions at PMC-Sierra Inc. Mamta received her education in Electrical Engineering from Indian Institute of Technology.



RAN-WiserTM - A methodology to design portable RAN Modems and DSP applications

by

Shri Anindya Saha

Date & Time: 30th July 2021 (1400-1430 hours) Indian Standard Time

Location: Auditorium

Abstract:

In 5G networks, the concepts of "disaggregation" and "virtualization" make the telco networks look like IT cloud networks. The scaling benefits accrued in an IT cloud network are thus being brought to the telco cloud simplifying deployment, provisioning, and automation. Specifically, the disaggregation in the DU landscape has propelled the separation of the DU hardware and software. DU High PHY has adopted a software-defined approach executing on COTS hardware. Consequently, there is a diverse ecosystem of DU Independent Software Vendors (ISV). However, the independent hardware vendor (IHV) ecosystem for DU is still very niche and results in vendor lock-in.

The talk describes a new methodology to design and develop portable RAN Modems in a hardware-agnostic manner. The proposed method focuses on optimizing a "virtualized RAN" architecture deployed by telecom operators and could be used for any DSP application.

The solution allows mobile network operators to work with custom RAN hardware without sacrificing COTS solution benefits, allowing the operators to move across multiple hardware vendors. Along with portability, the dynamic and optimum utilization of the underlying compute resources is a crucial requirement addressed by this methodology. The proposed method is thus an essential step in the development of a Truly Open Virtualized RAN.

Bio:

Anindya Saha is Chief Technology Officer (CTO) at Saankhya Labs with approximately 25 Years of experience. He is an expert on Software Defined Radios and leading the design and development of the Baseband and RF subsystems for Saankhya's products in wireless communication, including Radio development for 5G. He has been instrumental in SDR Platform development and holds several fundamental patents and publications in this domain.

He is a Senior Member, IEEE and participates in standardization activities in TSDSI, O-RAN, and 3GPP. Anindya is also a Governing Council member, TSDSI, which is the Indian Standards Development Organization. He holds 30+ approved US and India patents related to Wireless Radios, RF/Baseband design, VLIW CPU architectures, and SDR Platforms. He has authored 5 IEEE publications and co-authored a chapter titled "IEEE 802.22/802.22.3 Cognitive Radio Standards: Theory to Implementation" in the Handbook of Cognitive Radio, published by Springer. Anindya has a Master's degree in Electrical Communication Engg from IISC, Bangalore (1994-1996) and a Bachelor's degree in Electrical Communication Engg from IIT-BHU, Varanasi (1989-1993), where he was the recipient of the Gold Medal in Graduate Studies. His profile is available at https://in.linkedin.com/in/anindyasaha



Role of AI in Beyond-5G Terminals & Networks

by

Ratnakar Rao

Date & Time: 30th July 2021 (1720-1750 hours) Indian Standard Time

Location: Auditorium

Abstract:

With advances in computation capabilities, we have seen how AI has taken over various fields. It is time for wireless systems to take advantage of AI, spanning various facets of wireless ranging from RF to transport protocols. Trends like Network feature virtualization and Multi-access edge computing can only accelerate the adoption of AI. We talk on how AI is transforming fundamental aspects of wireless networks and terminals eventually paving a new path for Beyond-5G systems.

Bio:

Ratnakar Rao is Senior Director, Engineering at Samsung R&D Institute in Bangalore, where he leads the Beyond 5G Communication R&D team. He has over 20 years of experience in telecommunication industry . He specializes in Wireless protocols and played a key role in the launch of Samsung's 5G mmWave and Standalone smartphones in worldwide markets. He is a Senior Member, IEEE and has 20+ International patent grants. His current areas of interest include AI-in-Wireless and Next generation communication systems. Ratnakar holds a Master's degree in Telecommunication Systems Engineering from IIT, Kharagpur. He is a TEDx speaker and has delivered several invited talks and podcasts technological advances. His profile is available on at www.linkedin.com/in/ratnakar-rayavarapu



W1: Women in Engineering Workshop Program for NCC 2021

Start Time (IST)	End Time (IST)	торіс	SPEAKERS
0900	1000	Plenary Talk Active Hypothesis Testing for Fast Decision Making with applications to SARS-CoV-2 testing	Prof. Urbashi Mitra, University of Southern California
1000	1030	Assessing Oral Reading Skills with Speech Processing	Prof. Preeti Rao, IIT Bombay
1030	1100	Technology Frontiers: Designing 5G chips in New Technology nodes	Ms. Mamta Bansal
1100	1130	Particle Filter based Nonlinear Data Detection in Hybrid Mmwave Massive MIMO Systems	Prof. Debarati Sen, IIT Kharagpur
1130	1200	Privacy Preserving Inference in Medical Imaging	Dr. Divya Gupta, Microsoft Research, Bangalore



Active Hypothesis Testing for Fast Decision Making with applications to SARS-CoV-2 testing

by

Prof. Urbashi Mitra

Date & Time: 28th July 2021 (0900-1000 hours) Indian Standard Time

Location: Auditorium

Abstract: Many modern (machine) learning strategies depend on the intelligent acquisition of informative samples. Such sampling methods can be viewed as an instantiation of the exploration-exploitation problem. Initially, one is unclear about the state of the environment and the goal is to take observations that refine the understanding of the state. If one has a series of "experiments" (or queries), each of which provide information about the state, an important question is how to design that sequence of experiments to enable a decision about the environmental state as quickly as possible. Exploration-exploitation problems abound in applications such as anomaly detection, target localization, dynamical system tracking, medical diagnosis, wireless body area sensor networks etc. The problem of experiment design for classification (hypothesis testing) has been persistently studied since the 1940s. Then and now, there has been an emphasis on the design of asymptotically optimal methods. Herein, we will provide new analysis which enables the design of strategies for the finite sample regime. In key cases, our methods are also asymptotically optimal, but provide significantly improved finite sample performance. We specialize our analysis to the problem of anomaly detection for which we can determine asymptotically tight upper and lower bounds on the misclassification error and provide an experiment design strategy with excellent finite sample performance. We further consider the application of our approach to group-testing, wherein different experiments call for the pooling of samples which can dramatically reduce the number of experiments needed. Finally, we consider the problem of testing of populations to provide good spatial estimates of the incidence of an anomaly, such as SARS-CoV-2 positivity. We have preliminary analysis of SARS-CoV-2 serological tests based on randomized testing undertaken by a colleague at USC's School of Public Policy. Our proposed strategy suggests that uniform allocation for randomized testing over heterogeneous regions may not yield the best estimates of positivity rates and offers a method by which active hypothesis testing can be used to improve such estimates.

Bio:

Urbashi Mitra received the B.S. and the M.S. degrees from the University of California at Berkeley and her Ph.D. from Princeton University. Dr. Mitra is currently the Gordon S. Marshall Professor in Engineering at the University of Southern California with appointments in Electrical & Computer Engineering and Computer Science. She was the inaugural Editor-in-Chief for the IEEE Transactions on Molecular, Biological and Multiscale Communications. She has been a member of the IEEE Information Theory Society's Board of Governors (2002-2007, 2012-2017), the IEEE Communications Society's Boad of Governors (2018-2020), the IEEE Signal Processing Society's Technical Committee on Signal Processing for Communications and Networks (2012-2016), the IEEE Signal Processing Society's Awards Board (2017-2018), and the Chair/Vice-Chair of the IEEE Communication Theory Technical Committee (2017-2020). Dr. Mitra is a Fellow of the IEEE. She is the recipient of: the 2021 USC Viterbi School of Engineering Senior Research Award, the 2017 IEEE Women in Communications Engineering Technical Achievement Award, a 2015 UK Royal Academy of Engineering Distinguished Visiting Professorship, a 2015 US Fulbright Scholar Award, a 2015-2016 UK Leverhulme Trust Visiting Professorship, IEEE Communications Society Distinguished Lecturer, 2012 Globecom Signal Processing for Communications Symposium Best Paper Award, 2012 US National Academy of Engineering Lillian Gilbreth Lectureship, the 2009 DCOSS Applications & Systems Best Paper Award, 2001 Okawa Foundation Award, 2000 Ohio State University's College of Engineering Lumley Award for Research, and a 1996 National Science Foundation CAREER Award. She has been an Associate Editor for the following IEEE publications: Transactions on Signal Processing, Transactions on Information Theory, Journal of Oceanic Engineering, and Transactions on Communications. Dr. Mitra has held visiting appointments at: King's College, London, Imperial College, the Delft University of Technology, Stanford University, Rice University, and the Eurecom Institute. Her research interests are in: wireless communications, communication and sensor networks, biological communication systems, detection and estimation and the interface of communication, sensing and control.



Assessing Oral Reading Skills with Speech Processing

by

Prof Preeti Rao

Date & Time: 28th July 2021 (1000-1030 hours) Indian Standard Time

Location: Auditorium

Abstract: Education policies, both nationally and globally, accord the highest importance to achieving foundational literacy in the early school years. However, the regular assessment of progress, critical to the effectiveness of education interventions, tends to be expensive in terms of time and human resources. With oral reading being one of the important means of evaluating literacy and language competence, we present an automatic system for the objective evaluation of reading skill from audio recordings. Established reading rubrics that incorporate aspects of word accuracy, speed and fluency are modeled using speech recognition and prosody detection trained on expert ratings of field-collected data. We present the challenges posed by the task and research related to finding effective solutions.

Bio:

Preeti Rao is on the faculty of Electrical Engineering at I.I.T. Bombay, in the area of signal processing for speech and audio. She received her Ph.D. from the University of Florida in Gainesville in 1990. Her research interests include speech recognition, speech prosody and music information retrieval. She has been involved in the development of technology for Indian music and spoken language learning applications. She co-founded SensiBol Audio Technologies, a start-up incubated by I.I.T. Bombay, with her Ph.D. and Masters students in 2011. She is a recipient of the Abdul Kalam Technology Innovation National Fellowship for 2020.



Technology Frontiers : Designing 5G chips in New Technology nodes

by

Mamta Bansal

Date & Time: 28th July 2021 (1030-1100 hours) Indian Standard Time

Location: Auditorium

Abstract:

5G wireless innovation is transforming how the world connects, computes and communicates. A walk through the Technology and Innovations in development of leading 5G SoCs. New architecture trends are driving methodologies and design flow changes. We discuss the trends and opportunities of practical research in Concept to Silicon design solutions.

Bio:

Mamta Bansal is Sr. Director of Engineering at Qualcomm Technologies Inc., where she leads the Global CAD chip Implementation solutions at Qualcomm Technologies Inc. She has over 25 years of experience in the semiconductor industry. Mamta joined Qualcomm in 2010 and has lead worldwide engineering teams responsible for RTL2GDS design flow for Qualcomm SoCs in cutting-edge advance process nodes. Prior, she held IP design manager, technology access manager and Director- EDA positions at PMC-Sierra Inc. Mamta received her education in Electrical Engineering from Indian Institute of Technology.



Particle Filter based Nonlinear Data Detection in Hybrid Mmwave Massive MIMO Systems

by

Prof. Debarati Sen

Date & Time: 28th July 2021 (1100-1130 hours) Indian Standard Time

Location: Auditorium

Abstract: The nonlinear distortions attributed by the radio frequency (RF) power amplifier (PA) and other RF circuits from the enormous bandwidth of millimeter wave (mmWave) and high frequency design limitations of the integrated circuits involved, degrade the performance of the hybrid mmWave MIMO-OFDM systems. These distortions cause nonlinear coupling of the hybrid precoder with the data signals. Further, it induces intercarrier interference (ICI) in the OFDM systems, which also involves the interference from the precoders of other subcarriers. These difficulties in collusion with frequency selective channel and carrier frequency offset (CFO) may pose great challenges to the estimation accuracy of these parameters (channel gains and CFO) and signal detection. The nonlinearity causes the target posterior distribution for data detection as non-Gaussian and analytically intractable.

A novel pilot assisted maximum likelihood (ML) based framework for estimating the CFO with PA impairment in the time domain by formulating a low dimensional equivalent channel matrix is presented here. This channel matrix is composed of hybrid precoders-combiners, high dimensional MIMO channel, and the nonlinearly distorted components from PA. Further, a group-sparse Bayesian learning (G-SBL) based semi-blind channel estimator is proposed in the time domain, which incorporates the CFO and nonlinearity of PA in its estimation process. With the estimated channel, a procedure to obtain the hybrid precoder and combiner matrices for data transmission is developed next. An iterative algorithm based on particle filter (PF) that effectively handles the nonlinear coupling of precoder matrix with data, and ICI is also proposed for data detection. Performance of proposed algorithm is evaluated over (a) synthetic geometric based mmWave channel and (b) realistic mmWave channel for an urban microcell (Umi) environment.

Bio:

Debarati Sen is currently an Associate Professor, IIT Kharagpur, India. She was a Post-Doctoral Research Fellow with the Chalmers University of Technology, Sweden, and a Senior Chief Engineer with the Samsung Research, Bangalore, India prior to join IIT Kharagpur in 2013. In 2014, Dr. Sen was a visiting faculty with the Institute for Comm. Engg., TUM, Germany; and in 2019, she was an academic visitor with the Dept. of ECSE, Monash University, Australia. She has about 12 years of R&D experience overall related to the domains of Wireless and Optical Communications including Interdisciplinary Computing, mostly on 5G/6G Communications, AI enabled Wireless, Millimeter

Wave and Terahertz Communications, Green Communications, Large MIMO, Cloud RAN etc. Her research is supported by a variety of Govt. Organizations including MHRD, MeitY, Min. of HI&PE, BEL, HAL, DST, DRDO, SERB, Indian Railways and external collaborators like AIRBUS, Samsung, Qualcomm (USA), Ericsson (Sweden), Rosenberger Technol. (China) etc. She has 13 patents published / applied to her credit including few US Patents, and has published more than 100 papers in Journals and Conferences of repute. She is an Editorial Board Member of two international journals; recipient of Best Paper Awards at Samsung Tech. Conference 2010 and IEEE ANTS 2016; IE(I) Young Engineers Award 2010; IETE N.V.G. Memorial Award 2013; Qualcomm Innovation Fellowship 2017, Faculty Excellence Award IIT Kharagpur 2020. She is a Senior Member of IEEE, Fellow of IE(I) and IETE.



Privacy Preserving Inference in Medical Imaging

by

Dr. Divya Gupta

Date & Time: 28th July 2021 (1130-1200 hours) Indian Standard Time

Location: Auditorium

Abstract:

Fueled by massive data and availability of extensive compute, sophisticated machine learning models have found diverse applications across verticals such as healthcare and finance. This has made the problem of privacy preserving machine learning increasingly important. In this talk, I will focus on two broad scenarios in the healthcare domain, namely secure prediction-as-a-service and secure model testing. In the prediction-as-a-service scenario, a hospital/ML provider has a machine learning model that has been trained on sensitive data, and patients have their private medical records. The goal is to enable the patients to learn the prognosis based on the model without revealing their sensitive medical data while preserving the confidentiality of the model held by the hospital. Secure model testing is a try-before-you-buy scenario where a hospital or a pathology lab wants to evaluate how the machine learning models from different vendors perform on its private data. This needs to be done without the hospital revealing their sensitive test data or the vendors revealing their proprietary models. Our work CrypTFlow provides a programmable, scalable and efficient cryptographic solution for both of CrypTFlow that automatically problems. is а system compiles these TensorFlow/ONNX inference code to secure computation protocols. It has two components. First component is an end-to-end compiler from TensorFlow/ONNX to a variety of secure computation protocols. Second, we build specialized protocols for secure machine learning for two and three party settings that are orders of magnitude more performant than prior works. We demonstrate that CrypTFlow is ready for disruption in secure healthcare by showcasing evaluation on multiple realworld case studies. These include ML models for detecting lung diseases including Covid19 from chest X-Rays, predicting frequency of doctor visits for Wet-AMD patients, and segmentation models for radiotherapy planning using 3D CT scans.

Bio:

Divya Gupta is a Senior Researcher at Microsoft Research India. Her research interest is cryptography and its applications to security and privacy. Currently her work at MSR focusses on secure multiparty computation and blockchains, and in particular, making cryptography practical, usable, and performant. She has published several papers in top computer science conferences such as Crypto, Eurocrypt, IEEE S&P, ACM CCS, OSDI, and so on and holds 3 US Patents. Before joining MSR, she was a postdoc at UC Berkeley hosted by Sanjam Garg. She completed her PhD at University of California at Los Angeles with Amit Sahai. Her PhD dissertation was recognized by the Dissertation Fellowship and the Dimitris N. Chorafas Dissertation Award, given for outstanding work in engineering sciences, medicine and the natural sciences. She got her bachelors and masters degree in Computer Science and Engineering from Indian Institute of Technology, Delhi.

TSDSI Standards Driven Research Workshop

27th National Conference on Communications



"Standards Driven Research" Online Workshop at the NCC2021

29 July 2021, 0900-1230 IST

Start Time (IST)	End Time (IST)	SESSION	TOPIC	SPEAKERS
0900	0905	Opening Session	Welcome Remarks	Prof Uday B Desai, Strategy Consultant- TSDSI
0905	0935	KEYNOTE	KEYNOTE: "The 5Gi Story – from Academic Research to a Global Standard"	Prof Abhay Karandikar, Director IIT Kanpur
0935	1015	CASE STUDIES	Academia: Ecosystem in India	Dr Sundaram Vanka, IIT Hyderabad
			Industry: Ecosystem in India	Mr Sharad Arora, Sensorise
1015	1030	Patent Perspective	How to Patent before publishing your paper/standardization	Mr Pankaj Bhagat, Chief Manager- IPM Cell, IIT Madras
1030	1130	Standardization Opportunities for 6G	Research Problems in relation to 6G: Core Network	Prof Mythili Vutukuru, IIT Bombay
			Research Problems in relation to 6G: Physical Layer	Dr Abhinav Kumar, IIT Hyderabad
				Dr Amit Kumar Dutta, IIT Kharagpur
	1215	"Need for active participation by Indian Research Community in formal Standardisation activities"		Remarks by Prof K V S Hari, IISc Bangalore
		Panel Discussion	Panel Discussion – "How to promote Standards driven research: what is the incentive?"	Moderator: Prof Ajit Chaturvedi, Director, IIT Roorkee
				Panelists:
				Mr Kishore Babu, DDG-SRI, DoT
1130				Prof Bhaskar Ramamurthi, Director, IIT Madras
				Prof Huzur Saran, IIT Delhi
				Prof Kiran Kuchi, IIT Hyderabad
				Prof Neelesh Mehta, IISc Bangalore
1215	1230	Closing Remarks and Way Forward	Closing Remarks and Way Forward	Ms. Pamela Kumar, DG-TSDSI



Opening Session: Welcome Remarks

by

Prof Uday B Desai, Strategy Consultant- Telecommunications Standard Development Society, India (TSDSI)

Date & Time: 29th July 2021 (0900-0905 hours) Indian Standard Time

Bio:

Prof. Uday B Desai is the Founding Director of Indian Institute of Technology, Hyderabad. He is Professor Emeritus at IIT Hyderabad.

He is also the Chancellor of Anurag University. He is also Honorary Professor of Woosong University, South Korea. He was mentor director of IIT Bhilai from August 2016 to January 2017 and mentor director for IIIT Chittoor during the first five years of the founding of IIT Chittoor.

Prof Desai is currently associated with TSDSI as Strategy Consultant.



KEYNOTE: "The 5Gi Story – from Academic Research to a Global Standard"

by

Prof Abhay Karandikar, Director IIT Kanpur

Date & Time: 29th July 2021 (0905-0935 hours) Indian Standard Time

Abstract: The research and development of information and communications technologies especially wireless communications technology is being driven through global standardization efforts today. While these efforts are expected to transform the society, they also pose new challenges for nations and people who are unable to become a stakeholder in this process. The newer technologies are developed and standardized to take care of the needs of the stakeholders and those who are unable to participate in this process are likely to be left behind; their economic and national sovereignty threatened due to lack of IPR ownership. It is imperative therefore, that India as a nation embarks whole heartedly on this journey and become a key stakeholder in the global standardization efforts in ICT domain.

This talk tries to highlight some of the significant steps taken by us in this direction in the recent past and explains how "standards driven research" can play an important role in making India a powerhouse in the world of technology and innovation. It discusses the story of 5Gi, an enhancement to 5G communications technology to take care of the needs of India, especially rural India. It also takes us through the arduous but successful and gratifying journey the 5Gi had to make to move from the confines of our academic institutions to a global standard.

Bio:

Prof Abhay Karandikar is currently the Director, Indian Institute of Technology (IIT) Kanpur, one of the premier technical institutes of India. Before joining IIT Kanpur as the Director in April 2018, he served as Institute Chair Professor in the Department of Electrical Engineering at Indian Institute of Technology (IIT) Bombay. He also served as Dean (Faculty Affairs) and Head of the Electrical Engineering Department at IIT Bombay. Prof Karandikar was the founding member and former Chairman of TSDSI. He was also Member (Part-Time) of Telecom Regulatory Authority of India (TRAI) from January 2017- January 2020. He serves on the board

of several companies and has founded and mentored start-ups in telecom and networking. He was member of High-Level Forum on 5G setup by the Government of India and Chaired the 5G Spectrum Policy Task Force.

Prof Karandikar has several patents issued and pending, contributions to IEEE, 3GPP standards, contributed chapters in books and large number of papers in international journals and conferences to his credit. Prof Karandikar was awarded with IEEE SA's Standards Medallion in December 2016 in New Jersey. His team also won Mozilla Open Innovation challenge prize in March 2017 for his work on rural broadband and digital empowerment in rural India. He is co-author of papers which won the Best paper awards in ACM MobiHoc 2009, Workshop on Indoor and Outdoor Small Cells WiOpt2014 and finalist for the best paper award in IEEE LCN 2012 and IEEE NCC 2014 conferences.



CASE STUDIES:

Academia: Ecosystem in India by Dr. Sundaram Vanka, IIT Hyderabad

Industry: Ecosystem in India by Mr Sharad Arora, Sensorise

Date & Time: 29th July 2021 (0935-1015 hours) Indian Standard Time

Title: IEEE 802.11 as the Building Set for Wireless LAN Standards Development by Dr. Sundaram Vanka, IIT Hyderabad

Abstract: The IEEE 802.11 standards are a family of wireless LAN (colloquially, "Wi-Fi") standards created by contributing to, borrowing from - and innovating upon - a shared pool of techniques, many of which have been deployed at scale for the past twenty odd years. This building set model permits the independent development of multiple standards targeting widely different applications. For instance, a new wireless LAN IOT standard and V2X standard can be developed and ratified independently, all the while borrowing useful ideas from each other as necessary. This talk provides a flavor of the research activity in the context of the relevant terminology and the processes connected to IEEE 802.11 standards development, with the recently ratified 802.11-2021 as a case study. The talk ends with a discussion on the open problems and future directions in Wi-Fi.

Bio:

Dr. Sundaram Vanka is an Associate Professor in Department of Electrical Engineering at Indian Institute of Technology Hyderabad, India. Prior to joining IITH, Dr. Vanka was an R&D IC Design Engineer in the wireless system architecture group at Broadcom, Inc., in San Jose, California, USA that he joined after obtaining his PhD from the University of Notre Dame, Notre Dame, Indiana, USA in 2012. He was also among the early lead designers of Wi-Fi chipsets at Redpine Signals, Inc., (now part of Silicon Labs), from 2003-2007. Dr. Vanka obtained his B.Tech. and M.

Tech. degrees in Electrical Engineering from IIT Madras in 2003. His research interests span the mathematical modeling, simulation and prototyping of wireless systems and networks, especially low power applications.

Industry: Ecosystem in India by Mr Sharad Arora, Sensorise

Bio:

Mr. Sharad Arora is the Founder of Sensorise Digital Services. He is serving as Vice Chair, SGSS & GC Member, TSDSI. He is a Technology Evangelist who has expertise in Telecom Technologies & Operator IT and BSS, Certification Authority Technologies and Deployment, Network & Device Security, Machine to Machine Communications, Embedded Systems & IoT, Information Technology for Telecom VAS, SIM Cards, related infrastructure and Security.

He has continuously supported the standardisation and policy initiatives for Telecoms, IT, Transport and Urban Development. He has authored / edited in excess of six Technical Reports, three ITU contributions and Several IoT, Security, LPWAN Work Items of TSDSI other than being an active member of four TEC National Working Groups, MTCTE Committee on Certification, Telematics Working Group of Niti Aayog, TEPC, TRAI Consultation, Rapporteur, SmartCities Standards Advisory Committee, TSDSI Roadmap and Outreach Committee.



Patent Perspective: How to Patent before publishing your paper/standardization

by

Mr. Pankaj Bhagat, Chief Manager- IPM Cell, IIT Madras

Date & Time: 29th July 2021 (1015-1030 hours) Indian Standard Time

Abstract: The talk will cover:

Impact of Publication on patent protection

When to publish the paper

What's the remedies available after publication

What's the process for filing patents

Bio:

Mr. Pankaj Kumar Bhagat has 18+ years of diverse experience in IP Leadership, IP management, licensing and commercialization of IP. Currently, at IITM he is leading 12-members team in the areas of IP management, Patent analytics, Patent prosecution for Indian and Foreign Patents.

At IITM, Pankaj has created compelling IP strategy, IP commercialization models and end-to-end IP solutions to cater the requirement of the Institute on par with top Foreign Universities both in value and cost. His leadership helped a small unskilledoffice employee into a professional IP team including patent agents that now owns and drives Indian and International strategic IP operations helping to build IP portfolio and achieve NIRF and ARIIA ranking to the institute.

Pankaj was an accomplished Examiner of Patents & Designs at Indian Patent Office, Govt. Of India with a distinction of examining more than 650 Patent applications from diverse technology domain making them in order for grant by the Controller of Patents. Pankaj has also excelled in designing commercial IP strategies and sizeable patent portfolio to Tata Motors Ltd. Pune, Thermax Ltd. Pune and Infosys Ltd, Bangalore previously working as an IP specialist before he joined Indian Institute of Technology Madras (IITM) in May 2018 as Head and Chief Manager-IPM at IC&SR.



Standardization Opportunities for 6G: Research Problems in relation to 6G

Core Network by Prof Mythili Vutukuru, IIT Bombay

Physical layer by Dr Abhinav Kumar, IIT Hyderabad and Dr Amit Kumar Dutta, IIT Kharagpur

Date & Time: 29th July 2021 (1030-1130 hours) Indian Standard Time

Title: Research challenges in the 5G core by Prof Mythili Vutukuru, IIT Bombay

Abstract: This talk will present some of the research challenges in the design and implementation of the 5G core. The 5G core connects the radio access network to external networks. The control plane of the 5G core is responsible for implementing signaling procedures like registration, authentication, session management, and mobility, while the data plane forwards user traffic. We first compare the performance of the various implementation options of the 5G core control plane and discuss how the choice of the underlying network stack impacts the performance of the various implementation options of the costs and benefits of the various implementation options of the stack impacts the performance of the various implementation options of the 5G core components. Next, we look at the costs and benefits of the various implementation options of the 5G core data plane, including evaluating the performance gains due to hardware acceleration of the data plane. The talk will end with a summary of research directions that can drive standardization efforts in the future.

Bio:

Prof Mythili Vutukuru is an Associate Professor at the Department of Computer Science and Engineering at IIT Bombay. Before joining IITB in 2013, she obtained her Ph.D. and M.S. degrees in Computer Science from the Massachusetts Institute of Technology in 2010 and 2006 respectively. After her Ph.D., she worked at Movik Networks, a start-up in the telecom space, for 3 years before joining IITB. Earlier,

she obtained a Bachelors in Computer Science and Engineering from the Indian Institute of Technology, Madras in 2004.

Title: Research opportunities in RAN for 5G and Beyond 5G networks by Dr Abhinav Kumar, IIT Hyderabad

Abstract: In this talk, we will briefly study the key use cases in 5G. Some PHY and MAC technologies in 5G radio access network (RAN) that enable these use cases will be discussed. Potential advantages and shortcomings of these technologies will be analyzed. The requirements for Beyond 5G networks will be discussed. Based on these requirements, potential research opportunities in RAN for 5G and Beyond 5G networks will be highlighted.

Bio:

Dr. Abhinav Kumar received the BTech+MTech (Dual Degree) and PhD degree in Electrical Engineering from the Indian Institute of Technology Delhi, in 2009 and 2013, respectively. From September to November 2013, he was a research associate in the Indian Institute of Technology Delhi. From December 2013 to November 2014, he was a postdoctoral fellow at the University of Waterloo, Canada. Since November 2014, he has been with Indian Institute of Technology Hyderabad, India, where he is currently an Associate Professor. His research interests are in the different aspects of Wireless Communications and Networking. He is a Senior member of IEEE.

Title: Waveform Design for Wideband THz Communication by Dr Amit Kumar Dutta, IIT Kharagpur

Abstract: THz communication will become an integral part of the 6G communication, specially in the short-range wide band data transfer. However, due to very large RF frequency and very large bandwidth, it comes with severe bottleneck including frequency channel. In this talk, we discuss a possible transmitter side waveform design based on the parallel OFDM and Filter banks, which may be suitable to counter this frequency dependency. We will also describe a very narrow beam forming technique in the context of MIMO-OFDM THz filter bank system.

Bio:

Dr. Amit Kumar Dutta is currently working as an Assistant Professor at IIT Kharagpur, India. Prior to this, he has worked in Texas Instrument, Broadcom Technology, NxP for almost 14 years in total in the field of DSP/Communication algorithm and System-on-Chip development. He has several IEEE Transactions and granted US patents to his credit. He holds PhD in Wireless communication from Indian Institute of Science, Bangalore. His current research interests include THz communication, General Physical Layer, 6G and beyond, Quantum Signal Processing and VLSI architecture for DSP/Communication.



"Need for active participation by Indian Research Community in formal Standardisation activities"

Remarks by Prof K V S Hari, IISc Bangalore

PANEL DISCUSSION: "How to promote Standards Driven Research: What is the incentive?"

Moderator: Prof Ajit Chaturvedi, Director, IIT Roorkee

Panelists: Mr. Kishore Babu, DDG-SRI, DoT; Prof Bhaskar Ramamurthi, Director, IIT Madras; Prof Huzur Saran, IIT Delhi; Prof Kiran Kuchi, IIT Hyderabad; and Prof Neelesh Mehta, IISc Bangalore

Date & Time: 29th July 2021 (1130-1215 hours) Indian Standard Time

Bio:

Prof K V S Hari is a Professor in the Department of ECE, Indian Institute of Science, Bangalore. He holds a BE (ECE) degree from Osmania University, Hyderabad, MTech (Radar and Communication Systems) from IIT Delhi and PhD (Systems science) from U C San Diego and has been a visiting faculty at Stanford University and KTH- Royal Institute of Technology, Stockholm. His research interests are in Signal Processing with applications to 5G wireless communications, radar systems, autonomous vehicles, and affordable MRI systems. He is a co-author of an IEEE 802.16 standard on wireless channel models. He was an Editor of EURASIP's Signal Processing from 2006 to 2016 and is currently the Chief Editor (Electrical Sciences) of Sadhana, the journal of the Indian Academy of Sciences published by Springer. He is a Fellow of the Indian National Academy of Engineering and a Fellow of IEEE and also on the Board of Governors, IEEE Signal Processing Society.

Bio:

Prof. Ajit Kumar Chaturvedi received the B.Tech., M.Tech., and Ph.D. degrees in Electrical Engineering from Indian Institute of Technology Kanpur in 1986, 1988, and 1995, respectively. He served the Department of Electronics Engineering at Indian Institute of Technology, Banaras Hindu University, Varanasi from 1994 to 1996. Subsequently, he joined the faculty of the Department of Electronics and Computer Engineering at Indian Institute of Technology Roorkee. In 1999, he moved to Indian Institute of Technology Kanpur where he also held the positions of Head of the Department of Electrical Engineering, Dean of Research & Development and Deputy Director. He is now the Director of IIT Roorkee. Prof. Chaturvedi was the Coordinator of the BSNL-IITK Telecom Centre of Excellence which has done large number of projects for the Indian telecom sector. He is a recipient of the INSA Teachers award, the Distinguished Teacher award of IIT Kanpur and Tan Chin Tuan Fellowship of Nanyang Technical University, Singapore. He is a founding member of the Telecom Standards Development Society of India (TSDSI). Prof. Chaturvedi was a member of the DoT committee which recommended criteria for spectrum allocation to telecom operators, in 2008. His research interests are in communication theory and wireless communications.

Bio:

Mr. Kishore Babu is currently DDG-SRI, DoT.

He has 28 years of experience in diverse leadership positions in Information & Communication Technologies (ICTs), Telecommunications.

He is responsible for Multilateral Cooperation from the Department of Telecommunications with International and Regional Organizations.

Kishore Babu has made important contributions on ITU, APT and other Platforms for ITU WTDC, ITSO Assembly Parties meeting, ITU WCIT, WSIS, APT meetings.

Bio:

Prof. Bhaskar Ramamurthi got his B.Tech in Electronics from IIT Madras in 1980, and his M.S. and Ph.D in Electrical Engineering from the University of California at Santa Barbara, in 1982 and 1985 respectively. After working at AT&T Bell Laboratories for a couple of years, he joined the faculty of IIT Madras, his alma mater, in 1986. He took over as Director, IIT Madras in September 2011. He played a key role in the formation of Telecommunications Standards Development Society, India (TSDSI) and was its Chair from OCtober 2018 through October 2020.

His areas of specialisation are Communications and Signal Processing. His research work is in Wireless Networks, Modulation, Wireless Data, and Audio and Video Compression. He is currently also honorary Director of the Centre of Excellence in Wireless Technology, a public-private initiative at the IIT-M Research Park to make India a wireless technology leader.

He is a Fellow of the Indian National Academy of Engineering, and of the Institute of Electrical and Electronics Engineers (IEEE). He was awarded the Vasvik Award for Electronic Sciences and Technology (2000), the Tamil Nadu Scientist Award for Engineering and Technology (2003), India Semiconductor Association TechnoVisionary Award (2011), Doyens of Madras Award for (2014), ACCS–CDAC Foundation Award (2015) and RWTH Honorary Fellow Award (2020).

Bio:

Prof Huzur Saran is the Head of the Department of Computer Science at IIT Delhi. Prior to joining IIT Delhi in 1990, he did his Ph. D in Computer Science from the University of California, Berkeley in 1989 and, a B.Tech in Electrical Engineering from the Department of Electrical Engineering at the IIT Delhi in 1983. His research is focused on Computer Networks and Algorithms. Prior to this he was the Head of the Amar Nath & Shashi Khosla School of IT, at IIT Delhi.

Prof Saran has been actively working in 4G wireless technologies. During 2000-2002 he was a Visiting Professor at the Information Systems Lab, Stanford where he worked on the media access control layer of an exploratory 4G wireless systems. He has been investigating wireless access and mesh technologies to enable ICT for rural masses.

More recently his group has been working on a rural content distribution framework for building disruption tolerant applications and in the area of peer-to-peer audio/video collaboration frameworks for online education (supported in part under the National Mission on Education through ICT). Dr Saran has also collaborated in the past with AT&T Research and Lucent Bell Labs in the area of Network Performance Analysis as a consultant (during 1993-2000). Dr Saran has also been a consultant during 2004-2010 to Solidcore Inc, a Software Startup. During this time he helped define and build a novel software protection technology for critical servers and embedded products. Solidcore was purchased by Mcafee in 2009 for its pathbreaking Dynamic Whitelisting technology.

Bio:

Dr. Kiran Kuchi, a professor at IIT Hyderabad, is a globally recognized innovator in the realm of 5G standards development. He has introduced the culture of developing wireless Standards Related Patents in India through his leadership role at Telecom Standards Development Society, India (TSDSI) and has contributed towards the creation of several important technologies in the 5G standards. Dr. Kuchi has invented & co-invented over 100 patents in the 4G/5G technology, of which more than 50 patents have resulted from his work carried out in India.

Bio:

Prof Neelesh B. Mehta is a Professor in the Department of Electrical Communication Engineering at the Indian Institute of Science (IISc), Bangalore. His research focuses on wireless communications. He has worked on 3G/4G/5G cellular communication standards, energy harvesting and green wireless sensor networks, cognitive radio, cooperative communications, multi-antenna technologies, and multiple access protocols.

He is a Fellow of the IEEE, Indian National Science Academy (INSA), Indian National Academy of Engineering (INAE), and National Academy of Sciences India (NASI). He is a recipient of the prestigious Shanti Swarup Bhatnagar Award, DST-Swarnajayanti Fellowship, NASI-Scopus Young Scientist Award, Hari Om Ashram Prerit Vikram Sarabhai Research Award, and the INAE Young Engineer Award. He currently serves on the Steering Committee of the IEEE Transactions on Wireless Communications and on the IEEE ComSoc Awards committee. In the past, he has served as an editor for the IEEE Wireless Communication Letters and Journal on Communications during 2013-19. He served on the Executive Editorial Committee of the IEEE Transactions on Wireless Chair during 2017-18. He served on the Board of Governors of the IEEE Communications Society from 2012-15.



Closing Remarks and Way Forward

by

Ms. Pamela Kumar, Director General, Telecommunications Standards Development Society, India (TSDSI)

Date & Time: 29th July 2021 (1215-1230 hours) Indian Standard Time

Bio:

Ms. Pamela Kumar is Director General, Telecommunications Standards Development Society (TSDSI), Founding Chair & Current President of CCICI and the Bharti Chair Visiting Professor at UIET Panjab University.

Since her joining TSDSI as Director General in early 2017, TSDSI has made a mark in the global standards arena – with its contribution of the Low Mobility Large Cell (LMLC) requirement for 5G Rural broadband in ITU and later approval of its Radio Interface Technology (RIT) - 5Gi as an IMT2020 technology standard by the ITU. She drove adoption of TSDSI Transposed oneM2M as the national standard for IoT/M2M in India. She worked with Department of Telecom to conceptualise 5G High Level Forum, leading several of its task forces and is now actively driving execution of its recommendations. TSDSI has forged deep partnerships with global SDOs and forums under her watch.

She spent the first 10 years of her career at AT&T, Bell Labs in USA and at C-DOT in Bangalore. Later, she held leadership positions in Texas Instruments, IBM, Hewlett Packard Enterprise, R&D labs in India. She also did a short stint with 2 startups, setting up the R&D centers of Network Programs and Alliance Semiconductors. She holds 3 Patents granted by USPTO and has 5 patent applications pending in the Networking Accelerators domain. She has been a Keynote/ invited speaker in 90+ Local and Global forums.

Pamela has held various honorary positions - Vice Chair of 3GPP PCG, member of the IEEE-SA Nominations & Appointments Committee, Member at large- IEEE

Standards Association Board of Governors, Chair of the IEEE Charles Steinmetz Awards Committee, General Chair of IEEE ANTS Conference & COMSNETS Conference, Coordinator Industry Relations for IEEE Region 10, Chair for IEEE Computer Society Chapter & Vice Chair of IEEE Bangalore section, etc.

Pamela earned her B.E in Electronics and Electrical Communication from Punjab Engineering College Chandigarh, Master's degree in Electrical Engineering from Rutgers University, USA and Executive MBA from IIM Bangalore.

She is passionate about the role of technology in driving quality of life and socioeconomic development. She firmly believes that national and international collaborations between Industry, Academia and Government are key enablers for sustainable development.

Applications of Machine Learning Workshop

27th National Conference on Communications

<u>Schedule</u>

Start Time (IST)	End Time (IST)	торіс	SPEAKERS
1520	1600	Machine learning for sound sensing	Prof. Mark Plumbley
1600	1640	Contextualized deep graph infomax for multi-layer networks	Prof. Balaraman Ravindran
1810	1850	Personalizing Federated Learning to the Edge Device	Prof. Venkatesh Saligrama
1810	1850	AI vs ML an introduction	Prof. Bhiksha Raj



Machine learning for sound sensing

by

Prof. Mark Plumbley

Date & Time: 30th July 2021 (1520-1600 hours) Indian Standard Time

Location: Auditorium

Abstract:

Imagine you are standing on a street corner in a city. Close your eyes: what do you hear? Perhaps some cars and busses driving on the road, footsteps of people on the pavement, beeps from a pedestrian crossing, and the hubbub of talking shoppers. You can do the same in a kitchen as someone is making breakfast, or as you are travelling in a vehicle. Now, following the success of AI and machine learning technologies for speech and image recognition, we are beginning to build computer systems to automatically recognize real-world sound scenes and events. In this talk, we will explore some of the work going on in this rapidly expanding research area, and discuss some of the potential applications emerging for sound recognition, from home security and assisted living to environmental noise and sound archives. We will also outline how we are adopting participatory methods, such as a virtual world cafe approach, to direct project outcomes from stakeholders, and so help us realise the potential benefit of sound sensing to society and the economy.

Bio:

Mark Plumbley is Professor of Signal Processing at the Centre for Vision, Speech and Signal Processing (CVSSP) and Head of School of Computer Science and Electronic Engineering at the University of Surrey, in Guildford, UK. He is an expert on analysis and processing of audio, using a wide range of signal processing and machine learning methods. He led the first international data challenge on Detection and Classification of Acoustic Scenes and
Events (DCASE), and is a co-editor of the recent book on "Computational Analysis of Sound Scenes and Events" (Springer, 2018). He currently holds a 5-year EPSRC Fellowship "AI for Sound" on automatic recognition of everyday sounds. He is a Member of the IEEE Signal Processing Society Technical Committee on Audio and Acoustic Signal Processing, and a Fellow of the IET and IEEE.



Contextualized deep graph infomax for multi-layer networks

by

Prof. Balaraman Ravindran

Date & Time: 30th July 2021 (1600-1640 hours) Indian Standard Time

Location: Auditorium

Abstract:

The InfoMax principle has been gaining popularity as an approach to learning representations in deep neural networks. In this talk, I will introduce the graph InfoMax criterion and how it is applied in graph neural networks. Multiplex networks are complex graph structures in which a set of entities are connected to each other via multiple types of relations, each relation representing a distinct layer. Such graphs are used to investigate many complex biological, social, and technological systems. In this talk, I will present a novel semi-supervised approach for structure-aware representation learning on multiplex networks. Our approach relies on maximizing the mutual information between local node-wise patch representations and label correlated structure-aware global graph representations to model the nodes and cluster structures jointly. The proposed architecture outperforms state-of-the-art methods in a range of tasks: classification, clustering, visualization, and similarity search on seven real-world multiplex networks for various experiment settings. The work will appear in ACM SIGKDD 2021.

Bio:

Professor B. Ravindran heads the Robert Bosch Centre for Data Science & Artificial Intelligence (RBCDSAI) at IIT Madras, the leading interdisciplinary AI research centre in India. He is the Mindtree Faculty Fellow and Professor in the Department of Computer Science and Engineering at IIT Madras. He has held visiting positions at the Indian Institute of Science, Bangalore, India, University of Technology, Sydney, Australia and Google Research. Currently, his research interests are centred on learning from and through interactions and span the areas of geometric deep learning and reinforcement learning. He

is currently serving on the editorial boards of Machine Learning Journal, Journal of AI Research, PLOS One, and Frontiers in Big Data and AI. He has published nearly 100 papers in premier journals and conferences. He received his PhD from the University of Massachusetts, Amherst and his Master's degree from the Indian Institute of Science, Bangalore. He is a senior member of the Association for Advancement of AI (AAAI).



IEEE Signal Processing Society Distinguished Lecture

Personalizing Federated Learning to the Edge Device

by

Prof. Venkatesh Saligrama

Date & Time: 30th July 2021 (1810-1850 hours) Indian Standard Time

Location: Auditorium

Abstract:

We propose a novel method for federated learning that is customized to the objective of a given edge device. In our proposed method, a server trains a global meta-model by collaborating with devices without actually sharing data. The trained global metamodel is then customized locally by each device to meet its specific objective. Different from the conventional federated learning setting, training customized models for each device is hindered by both the inherent data biases of the various devices, as well as the requirements imposed by the federated architecture. We present an algorithm that locally de-biases model updates, while leveraging distributed data, so that each device can be effectively customized towards its objectives. Our method is fully agnostic to device heterogeneity and imbalanced data, scalable to massive number of devices, and allows for arbitrary partial participation. Our method has built-in convergence guarantees, and on benchmark datasets we demonstrate that it outperforms other state-of-art methods.

Bio:

Venkatesh Saligrama is a faculty member in the Department of Electrical and Computer Engineering, the Department of Computer Science (by courtesy), and a founding member of the Faculty of Computing and Data Sciences at Boston University. He holds a PhD from MIT. His research interests are broadly in the area of Artificial Intelligence, and his recent work has focused on machine learning with resource-constraints. He is an IEEE Fellow and recipient of several awards including Distinguished Lecturer for IEEE Signal Processing Society, the Presidential Early Career Award (PECASE), ONR Young Investigator Award, the

NSF Career Award. More information about his work is available at http://sites.bu.edu/data



AI vs ML -- an introduction

bv

Prof. Bhiksha Raj

Date & Time: 30th July 2021 (1850-1930 hours) Indian Standard Time Location: Auditorium

Abstract:

"Artificial Intelligence" and "Machine Learning" have become popular buzz phrases in both the technical and lay communities. Often the terms are used interchangeably. But what are AI and ML, and what is the difference between the two?

In this talk we will try to explain the concepts and distinguish between them using simple examples aimed at a lay audience. The talk will be somewhat interactive; the audience is required to arrive with no more than their smarts; no prior technical expertise is assumed.

Bio:

Bhiksha Raj received the Ph.D. degree in electrical and computer engineering from Carnegie Mellon, Pittsburgh, PA, USA, in 2000. He is a Professor of the Computer Science Department, Carnegie Mellon University where he leads the Machine Learning for Signal Processing Group. He joined the Carnegie Mellon faculty in 2009, after spending time at the Compaq Cambridge Research Labs and Mitsubishi Electric Research Labs. He has devoted his career to developing speech and audio-processing technology. He has had several seminal contributions in the areas of robust speech recognition, audio content analysis and signal enhancement, and has pioneered the area of privacy-preserving speech processing. He is also the Chief Architect of the popular Sphinx-4 speech-recognition system.



27th National Conference on Communications

Wednesday, July 28th, 2021

NCC 2021: 2021 National Conference on Communications (NCC)

S1A: Communication Systems

Session time Wednesday, 12:10 pm until 01:30 pmLocation AuditoriumTalk time 20Chaired by: Prof. Pyari Pradhan

12:10 pm: An All-Digital Wideband OFDM-Based Frequency-Hopping System Using RF Sampling Data Converters

Amit Sravan Bora (National Chiao Tung University, Taiwan); Harishore Singh Tourangbam (National Chiao Tung University, Taiwan); Po-Tsang Huang (National Chiao Tung University, Taiwan)

Abstract: Traditionally, a wideband frequency hopping spread-spectrum (FHSS) system involves the use of analog mixers and oscillators for hopping the baseband signal to different higher frequencies. Such typical heterodyne receiver architectures have higher cost and form factors. Motivated by the recent development of direct radio-frequency (RF) data converters, this paper proposes an all-digital wideband orthogonal frequency division multiplexing (OFDM) based FHSS system using an RF direct sampling receiver architecture. The frequency-hopping is done in a two-stage process, with one at the baseband and the other at the carrier frequency to make it robust from any malicious attacks in the form of eavesdropping and jamming. The all-digital process of RF signal generation and detection in the system is verified over-the-air by using the RF sampling data converters of the Xilinx Ultrascale ZCU111 RFSoC board and Qorvo RF front-end. Later, a simulated bit error rate (BER) analysis of the system under a slow-fading channel and pilot-based channel estimation is carried out, which shows comparable performance with that of an analog FHSS system at radio frequencies.

12:30 pm: Digital Predistortion Resource Optimization for Frequency Hopping Transceiver System

Jaya Mishra (Indian Institute of Technology, Roorkee, India); Girish Chandra Tripathi (Indian Institute of Technology Roorkee, India); Meenakshi Rawat (IIT Roorkee, India)

Abstract: Frequency hopping (FH) is one of the best spread spectrum techniques for interference avoidance. Nonlinearity of PA is still a hindrance in using high efficiency modulation like QAM with FH. As dwell time is short, applying digital predistortion (DPD) to mitigate nonlinearity becomes critical. Memory Polynomial Model (MPM) based indirect learning architecture offers feasible solutions with reasonable resource utilization for FPGA

implementation. Hard coded DPD in FPGA is the best possibility for FH system. It takes less time in the implementation and application of DPD. If a single DPD for the whole frequency band 105MHz (2.395GHz to 2.5GHz) is used, it will consume less FPGA resource but will not provide good result. Hard coded DPD at each hopping frequency is not possible because of limited resource of FPGA. So, a solution has been worked out to use six DPD, each DPD for 3 to 4 hopping frequency. Thus, this paper provides a real-time solution of DPD implementation for the FH system in the above band. NMSE has been used to judge the efficacy of DPD. The resource utilized and time taken has been studied in this paper.

12:50 pm: Capacity Analysis of Adaptive Combining for Hybrid FSO/RF Satellite Communication System

Narendra Vishwakarma (Indian Institute of Technology Indore, India); Swaminathan Ramabadran (Indian Institute of Technology Indore, India)

Abstract: Free space optics (FSO) technology has fulfilled the needs of the gigabit capacity due to its exemplary features. Nevertheless, the FSO link is vulnerable to atmospheric turbulence, pointing errors, weather conditions like fog, snow etc. Subsequently, the more reliable radio frequency (RF) link can be used in combination with the FSO link to counteract the limitations. Therefore, a hybrid FSO/RF system is a promising solution for next-generation satellite communication (SATCOM) systems. In this context, we investigate an adaptive-combining-based switching scheme for a hybrid FSO/RF system considering both uplink and downlink SATCOM scenarios. Adaptive combining involves switching of the FSO link to maximal ratio combining (MRC) of FSO and RF links provided the operating FSO link quality becomes unacceptable for transmission. Further, in this paper, the performance of the adaptive-combining-based hybrid FSO/RF system is examined through exact and asymptotic ergodic capacity analysis. We have also determined a range of optimum switching threshold for different average signal-to-noise ratio (SNR) values of FSO and RF links to obtain optimal capacity performance. Moreover, we compare the performances of the adaptive-combining-based hybrid FSO/RF system, MRC-based, and hard-switching-based hybrid FSO/RF systems.

01:10 pm: Development of Improved SOQPSK Based Data Transmission over Aeronautical Telemetry Link

Ravindra Mohan Nigam (Aeronautical Development Agency, India); Pyari Mohan Pradhan (IIT Roorkee, India)

Abstract: In aeronautical telemetry Alamouti encoded Shaped Offset Quadrature Phase Shift Keying - Telemetry Group (SOQPSK-TG) modulated signal is used to resolve "Two antenna problem" due to simultaneous transmission from the two on-board antennae. Detection of this signal at the receiver requires estimation of channel impairments (channel gains, time delays and frequency offset). The Maximum Likelihood Sequence Estimation (MLSE) based decoder of Space Time Coding (STC) encoded SOQPSK-TG signal requires 512 states, which is too complex for implementation. In this paper, pulse shaping is performed on SOQPSK-TG frequency pulse to reduce the pulse duration. Pulse of length 2 bit interval is found to be approximately matching the SOQPSK-TG characteristic while reducing the decoder complexity

to 8 number of states. Subsequently parameter estimation is carried out for STC encoded SOQPSK-2T by Maximum Likelihood (ML) estimation method. The performances of proposed pulse shaping functions are compared with those of SOQPSK-TG and Feher's Quadrature Phase Shift Keying (FQPSK-JR), and are found to be superior for aeronautical telemetry display and level flight operations.

S1B: Optical Communication

Session time Wednesday, 12:10 pm until 01:30 pm Location Hall A Talk time 20 Chaired by Prof. Pradeep Kumar

12:10 pm: Generation of Optical Frequency Comb Using Cascaded Brillouin Scattering at Low Power Utilizing Pump Recycling Technique in a Single Mode Fiber

Aritra Paul (Indian Institute of Technology Kanpur, India); Pradeep Kumar (Indian Institute of Technology Kanpur, India)

Abstract: The paper describes the process of optical frequency comb generation using cascaded stimulated Brillouin scattering in optical fibers. The cascaded stimulated Brillouin scattering process is induced by the SBS-pump recycling technique in a single mode fiber. The single mode fiber is placed inside a recirculating cavity, with a loop mirror placed at the terminal end of the fiber. The pumps are obtained from four wave mixing process in a semiconductor optical amplifier. We have achieved a total of 8 comb lines – 5 lines within 6 dB power variation. The comb lines are separated by approximately 11 GHz (~0.085 nm).

12:30 pm: *Multi-Rate Kalman Filter for Carrier Phase Recovery in 200 Gbps PDM Coherent Optical Receivers*

Wrivu Sanyal (Indian Institute of Technology, Kanpur, India); Srishti Sharma (Indian Institute of Technology, Delhi, India); Pradeep Kumar (Indian Institute of Technology Kanpur, India)

Abstract: The Kalman filter is often used for tracking and estimation of effects such as LPN and NLPN in long haul coherent optical communication systems. However, real-time symbol-by-symbol estimation of these parameters is computationally challenging. We use a multi-rate Kalman filtering scheme that allows for different sampling and state update rates in the system. This scheme achieves high Q-factor by making use of maximum available samples while reducing computational load. Simulations are performed for 200 Gbps PDM-16-QAM system by transmitting 20000 symbols over 800 km optical channel. The filter has Q-factor of 17.25 dB with state estimates being updated after every 20 samples. The filter shows more than 1 dB improvement in Q-factor when compared to a KF where the intermediate samples are not utilised for phase estimation.

12:50 pm: Optical Sideband Interference Using Optical IQ and Mach-Zehnder Modulators

Govind Kumar (Indian Institute of Technology Kanpur, India); Nishant Chandra (Indian Institute of Technology Kanpur, India); Pradeep Kumar (Indian Institute of Technology Kanpur, India)

Abstract: We observe optical sideband interference using an optical IQ modulator at the transmitter and a Mach-Zehnder modulator at the receiver. We measure 82% interference visibility in back-to-back configuration and 71% interference visibility over 25 km optical fiber channel. We also show the simulation of optical sideband interference using IQ modulator and Mach-Zehnder modulator. We measure 77% visibility by simulation in back-to-back connection of transmitter and receiver. We study the effect of the linewidth of the laser on the optical spectrum of the sideband. We derive expressions for sideband power as a function of the applied phase difference between transmitter and receiver in the presence of chromatic dispersion in the fiber.

01:10 pm: Mode Analysis of AlGaAs Based Hybrid Metal Insulator Plasmonic Waveguide with Nanoscale Confinement

Santosh Kumar (NIT PATNA, India); Pintu Kumar (National Institute of Technology Patna, India); Rakesh Ranjan (National Institute of Technology Patna, India)

Abstract: An aluminum gallium arsenide (AlGaAs) based hybrid metal insulator plasmonic waveguide (HMIPW) has been investigated to analyze the optical properties of fundamental and higher order modes, such as real part of effective index, normalized effective mode area, and propagation length at 1550 nm of wavelength. The modal investigations have been done by varying the thicknesses of high index, low-index, and metal regions. The propagation length, up to 480 µm has been achieved, for the fundamental mode propagation. The multi-mode analysis presented in the current work can be extended for the analysis of biosensors, multimode interferometer, high speed optical signal processing, etc.

S1C: Speech Processing 1

Session time Wednesday, 12:10 pm until 01:50 pm Location Hall B Talk time 20 Chaired by Prof. Prithwijit Guha

12:10 pm: Detection of Speech Overlapped with Low-Energy Music Using Pyknograms

Mrinmoy Bhattacharjee (Indian Institute of Technology Guwahati, India); Mahadeva Prasanna (IIT Dharwad, India); Prithwijit Guha (IIT Guwahati, India)

Abstract: Detection of speech overlapped with music is a challenging task. This work deals with discriminating clean speech from speech overlapped with low-energy music. The overlapped signals are generated synthetically. An enhanced spectrogram representation called Pyknogram has been explored for the current task. Pyknograms have been previously used in overlapped speech detection. The classification is performed using a neural network that is designed with only convolutional layers. The performance of Pyknograms at various high SNR levels is compared with that of discrete fourier transform based spectrograms. The classification system is benchmarked on three publicly available datasets, viz., GTZAN, Scheirer-slaney and MUSAN. The Pyknogram representation with the fully convolutional classifier performs well, both individually and in combination with spectrograms.

12:30 pm: A Spectral Variation Function for Variable Time-Scale Modification of Speech

Pramod Haribhau Kachare (IIT Bombay & Ramrao Adik Institute of Technology, India); Prem C. Pandey (IIT Bombay, India)

Abstract: Spectral variation function is used to detect salient segments (segments with sharp spectral transitions). It is calculated from cosine of the angle between the averaged feature vectors of the adjacent segments. A modified version of this function is presented for variable time-scale modification of the speech signal. It uses the magnitude spectrum smoothed by auditory critical band filters and a small offset in the normalization for the angle cosine. Test results showed that the modified function detects spectral saliencies and does not have spurious peaks. It is applied for variable time-scale modification without altering the overall duration. Listening tests showed significantly better speech quality for processing using the modified function.

12:50 pm: *Effect of High-Energy Voiced Speech Segments and Speaker Gender on Shouted Speech Detection*

Shikha Baghel (Indian Institute of Technology, Guwahati, India); Mahadeva Prasanna (IIT Dharwad, India); Prithwijit Guha (IIT Guwahati, India)

Abstract: Shouted speech detection is an essential preprocessing task in many conventional speech processing systems. Mostly, shouted speech has been studied in terms of the characterization of vocal tract and excitation source features. Previous works have also established the significance of voiced segments in shouted speech detection. This work posits that a significant emphasis is given to a portion of the voiced segments during shouted speech production. These emphasized voiced regions have significant energy. This work analyzes the effect of high-energy voiced segments on shouted speech detection. Moreover, fundamental frequency is a crucial characteristic of both shouted speech and speaker gender. Authors believe that gender has a significant effect on shouted speech detection. Therefore, the present work also studies the impact of gender on the current task. The classification between normal and shouted speech is performed using a DNN based classifier. A statistical significance test of the features extracted from high-energy voiced segments is also performed. The results support the claim that high-energy voiced segments carry highly discriminating information. Additionally,

classification results of gender experiments show that gender has a notable effect on shouted speech detection.

01:10 pm: DNN Based Phrase Boundary Detection Using Knowledge-Based Features and Feature Representations from CNN

Pavan Kumar J (Indian Institute of Science, India); Chiranjeevi Yarra (International Institute of Information Technology, India); Prasanta Kumar Ghosh (Indian Institute of Science, India)

Abstract: Automatic phrase boundary detection could be useful in applications, including computer-assisted pronunciation tutoring, spoken language understanding, and automatic speech recognition. In this work, we consider the problem of phrase boundary detection on English utterances spoken by native American speakers. Most of the existing works on boundary detection use either knowledge-based features or representations learnt from a convolutional neural network (CNN) based architecture, considering word segments. However, we hypothesize that combining knowledge-based features and learned representations could improve the boundary detection task's performance. For this, we consider a fusion-based model considering deep neural network (DNN) and CNN, where CNNs are used for learning representations and DNN is used to combine knowledge-based features and learned representations. Further, unlike existing data-driven methods, we consider two CNNs for learning representation, one for word segments and another for word-final syllable segments. Experiments on Boston University radio news and Switchboard corpora show the benefit of the proposed fusion-based approach compared to a baseline using knowledge-based features only and another baseline using feature representations from CNN only.

01:30 pm: Towards a Database for Detection of Multiple Speech Disfluencies in Indian English

Sparsh Garg (International Institute of Information Technology Hyderabad, India); Utkarsh Mehrotra (International Institute of Information Technology Hyderabad, India); Krishna Gurugubelli (IIIT-Hyderabad, India); Anil Kumar Vuppala (International Institute of Information Technology Hyderabad, India)

Abstract: The detection and removal of disfluencies from speech is an important task since the presence of disfluencies can adversely affect the performance of speech-based applications such as Automatic Speech Recognition (ASR) systems and speech-to-speech translation systems. From the perspective of Indian languages, there is a lack of studies pertaining to speech disfluencies, their types and frequency of occurrence. Also, the resources available to perform such studies in an Indian context are limited. Through this paper, we attempt to address this issue by introducing the Indian English Disfluency (IED) Dataset. This dataset consists of 10-hours of lecture mode speech in Indian English. Five types of disfluencies - filled pause, prolongation, word repetition, part-word repetition and phrase repetition were identified in the speech signal and annotated in the corresponding transcription to prepare this dataset. The IED dataset was then used to develop frame-level automatic disfluency detection systems. Two sets of features were extracted from the speech signal and then used to train classifiers for the task of disfluency detection. Amongst all the systems employed, Random Forest with MFCC features resulted in the highest average accuracy of 89.61% and F1-score of 0.89.

S2A1: Age of Information

Session time Wednesday, 02:30 pm until 03:10 pm Location Auditorium Talk time 20 Chaired by Prof. Sharayu Moharir

02:30 pm: Age-Of-Information Bandits with Heterogeneous Data Rates

Harsh S Deshpande (IIT Bombay, India); Sucheta Ravikanti (Indian Institute of Technology, Bombay, India); Sharayu Moharir (Indian Institute of Technology Bombay, India)

Abstract: We consider a system with a sensor tracking a time-varying quantity and sending updates to a monitoring station using one of K different data-rates for each update. The probability of an attempted update is an unknown function of the data-rate of the update. The metric of interest is the Age-of-Information (AoI), defined as the time elapsed since the sensor made the measurement sent in the latest update received by the monitoring station. The algorithmic challenge is to determine which data-rate to use to minimize cumulative AoI over a finite time-horizon. We propose two policies and characterize their performance via analysis and simulations. One of the key takeaways is that taking the current AoI into account while determining which data-rate to use is key for good performance. In addition, we study the trade-off between AoI and throughput for the system considered.

02:50 pm: On the Age of Information of a Queuing System with Heterogeneous Servers

Anhad Bhati (IIT Bombay, India); Sibi Raj B Pillai (IIT Bombay, India); Rahul Vaze (TIFR Mumbai, India)

Abstract: An optimal control problem with heterogeneous servers to minimize the average age of information (AoI) is considered. Each server maintains a separate queue, and each packet arriving to the system is randomly routed to one of the servers. Assuming Poisson arrivals and exponentially distributed service times, we first derive an exact expression of the average AoI for two heterogeneous servers. Next, to solve for the optimal average AoI, a close approximation is derived, called the \emph{approximate AoI}, this is shown to be useful for multi-server systems as well. We show that for the optimal approximate AoI, server utilization (ratio of arrival rate and service rate) for each server should be same as the optimal server utilization with a single server queue. For two identical servers, it is shown that the average AoI is approximately \$5/8\$ times the average AoI of a single server.

S2B: Optical Systems

Session time Wednesday, 02:30 pm until 03:50 pm Location Hall A Talk time20Chaired byProf. Brejesh Lall

02:30 pm: A Penalty-Based Routing and Spectrum Assignment in Fragmented Elastic Optical Network Spectrum

Anjali Sharma (Indian Institute of Technology Kanpur, India); Sobir Ali (Indian Institute of Technology Kanpur, India); Varsha Lohani (IIT Kanpur, India); Yatindra Nath Singh (Indian Institute of Technology Kanpur, India)

Abstract: Routing and spectrum assignment (RSA) has been an area of keen interest in Elastic Optical Networks (EONs). Improper resource provisioning causes fragmentation in the network spectrum, which leads to inefficient spectrum utilization. It also causes an increase in blocking of the new connection requests. Fragmentation management techniques are complicated and costly. There is a need to operate the network in a fragmented state without worsening the performance. In this work, we present a penalty-based routing and spectrum assignment technique to mitigate fragmentation effects. We also propose a best-effort routing and spectrum assignment if the demanded spectrum resources are not available. The simulation results show that the proposed techniques perform better in terms of resource blocking ratio and network spectrum utilization.

02:50 pm: Neural Networks for Predicting Optical Pulse Propagation Through Highly Nonlinear Fibers

Naveenta Gautam (Indian Institute of Technology, India); Amol Choudhary (Indian Institute of Technology (IIT), Delhi, India); Brejesh Lall (Indian Institute of Technology Delhi, India)

Abstract: Due to increase in demand of the optical fiber communication system there is a special emphasis on diagnosing ultrashort pulses. The linear and nonlinear distortions introduced during transmission gives rise to wide variety of wave dynamics. The conventional signal processing techniques being used for characterising these pulses are computationally inefficient. Since machine learning has shown improvement compared to other analytical methods, we present a comparative study of different neural network (NN) architectures to predict the output pulse profile after transmission through highly nonlinear and dispersive fibers. The trained network has the ability to learn the mapping from a set of input and output pulses for the case of both known and unknown fibers. Since each NN has its own advantages and disadvantages, we to the best of our knowledge, present a comprehensive analysis of six different NN architectures (i) fully connected NN (FCNN), (ii) cascade forward NN (CaNN), (iii) Convolutional NN (CNN), (iv) long short term memory network (LSTM), (v) bidirectional LSTM (BiLSTM) and (vi) gated recurrent unit (GRU) for the first time.

03:10 pm: Coupling Length Analysis by Using Three Strips for Compact Design of Photonic Waveguide in Photonic Integrated Circuit

Veer Chandra (National Institute of Technology Patna, India); Santosh Kumar (NIT PATNA, India); Rakesh Ranjan (National Institute of Technology Patna, India)

Abstract: Development of compact photonic waveguide makes the possibility to design very dense photonic integrated circuits by using complex design structure. Conversely, compact photonic waveguide requires high coupling length between the neighboring photonic waveguides to avoid crosstalk between them. Some recent research demonstrated that to increase the coupling length between adjacent photonic waveguides, one can use the strips between them. In the current work, our focus is to obtain higher coupling length with reduced separation between the adjacent waveguides. By using three uniform silicon strips, the maximum coupling length of 3029 μ m has been achieved for the end-to-end separation between photonic waveguides of 300 nm. The obtained result is higher than previously reported values at the same separation of photonic waveguides. Higher coupling length is beneficial to design many compact photonic devices such as splitter, photonic switches, etc.

03:30 pm: Quantized Feedback-Based Space Shift Keying in Visible Light Communication

Sivanjan Rao Chandhu (Indian Institute of Technology, Roorkee, India); Anshul Jaiswal (Indian Institute of Technology Roorkee, India)

Abstract: This work proposes a novel feedback-based space shift keying (SSK) scheme to remove the limitations of the conventional SSK scheme in the visible light communication (VLC) system. The proposed scheme requires finite feedback bits to transfer the knowledge of channel gain ordering at the transmitter side and therefore termed as quantized feedback-based SSK (QF-SSK) scheme. Due to the symmetric nature of the channel gain in the VLC system, there are many locations where two or more channel gains become the same, which leads to the very high bit error rate (BER) performance for the SSK scheme. Furthermore, the fixed spatial constellation of the SSK scheme in the VLC system may not follow the gray mapping for real-line constellation points at every location, which is another reason for high BER. To overcome these limitations, the proposed QF-SSK scheme provides uneven power allocation between LEDs and uses an adaptive spatial constellation based on the information of channel gain order. It is noticed from the analysis that the proposed QF-SSK scheme significantly improves BER performance over all locations in VLC system as compared to conventional SSK scheme with very small feedback bits.

S2C: Speech Processing 2

Session time Wednesday, 02:30 pm until 03:50 pm

Location Hall B

Talk time 20

Chaired by Prof. Sri Rama Murty Kodukula

02:30 pm: Instantaneous Frequency Filter-Bank Features for Low Resource Speech Recognition Using Deep Recurrent Architectures

Shekhar Nayak (Samsung R&D Institute Bangalore & IIT Hyderabad, India); Chintigari Shiva Kumar (IIT Hyderabad, India); Sri Rama Murty Kodukula (Indian Institute of Technology Hyderabad, India)

Abstract: Recurrent neural networks (RNNs) and its variants have achieved significant success in speech recognition. Long short term memory (LSTM) and gated recurrent units (GRUs) are the two most popular variants which overcome the vanishing gradient problem of RNNs and also learn effectively long term dependencies. Light gated recurrent units (Li-GRUs) are more compact versions of standard GRUs. Li-GRUs have been shown to provide better recognition accuracy with significantly faster training. These different RNN inspired architectures invariably use magnitude based features and the phase information is generally ignored. We propose to incorporate the features derived from the analytic phase of the speech signals for speech recognition using these RNN variants. Instantaneous frequency filter-bank (IFFB) features derived from Fourier transform relations performed at par with the standard MFCC features for recurrent units based acoustic models despite being derived from phase information only. Different system combinations of IFFB features with the magnitude based features provided lowest PER of 12.9% and showed relative improvements of up to 16.8% over standalone MFCC features on TIMIT phone recognition using Li-GRU based architecture. IFFB features significantly outperformed the modified group delay coefficients (MGDC) features in all our experiments.

02:50 pm: *CTC-Based End-To-End ASR for the Low Resource Sanskrit Language with Spectrogram Augmentation*

Anoop Chandran Savithri (Indian Institute of Science, Bangalore, India); Ramakrishnan Angarai Ganesan (Indian Institute of Science & RaGaVeRa Indic Technologies Pvt Ltd, India)

Abstract: Sanskrit is one of the Indian languages which fares poorly, with regard to the development of language based tools. In this work we build a connectionist temporal classification (CTC) based end-to-end large vocabulary continuous speech recognition system for Sanskrit. To our knowledge, this is the first time an end-to-end framework is being used for automatic speech recognition in Sanskrit. A Sanskrit speech corpus with around 5.5 hours of speech data is used for training a neural network with CTC objective. 80-dimensional melspectrogram together with their delta and delta-delta are used as the input features. Spectrogram augmentation techniques are used to effectively increase the amount of training data. The trained CTC acoustic model is assessed in terms of character error rate (CER) on greedy decoding. Weighted finite state transducer (WFST) decoding is used to obtain the word level transcriptions from the character level probability distributions obtained at the output of the CTC network. The decoder WFST, which maps the CTC output characters to the words in the lexicon, is constructed by composing 3 individual finite state transducers (FST), namely token, lexicon and grammar. Trigram models trained from a text corpus of 262338 sentences are used for language modeling in grammar FST. The system achieves a word error rate (WER) of 7.64% and a sentence error rate (SER) of 32.44% on the Sanskrit test set of 558 utterances with spectrogram augmentation and WFST decoding. Spectrogram augmentation provides an absolute improvement of 13.86% in WER.

03:10 pm: Spoken Language Diarization Using an Attention Based Neural Network

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

Abstract: Spoken language diarization (SLD) is a task to perform automatic segmentation and labeling of the languages present in a given code-switched speech utterance. Inspiring from the way humans perform SLD (i.e capturing the language specific long term information), this work has proposed an acoustic-phonetic approach to perform SLD. This acoustic-phonetic approach consists of an attention based neural network modelling to capture the language specific information and a Gaussian smoothing approach to locate the language change points. From the experimental study, it has been observed that the proposed approach performs better when dealing with code-switched segment containing monolingual segments of longer duration. However, the performance of the approach decreases with decrease in the monolingual segment duration. This issue poses a challenge in the further exploration of the proposed approach.

03:30 pm: Speech-Training Aid with Time-Scaled Audiovisual Feedback of Articulatory Efforts

Pramod Haribhau Kachare (IIT Bombay & Ramrao Adik Institute of Technology, India); Prem C. Pandey (IIT Bombay, India); Vishal Mane (India, India); Hirak Dasgupta (IIT Bombay, India); K. S. Nataraj (Indian Institute of Technology, Bombay, India)

Abstract: Hearing-impaired children lack auditory feedback and experience difficulty in acquiring speech production. They can benefit from speech training aids providing visual feedback of key articulatory efforts. Requirements for such aid are developed through extended interaction with speech therapists and special education teachers. The aid is developed as a PCbased app for ease of distribution and use. It has two panels to enable comparison between the articulatory efforts of the learner and a teacher or a pre-recorded reference speaker. The visual feedback for an utterance is based on the information obtained from its audiovisual recording. The speech signal is processed to obtain time-varying vocal tract shape, level, and pitch. The vocal tract shape estimation uses LP-based inverse filtering, and the pitch estimation uses glottal epoch detection using Hilbert envelope for excitation enhancement. Visual feedback comprises a variable-rate animation of the lateral vocal tract shape, level, and pitch, and time-aligned display of the frontal view of the speaker's face along with playback of time-scaled speech signal. The graphical user interface and modules for signal acquisition, speech analysis, and time-scaled animation are developed and integrated using Python. The app has been tested for its functionalities and user interface and needs to be evaluated for speech training of hearingimpaired children. It may also be useful to second-language learners in improving the pronunciation of unfamiliar sounds.

S2A2: Machine Learning for Communications

Session time Wednesday, 03:10 pm until 03:50 pm

LocationAuditoriumTalk time20Chaired byProf. Alentattil Rajesh

03:10 pm: Learning to Decode Trellis Coded Modulation

Jayant Sharma (IIIT Hyderabad, India); V. Lalitha (IIIT Hyderabad, India)

Abstract: Trellis coded modulation (TCM) is a technique combining modulation with coding using trellises designed with heuristic techniques that maximize the minimum Euclidean distance of a codebook. We propose a neural networks based decoder for decoding TCM. We show experiments with our decoder that suggest the use of Convolutional Neural Network (CNN) with Recurrent Neural Network (RNN) can improve decoding performance and provide justification for the same. We show the generalization capability of the decoder by training it with small block length and testing for larger block length. We also test our decoder for its performance on noise model unseen in the training.

03:30 pm: Auto-SCMA: Learning Codebook for Sparse Code Multiple Access Using Machine Learning

Ekagra Ranjan (Indian Institute of Technology (IIT) Guwahati, India); Ameya Vikram (Indian Institute of Technology (IIT) Guwahati, India); Alentattil Rajesh (IIT G, India); Prabin Kumar Bora (Indian Institute of Technology Guwahati, India)

Abstract: Sparse Code Multiple Access (SCMA) is an effective non-orthogonal multiple access technique that facilitates communication among users with limited orthogonal resources. Currently, its performance is limited by the quality of the handcrafted codebook. We propose Auto-SCMA, a machine learning based approach that learns the codebook using gradient descent while using a Message Passing Algorithm decoder. It is the first machine learning based approach to generalize successfully on the Rayleigh fading channel. It is able to learn an effective codebook without involving any human effort in the process. Our experimental results show that Auto-SCMA outperforms previous methods including machine learning based methods.

S3A: Communication Theory 1

Session timeWednesday, 04:00 pm until 05:20 pmLocationAuditoriumTalk time20Chaired byProf. Suvra Sekhar Das

04:00 pm: Channel Estimation and Data Detection of OTFS System in the Presence of Receiver IQ Imbalance

Sapta Girish Babu Neelam (Bharat Electronics Limited & IIT Bhubaneswar, India); Pravas Ranjan Sahu (Indian Institute of Technology Bhubaneswar, India)

Abstract: Orthogonal time frequency space modulation (OTFS), which is very robust to doublydispersive channels under high mobility is an emerging waveform for 5G cellular applications. In this paper, we first derive the input-output vectorized relation of OTFS system in the delay-Doppler domain in presence of IQ imbalance. Next, we study the effects of receive IQ imbalance on the performance of OTFS system. We also study the channel estimation and data detection of OTFS system in the presence of receiver IQ imbalance using pilot based transmission. We use a two level threshold based technique for 1. Pilot aided channel estimation and for 2. IQ imbalance parameter estimation. We compare the performance analysis of receiver IQ imbalanced OTFS with the estimated one and observe that the error flooring effect is removed.

04:20 pm: Parametric Estimation of SINR Distribution Using Quantized SINR Samples for Maximizing Average Spectral Efficiency

Karthik Mohan K (IIT Kharagpur, India); Suvra Sekhar Das (Indian Institute of Technology Kharagpur, India)

Abstract: Spectrally efficient wireless communication systems are designed to dynamically adapt transmission rate and power by comparing the instantaneous signal to interference plus noise ratio (SINR) samples against SINR switching thresholds, which can be designed a priori using perfect knowledge of SINR distribution. Nevertheless, a priori perfect knowledge of SINR distribution is hardly feasible in any practical operating system for the following reasons. The operating condition is not stationary owing to mobility, while it is impossible to have prior knowledge of all possible operating conditions. Even if the set of operating conditions is defined, identifying the current operating scenario is not a trivial task either. Considering the above challenges, dynamic estimation of SINR distribution is one possible way out. The challenge encountered in such estimation is that only quantized values of SINR are available. Leveraging the well-accepted log-normal approximation of the signal to interference plus noise ratio (SINR) distribution, we develop a mechanism to obtain parametric estimates of the distribution of SINR using quantized data in this work. The proposed method can be used at the transmitter and the receiver in the same manner with appropriate modifications to signalling protocols and algorithm parameter values. We demonstrate through numerical analysis that the proposed method can help achieve near-ideal average spectral efficiency (ASE).

04:40 pm: Optimal Pilot Design for Data Dependent Superimposed Training Based Channel Estimation in Single/Multi Carrier Block Transmission Systems

Manjeer Majumder (IIT KANPUR, India); Aditya K Jagannatham (Indian Institute of Technology Kanpur, India)

Abstract: This paper develops a novel data dependent superimposed training technique for channel estimation in generic block transmission (BT) systems comprising of single/multicarrier (SC/MC) and zero-padded (ZP)/ cyclic prefix (CP) systems. The training sequence comprises of the summation of a known training sequence and a data-dependent sequence that is not known to

the receiver. A unique aspect of the scheme is that the channel estimation is not affected by the use of a data dependent sequence. The pilot design framework is conceived in order to minimize the Bayesian Cram´er-Rao bound (BCRB) associated with channel estimation error. Simulation results are provided to exhibit the performance of the proposed scheme for single and multi carrier zero-padded and cyclic prefixed systems.

05:00 pm: Superimposed Pilot Based Channel Estimation for MIMO Coded FBMC Systems

Murali Krishna Pavuluri (Indian Institute of Technology Bombay, India); Seeram Ram Prakash Sri Sai (Indian Institute of Technology Bombay, India); Vikram M. Gadre (IIT Bombay, India); Aditya K Jagannatham (Indian Institute of Technology Kanpur, India)

Abstract: In this paper superimposed pilot based channel estimation technique is proposed for MIMO coded FBMC systems. In coded FBMC intrinsic interference is mitigated by using spreading of symbols across time. Superimposed pilot based channel estimation is a technique that improves the spectral efficiency by transmitting the pilot symbols along with the data symbols on a set of selected subcarriers. The proposed system achieves the same bit-error performance and mean square error performance as that of MIMO-OFDM with an additional advantage of improved spectral efficiency. The spectral efficiency is improved in two ways. By removing the cyclic prefix overhead and by avoiding the use of dedicated subcarriers for pilots.

S3B: RF & Microwave 1

Session time Wednesday, 04:00 pm until 05:00 pm

LocationHall ATalk time20Chaired byProf. Hrishikesh Sonalikar

04:00 pm: Wideband Circuit Analog Absorber Using Modified Resistive Cross-Dipoles

Aditya Mandar Jabade (BITS-Pilani, India); Hrishikesh Sonalikar (BITS, Pilani, India)

Abstract: In this paper, a novel circuit analog absorber design is proposed using resistive crossdipoles as the basic template. The absorber consists of two FR4 substrates separated by air. The top substrate consists of a modified cross-dipole frequency selective surface (FSS) having lumped resistors and the bottom substrate provides a ground plane. The proposed absorber has a very low profile of 0.0739 wavelengths at its lowest operating frequency and a fractional bandwidth of 100.55% from 3.13 to 9.46 GHz. The designed absorber is insensitive to incident polarization and shows stable performance at oblique angles of incidence. It is demonstrated that a slight modification in the form of a rectangular strip applied to the basic cross-dipole FSS reduces the thickness to bandwidth ratio of the absorber.

04:20 pm: Influence of Various Soil Types and Its Properties on Filamentary Planar Coil Based Magnetic Induction Communication System

Swathi Sugumar (SSN College of Engineering, India); Sakthivel Murugan Santhanam (SSN College of Engineering, India)

Abstract: A novel idea of using compact filamentary planar spiral coils for the magnetic induction (MI) based underground (UG) communication to achieve high received power and enhanced transmission distance is proposed. In the existing system, non-planar coils were employed as transceivers which lost their function due to their huge size and deployment difficulty. An enhanced MI UG channel model is proposed to accurately investigate the UG medium's influence on the MI system performance by considering various soil properties that were considered negligible in the earlier models. An analytical approach to calculate self-inductance and mutual inductance of circular and square coils are described from which the communication parameters such as received power, path-loss, and signal-to-ratio are derived. The simulation results reveal that the square coil achieves 9.22% higher received power than the circular coil due to its high inductive area and low resistance. Further, the influence of coil parameters, soil properties, and coil misalignment on the received power is studied for the proposed filamentary planar square spiral coil (FPSSC) and it's least and most sensitive parameters are identified. The received power of the proposed FPSSC system exhibits a significant improvement of 59.46% as compared to the traditional non-planar MI coil system.

04:40 pm: Two-Way Array Factor Supported by Thinning Strategy for an Improved Radar Performance

Rathod Rajender (NIT-Rourkela, India); Konidala Subhashini (National Institute Of Technology, India); B Pavan Kumar (APSD Communication Systems Group U R Rao Satellite Centre ISRO, India)

Abstract: The presence of side-lobes which are adjacent to main -lobe are serious concern in radar systems. The amplitude distributions across the array aperture improves the side-lobe performance at the cost of directivity and hence aperture efficiency. The current two-way array pattern optimization techniques reveals that if the receive pattern nulls are placed along transmit pattern side-lobe peaks and by using two weight amplitude distribution, side-lobe levels (SLL) can be suppressed up to -50dB. In this work, these techniques are further investigated using three weight amplitude excitation to achieve the best design of a radar array resulting in SLL less than -57dB. These solutions has been validated by parametric optimization and supported by two case studies.

S3C: Video Processing 1

Session time Wednesday, 04:00 pm until 05:20 pm Location Hall B Talk time 20 Chaired by Prof. Deepak Mishra

04:00 pm: DeepSCT: Deep Learning Based Self Correcting Object Tracking Mechanism

Khush Agrawal (Visvesvaraya National Institute of Technology, India); Rohit Lal (Visvesvaraya National Institute of Technology, India); Himanshu Patil (Visvesvaraya National Institute of Technology, India); Surender Kannaiyan (VNIT, Nagpur, India); Deep Gupta (Visvesvaraya National Institute of Technology, Nagpur, India)

Abstract: This paper presents a novel mechanism, DeepSCT, to handle the long-term object tracking problem in Computer Vision. The paper builds around the premise that the classical tracking algorithms can handle short-term tracking problems efficiently; however, they fail in the case of long-term tracking due to several environmental disturbances like occlusion and out-of-frame going targets. The relatively newer Deep Learning based trackers have higher efficacy but suffer from working in real-time on low-end hardware. We try to fuse the two methods in a unique way such that the resulting algorithm has higher efficiency and accuracy simultaneously. We present a modular mechanism, which can accommodate improvements in its sub-blocks. The algorithm was tested on the VisDrone-SOT2019 dataset for a person tracking task. We quantitatively and qualitatively show that DeepSCT significantly improved classical algorithms' performance in short-term and long-term tracking problems.

04:20 pm: Domain Randomization on Deep Learning Models for Image Dehazing

Abdul Fathaah Shamsuddin (National Institute of Technology Calicut, India); Abhijith P (National Institute of Technology Calicut, India); Deepak Raja Sekar P M (National Institute of Technology Calicut, India); Krupasankari Ragunathan (National Institute of Technology Calicut, India); Praveen Sankaran (National Institute of Technology Calicut, India)

Abstract: Haze is a naturally occurring phenomenon that obstructs vision and affects the quality of images and videos. Recent literature has shown that deep learning-based image dehazing gives promising results both in terms of image quality and execution time. However, the difficulty of acquiring real-world hazy -- clear paired images for training still remains a challenge. Widely available datasets use synthetically generated hazy images that suffer from flaws due to difficulty in acquiring accurate depth information to synthesize realistic-looking haze, causing a gap in the real and synthetic domain. In this paper, we propose the usage of domain randomization for image dehazing by generating a completely simulated training dataset for deep learning models. A standard UNET based dehazing model is trained on the simulated dataset without using any real-world data to obtain high quality dehazed images. The performance of the proposed approach is evaluated on the Sun-Dehaze dataset and RESIDE Standard (SOTS outdoor) dataset. We obtain favorable PSNR and SSIM scores on both sets and we also show how our approach yields better visual results compared to other learning-based approaches.

04:40 pm: Deep Video Compression Using Compressed P-Frame Resampling

Abhishek Kumar Sinha (Indian Institute of Space Science and Technology, India); Deepak Mishra (IIST, India)

Abstract: The Convolutional Neural Network has emerged as one of the major players in the field of deep video compression. Many deep learning models relying on convolutional layers have outperformed the state-of-the-art compression standards by a huge margin. Although their work is still at infancy level, they seem to be the future of video coding. The proposed approach uses a frame resampling based video compression approach using Temporal 3-D CNN based encoder and Y-style CNN based decoder concatenated with High Fidelity GAN based entropy coding for frame compression. The proposed architecture employs frame downsampling method over the residual frame to control the bitrate of the compressed data and is trained through a simplified stagewise training procedure. The extensive experiments are conducted with different datasets and different colorspaces. The study shows that the proposed model outperforms the H.265 by 0.255 dB in terms of PSNR and nearly 0.1 in terms of MS-SSIM.

05:00 pm: Forensics of Decompressed JPEG Color Images Based on Chroma Subsampling

Chothmal Kumawat (IIT Roorkee, India); Vinod Pankajakshan (Indian Institute of Technology Roorkee, India)

Abstract: Identification of the type of chroma subsampling in a decompressed JPEG color image stored in a lossless format is important in forensic analysis. It is useful in many forensic scenarios like detecting localized forgery and estimating the quantization step sizes in the chroma planes for source camera identification. In this work, we propose a machine learning-based method capable of identifying the chroma subsampling used in the compression process. The method is based on detecting the change in adjacent pixel correlations due to upsampling process in JPEG decompression. These changes in the correlation are measured using the two-sample KS-test statistic in different directions. The experimental results show the efficacy of the proposed method in identifying the chroma subsampling scheme.

S4A: Communication Theory 2

Session time Wednesday, 05:30 pm until 06:30 pmLocation AuditoriumTalk time 20Chaired by Prof. Seshan Srirangarajan

05:30 pm: Angle of Arrival Distribution for Coherent Scattering from an Undulating Sea Surface

Manishika Rawat (Indian Institute of Technology Delhi, India); Brejesh Lall (Indian Institute of Technology Delhi, India); Seshan Srirangarajan (Indian Institute of Technology Delhi, India)

Abstract: In this work, we aim to evaluate the statistical characterization of the angle of arrival (AoA) at the receiver due to coherent scattering from a random sea surface. We represent the sea surface as a Sum of Sinusoids (SoS) and model it using Pierson-Moscovitz (PM) sea wave spectrum. We evaluate the random behavior of potential scatterers along the sea surface, sea

surface wave height, and their possible impact on the distribution of AoA at the receiver. Initially, analysis is carried out for a single realization of the sea surface, i.e., a sinusoidal surface. The results obtained for a sinusoidal surface are averaged to evaluate the characteristics of the ensemble-averaged SoS surface. The AoA model proposed in this work can be applied to diverse environmental conditions. The PDF so obtained can further be used to evaluate the Doppler spread and Autocorrelation function in an UW channel.

05:50 pm: Robust Linear Transceiver Design for Parameter Tracking in IoT Networks

Mohammad Faisal Ahmed (Cisco Systems (India), India); Kunwar Pritiraj Rajput (Indian Institute of Technology Kanpur, India); Aditya K Jagannatham (Indian Institute of Technology Kanpur, India)

Abstract: This work develops a robust linear joint transceiver design framework toward tracking a time varying parameter in a multi-sensor network considering channel state information (CSI) uncertainty. To begin with, an optimal parameter tracking framework is developed for a scenario with perfect CSI. This is followed by formulation of the per slot average mean square error (MSE) optimization problem subject to individual sensor power constraints considering stochastic CSI uncertainty. Next, a fast block coordinate descent (BCD) based robust transceiver design is developed that minimizes the average MSE in each slot. Simulation results demonstrate the performance of the proposed scheme and also show the improvement against the existing schemes in the literature that ignore the CSI uncertainty.

06:10 pm: *Performance of Two Stage Cooperative NOMA Transmission for Full-Efficient Three User Network*

Ankur Bansal (Indian Institute of Technology Jammu, India); Sudhakar Modem (Indian Institute Of Technology, Jammu, India)

Abstract: In this paper, we investigate the performance of three user network with two-stage non-orthogonal multiple access (NOMA) scheme. In particular, the outage performance is analyzed by considering full efficiency information transmission protocol, where each user receives its own data symbol in every slot. We investigate outage performance metric at each user, and obtained closed-form expressions. Moreover, a novel fragmental outage probability at near users is evaluated, which is useful for obtaining optimum NOMA power allocation coefficients. The result shows that the considered scheme outperform conventional NOMA and optimal NOMA parameter selection maximizes the system performance. Simulation results corroborate the derived analytical expressions.

S4B: RF & Microwave 2

Session time Wednesday, 05:30 pm until 06:30 pm Location Hall A Talk time 20 Chaired by Prof. Mohammad Jaleel Akhtar

05:30 pm: A Miniaturized Wideband Half Mode Substrate Integrated Waveguide Bandpass Filter for C Band Applications

Swathy BH (IIITDM Kancheepuram, India); Pallepogu Prasanna Kumar (IIITDM Kancheepuram, India); Prerna Saxena (Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram, India)

Abstract: We propose a novel compact wideband bandpass filter for C band applications. The bandpass filter is designed using half mode substrate integrated waveguide and defected ground structure in the form of periodic circular vias are incorporated into it. RT/Duroid 5880 with a permittivity of 2.2 and thickness of 0.508mm is used as substrate for designing the proposed bandpass filter. Detailed parametric analysis is presented to study the influence of various design parameters on the filter characteristics. The proposed filter exhibits a passband over 5.7-7.3GHz with |S11| < -10dB and $|S21| \sim 0.6dB$. In addition, the filter has a 3dB fractional bandwidth of 23.2% along with a small size of 0.015 lambdag^2. The proposed bandpass filter has higher 3dB bandwidth and a much smaller size as compared to the state-of-the-art designs.

05:50 pm: Design of an Elementary Microstrip Power Splitter for Antenna Array

Chanchala Kumari (BIT MESRA RANCHI, India); Neela Chattoraj (Birla Institute of Technology, Mesra Ranchi, India)

Abstract: A new simple microstrip power divider is presented for an antenna array. In this proposed structure micro strip lines are used in place of conventional waveguide, so that its overall size reduced. In this paper the two-power splitter are presented one is the simple T junction and other one is 1:4 power splitter, both designs simulated in CST studio suit and results for S parameters presented. The designed structure is simulated in frequency range of 7GHz to 13GHz. In this design the return loss found to be less than -15dB and also shows acceptable results for transmission loss in both the power splitters, which is desirable for power splitter.

06:10 pm: A Miniaturized Interdigital Bandpass Filter for Intentional Electromagnetic Interference Applications

Abirami B (IIITDM Kancheepuram, India); Prerna Saxena (Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram, India); Premkumar K. (Indian Institute of Information Technology, Design and Manufacturing Kancheepuram, India)

Abstract: We propose a compact bandpass filter over 0.52-2.07 GHz at the receiver front-end of an intentional electromagnetic interference detection system. We design the filter using five microstrip stubs arranged in interdigital configuration along with a dumbbell shaped defected ground structure. We design the proposed filter on FR4 substrate with a relative permittivity of 4.4 and a thickness of 1.6 mm. We obtain a 3dB fractional bandwidth of 119.96%. The proposed filter exhibits a return loss >12 dB, an insertion loss ~0.922 dB and a flat group delay over the

entire bandwidth. Also, the proposed filter is compact and occupies an area of 3.55 x 1.557 cm2. As compared to the state-of-the-art designs, the proposed bandpass filter is highly miniaturized, easy to fabricate and exhibits good performance.

S4C: Video Processing 2

Session time Wednesday, 05:30 pm until 06:50 pmLocationHall BTalk time20Chaired byProf. Debashis Ghosh

05:30 pm: An Optical Flow Based Approach to Detect Movement Epenthesis in Continuous Fingerspelling of Sign Language

Navneet Nayan (Indian Institute of Technology, Roorkee, India); Pyari Mohan Pradhan (IIT Roorkee, India); Debashis Ghosh (Indian Institute of Technology (IIT) Roorkee, India)

Abstract: In this paper, the movement epenthesis problem in continuous fingerspelling is addressed. Movement epenthesis caused due to unwanted but unavoidable hand movement in between two sign gestures in continuous signing is one of the major problems in automatic sign language recognition. A novel method based on calculating the 2-norm values of the magnitude matrices of optical flow has been proposed in this paper to detect the movement epenthesis containing video frames. We used Horn-Schunck method to compute the optical flow and estimate the speed of hands in the the continuous fingerspelling videos. The 2-norm values of the magnitude matrix of optical flow provides a discriminative feature to distinguish of movement epenthesis frames from sign frames and hence mean of the 2-norm values is used as the threshold value to detect the movement epenthesis frames in a gesture video. We tested our method on continuous fingerspelling videos of Indian sign language. Experimental results show that the performance of our proposed method is 100% accurate in detecting the movement epenthesis frames in continuous fingerspelling.

05:50 pm: A Level Set Model Driven by New Signed Pressure Force Function for Image Segmentation

Soumen Biswas (National Institute of Technology Silchar, India); Ranjay Hazra (Nit Silchar, India); Shitala Prasad (Research Scientist, Singapore); Arvind Sirvee (Rajasthan Technical University, Kota, India)

Abstract: An image segmentation model using histogram-based image fitting (HF) energy is proposed to identify objects with poorly defined boundaries. The proposed energy model considers an improved fitting energy function based on normalized histogram and average intensities of objects inside as well as outside the contour curve. The fitting energy functions are computed before the curve evolution thereby reducing the complexity of intensity inhomogeneity images. Further, a new signed pressure force function is incorporated in the proposed energy model which can increase the efficiency of the curve evolution process at blur edges or at weak

edge regions. The comparative analysis of the proposed energy model produces better segmentation results compared to the other state-of-the-art energy models namely the Li et. al. model, local binary fitting (LBF), and Chen-Vese (C-V) models. The proposed model is also robust to intensity inhomogeneity. In addition, the calculation of the Jaccard Index (JI) proves the robustness of the proposed energy model.

06:10 pm: *Phrase Recognition Using Improved Lip Reading Through Phase-Based Eulerian Video Magnification*

Salam Nandakishor (National Institute of Technology Nagaland, India); Debadatta Pati (National Institute of Technology Nagaland, India)

Abstract: Lip reading is a technique to understand speech by visual observations of the lip movements. While speaking the subtle motion or temporal variations of our mouth are generally invisible by naked humans eyes. It is mainly due to the limited range of visual perception. These imperceptible visual information consist of useful hidden information. The Eulerian video magnification (EVM) technique is used to magnify the video for revealing such hidden information. In this work, the phase based EVM method is used to magnify the subtle spatial and temporal information of the mouth movements for phrases recognition task. The local binary pattern histogram extracted from three orthogonal plane (XY, XT and YT), known as LBP-TOP is used as visual feature to represent mouth movements. The support vector machine (SVM) is used for recognition of phrases. The experiments are performed on OuluVS database. The lip-reading approach without EVM provides 62% accuracy whereas the phase based EVM method provides 70% accuracy. This shows that the proposed method extracts comparatively more robust and discriminative visual features for phrase recognition task.

06:30 pm: Visibility Restoration of Diverse Turbid Underwater Images- Two Step Approach

Mary S Cecilia (Anna University & SSN College of Engineering, India); Sakthivel Murugan Santhanam (SSN College of Engineering, India)

Abstract: Underwater Images are of degraded quality due to the scattering and absorption. The color cast and turbidity that hinder the visibility of such images are due to the sediments present that vary for diverse environments. Shallow water images are very turbid. The images too suffer from negative effects of artificial illumination when capturing data. Here a two-step approach is formulated to restore and enhance the underwater images from different locations. The images are then blended using a wavelet fusion considering the mean of the images. The output images demonstrate reduced haze, improved contrast and enhanced sharpness with adequate removal of the color cast. The results project better visibility on both subjective and objective measures compared to recent restoration and enhancement methods.

Thursday, July 29th, 2021

NCC 2021: 2021 National Conference on Communications (NCC)

S11A: Millimeter Wave Systems

Session time Thursday, 08:20 am until 09:00 amLocationAuditoriumTalk time20Chaired byProf. Swades De

08:20 am: Joint Beamwidth and Number of Concurrent Beams Estimation in Downlink mmWave Communications

Nancy Varshney (IIT Delhi, India); Swades De (Indian Institute of Technology Delhi, India)

Abstract: This paper proposes a sectored-cell framework for mmWave communication. It consists of multiple concurrent beams generated from a partially-connected hybrid precoder at an eNodeB (eNB) to serve a dense user population in urban scenarios. Multiple beams sweep the cell in a round-robin fashion to serve the sectors with fair scheduling opportunities. Each beam serves all the users located within a sector using orthogonal frequency division multiple access. We aim to estimate an optimum beamwidth and an optimum number of beams required to maximize the average of long-run user rates with a given power budget for transmission and hardware consumption at the eNB. Simulation results demonstrate that employing higher beams increases the side-lobe interference still, the achievable average long-run user rate improves on account of longer sector sojourn time and higher frequency reuse. On the other hand, employing a very narrow beam is also not optimal.

08:40 am: A Blind Iterative Hybrid Analog/Digital Beamformer for the Single User mmWave Reception Using a Large Scale Antenna Array

Yash Vasavada (Dhirubhai Ambani Institute of Information and Communication Technology, India); Naitik N Parekh (Dhirubhai Ambani Institute of Information and Communication Technology, India); Aarushi Dhami (Dhirubhai Ambani Institute of Information and Communication Technology, India); Chandra Prakash (Space Applications Centre & ISRO, India)

Abstract: This paper develops a blind single-user beamforming algorithm for partiallyconnected hybrid analog-digital (HAD) antenna arrays operating at millimeter wave (mmWave) frequencies. The proposed scheme is optimal and computationally efficient - it is shown to converge to the optimal eigenvector beamformer without requiring an explicit eigenvector decomposition (EVD) of the received signal's correlation matrix. The Direction of Arrival (DoA) is estimated using the Fast Fourier Transform (FFT) of the digitally-formed beam weight vector and it is used to continually update the analog beams formed by the subarrays of the large array in a tracking mode. The simulation of the proposed scheme shows the bit error probability and DoA estimation performance close to the theoretical limits.

S11B: WSN

Session time Thursday, 08:20 am until 09:00 am Location Hall A Talk time 20 Chaired by Prof. Raja Dutta

08:20 am: Optimal Link Scheduling for Low Latency Data Transfer over Small World WSNs

Om Jee Pandey (University of Saskatchewan, Canada); Naga Srinivasarao Chilamkurthy (University of SRM AP, India); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

Abstract: In recent years, small world characteristics (SWC) received huge attention due to their various advantages in the context of social, electrical, computer, and wireless networks. A wireless sensor network (WSN) exhibiting SWC is known as small world WSN (SW-WSN). Therefore, SW-WSN consists small average path length and large average clustering coefficient. Here, in this paper, a novel optimal link scheduling method is proposed to develop SW-WSN. The proposed method determines, optimal number of new links need to be created in the network. Additionally, the method also finds the optimal node-pairs towards creation of these links. The developed algorithm considers node betweenness centrality measure for the introduction of SWC. SW-WSN obtained using proposed method yields reduced time complexity towards its development. Moreover, it also results in optimal SWC when compared to other existing methods. A reduced data transmission delay is noted over SW-WSN developed using proposed method. Random, near-optimal, and sub-optimal methods of introducing SWC and their time complexities are also investigated and compared to the proposed method. The results are computed over simulated and real WSN testbed. Obtained results demonstrate the significance of proposed method and its utilization over large scale network applications.

08:40 am: Efficient Message Dissemination in V2V Network: A Local Centrality-Based Approach

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

Abstract: Many vehicular applications require data dissemination where all the vehicles in a specific region of concern are the intended receivers of particular messages. Such dissemination is challenging due to vehicular networks' distinct properties, such as high mobility, low communication range, intermittent connectivity, and diverse variations in their topology. In this work, we propose a Local Centrality-based Dissemination scheme for vehicular networks based

on V2V communication. To this end, each vehicle node gathers their two-hop neighborhood information to identify the super-spreader nodes that continue the dissemination by rebroadcasting the receiving messages. In contrast, the rest of the nodes remain quiet. We validate the performance of our proposed scheme with real vehicular data. Extensive simulation results reveal the superior performance of our proposed scheme in terms of higher and quicker coverage with fewer redundant transmissions than the state-of-the-art data dissemination protocols.

S11C: Radar

Session time Thursday, 08:20 am until 09:00 am Location Hall B Talk time 20 Chaired by Prof. Chandramani Singh

08:20 am: Slotted Aloha for FMCW Radar Multiple Access Networks

Haritha K (Indian Institute of Science, India); Vineeth Bala Sukumaran (Indian Institute of Space Science and Technology, Trivandrum, India); Chandramani Singh (Indian Institute of Science, India)

Abstract: We study medium access in FMCW radar networks. In particular, we propose a slotted ALOHA protocol and analyze probability of interference between radars as a function of system parameters such as total number of radars, chirp duration, number of chirps in a repetition interval, as well as medium access probability. We see that the characteristics of interference probability in FMCW radar networks are very different from those in wireless communication networks. We observe that interference probability also depends on the number of chirps in a radar packet. We further propose a notion of throughput and study its variation with various parameters. We perform extensive simulation to verify our analytical results.

08:40 am: Analysis of 5G New Radio Waveform as an Illuminator of Opportunity for Passive Bistatic Radar

Purushottama Lingadevaru (National Institute of Technology Karnataka, India); Pardhasaradhi Bethi (National Institute of Technology - Karnataka, India); Pathipati Srihari, Dr (National Institute of Technology Karnataka, India); G. V. k. Sharma (GITAM University, India)

Abstract: Passive radar detects targets using the reflections of electromagnetic signals illuminated by unintended sources of opportunity in the given surveillance region. The illuminators of opportunity (IOO) like FM, DVB, DAB, LTE, WiMax, and radio frequency signals are used for the passive radar depending on the availability, frequency of operation and, type of application. This paper proposes the upcoming 5G New Radio waveform (5G NR) as an IOO for passive bistatic radar. The 5G NR waveform is used to perform parametric analysis of passive bistatic radar. The radar parameters like range resolution, velocity resolution, range product, maximum unambiguous PRF, and Cassini's ovals are investigated. Further, the 5G NR

IOO is compared against existing LTE and other IOOs. Simulation results reveals that all the radar parameters are outperforming for the 5G NR waveform, claiming that 5G NR is a potential candidate for the future IOO.

S5A: 5G New Radio

Session time Thursday, 02:30 pm until 03:30 pm Location Auditorium Talk time 20 Chaired by Prof. SaiDhiraj Amuru

02:30 pm: Improving the Throughput of a Cellular Network Using Machine Learning - A Case Study of LTE

Prasad Tukaram Gaikwad (IITH, India); SaiDhiraj Amuru (IIT Hyderabad, India); Kiran Kuchi (IIT Hyderabad, India)

Abstract: Long Term Evolution (LTE) focused on providing high data rates at low latency when compared to previous-generation technologies. The recent research and development in machine learning for wireless communication networks focus on making these networks more efficient, intelligent, and optimal. We propose a machine learning algorithm to improve the performance of LTE in a real-time deployments. Specifically, we focus on the case of single-user multipleinput multiple-output transmission mode (TM4 as known in LTE). The channel quality feedback from user to the base stations plays a crucial role to ensure successful communication with low error rate in this transmission mode. The feedback from the user includes precoding matrix indicator (PMI), rank indicator apart from the channel quality feedback. However, in practical systems, as the base station must support several users, there is a delay expected from the time a user sends feedback until the time it is scheduled. This time lag can cause significant performance degradation depending on the channel conditions and also in cases when the user is mobile. Hence, to eliminate this adverse impact, we present a machine learning model that predict future channels and the feedback from the user is calculated based on these predictions. Via several numerical simulations, we show the effectiveness of the proposed algorithms under a variety of scenarios. Without loss of generality, the same work can be applied in the context of 5G NR. LTE is used only as a case study due to its vast prevalence and deployments even as of today.

02:50 pm: Enhanced Transport Block Processing for 5G NR PUSCH Coverage Enhancement

Koteswara Rao G (Indian Institute of Technology Hyderabad, India); Subhash Kumawat (Indian Institute of Technology Hyderabad, India); SaiDhiraj Amuru (IIT Hyderabad, India); Kiran Kuchi (IIT Hyderabad, India)

Abstract: In 5G-New Radio (5G-NR), the available transmission power at the user is limited, and thus, the uplink transmissions define the coverage of 5G-NR systems. In this paper, we

propose various solutions to enhance the uplink coverage of 5G-NR. Each payload of the user in 5G-NR is appended with a cyclic redundancy check (CRC) before channel encoding and transmission. We identify that the overhead with the CRC attached payload is as high as 40% in the cell-edge transmissions. To address this issue, we propose a mechanism to transmit the data over multiple slots with a single CRC attached to the payload. This method significantly reduces the CRC overhead and improves the cell-coverage. Through link-level evaluations, we show that this proposed method achieves 450 meters improvement in the cell-coverage for the VoIP scenario. Further, we identify the under-utilization of resources in the special slots. To reduce the reference signal overhead in the special slot transmissions, we have proposed allocating the resources by jointly considering the available symbols in special and uplink slots. Through link-level evaluations, we show that this proposed scheme achieves an improvement of close to 2 dB in the link performance and 400 meters improvement in the cell-coverage of the eMBB scenario.

03:10 pm: Downlink Resource Allocation for 5G-NR Massive MIMO Systems

Pavan Reddy M (Indian Institute of Technology Hyderabad, India); Mounika Reddy (IIT Hyderabad, India); Abhinav Kumar (Indian Institute of Technology Hyderabad, India); Kiran Kuchi (IIT Hyderabad, India)

Abstract: The gNodeB (gNB) in 5G-New Radio (5G-NR) is capable of beamforming and spatial multiplexing the users to achieve a multi-fold increase in the network capacity. With multiple active beams and the possibility of varying payload sizes, the resource allocation algorithm should optimally utilize the resources in time, frequency, and space. Otherwise, the multi-fold increase expected from the massive number of antennae will not be realized in practice. Further, in the 5G-NR downlink, each payload transmitted in the shared channel has an associated payload in the control channel. Thus, to have optimal resource utilization, the gNB should simultaneously consider the control and the shared channel payloads while allocating resources. Unlike the 4G-Long Term Evolution (4G-LTE), both control channel and shared channel support beamforming in 5G-NR. Hence, when the gNB uses the existing 4G-LTE algorithms for 5G-NR, they do not achieve the optimal resource allocation. Motivated by this, we propose a joint control and shared channel allocation for 5G-NR downlink that maximizes the sum-throughput while ensuring fairness in the allocation. We formulate this proposed resource allocation as an integer linear program. We also present low-complexity sub-optimal and approximation algorithms due to their practical usefulness. We then evaluate the proposed algorithms using system-level simulations and show that they significantly outperform the baseline algorithm.

S5B: Networking

Session time Thursday, 02:30 pm until 03:50 pm

Location Hall A

Talk time 20

Chaired by Dr. Hemant Kumar Rath

02:30 pm: *Multi-Source TCP (MSTCP): A Transport Protocol for Distributed Content Delivery*

Lalhruaizela Chhangte (IITB-Monash Research Academy, India); Pramey Singh (IIT Bombay, India); D. Manjunath (IIT Bombay, India); Nikhil Karamchandani (Indian Institute of Technology Bombay, India)

Abstract: Fetching different parts of the same content (file) simultaneously through multiple network paths has been found to improve content delivery. There are several application layer programs that use this technique to improve the perceived performance at the end users. However, these applications use multiple sockets (multiple connections) at the transport layer, which has several disadvantages. Also, the existing transport layer protocols that allow content delivery over multiple network paths over a single transport layer connection (e.g., MPTCP) are limited to content delivery from a single source. With the availability of content across distributed content servers, there is a need for a transport layer protocol that provides the ability to deliver content from these distributed sources over a single transport layer connection. In this paper, we design and implement a multi-source transport control protocol (MSTCP) that can be used to deliver content from a distributed source to a client application over a single transport layer connection. A prototype implementation and preliminary performance measures showing the effectiveness of MSTCP are also presented.

02:50 pm: On Traffic Classification in Enterprise Wireless Networks

Sipra Behera (Tata Consultancy Services, India); Bighnaraj Panigrahi (Tata Consultancy Services, India); Hemant Kumar Rath (Tata Consultancy Services, India); Jyotirmoy Karjee (Samsung, Bangalore, India)

Abstract: Enterprises today are quickly adopting intelligent, adaptive and flexible wireless communication technologies in order to become compliant with Industry 4.0. One of the technological challenges related to this is to provide Quality of Services (QoS)-enabled network connectivity to the applications. Diverse QoS demands from the applications intimidate the underlying wireless networks to be agile and adaptive. Since the applications are diverse in nature, there must be a mechanism to learn the application types in near real-time so that the network can be provisioned accordingly. In this paper, we propose a Machine Learning (ML) based methods to classify the application traffic. Our method is different from the existing port based and Deep Packet Inspection (DPI) based methods and uses statistical features of the network traffic related to the applications. We validate the performance of the proposed model in a lab based SDNized WiFi set-up. SDNization ensures that the proposed model can be deployed in practice.

03:10 pm: A Light-Weight Delay Tolerant Networking Framework for Resource-Constrained Environments

Ajay Salas (Indian Institute of Space Science and Technology, India); Sarath Babu (Indian Institute of Space Science and Technology (IIST), India); Manoj Bs (Indian Institute of Space Science and Technology, India)

Abstract: Next generation communication infrastructures are characterized by customized network environments deployed for meeting the application or user specific needs as well as for

achieving the required Quality-of-Service (QoS). The surge of mobile devices and their applications form a major bottleneck in realizing the QoS due to the resource constraints in mobile devices and the uncertain mobility pattern of users. Delay/Disruption Tolerant Networking (DTN) approaches are employed to cope with the issues in dynamic wireless environments such as intermittent connectivity, high error rate and packet loss, and network heterogeneity. However, the overhead required in terms of protocol, memory, and computational power in traditional DTN approaches may not be suitable for energy-constrained mobile devices. Therefore, we propose a Light-Weight DTN (LWDTN) framework for resource-constrained delay/disruption-prone wireless environments. We follow the traditional custody-transfer approach in designing the LWDTN framework with three types of bundles involving minimal header fields. The experimental results from a DTN testbed show the efficacy of LWDTN in delivering around 80% packets within the feasible time.

03:30 pm: Differential Scale Based Multi-Objective Task Scheduling and Computational Offloading in Fog Networks

Mohit Kumar Saxena (Indian Institute of Technology, Patna, India); Sudhir Kumar (Indian Institute of Technology Patna, India)

Abstract: Cloud computing suffers from various challenging issues in Internet of Things (IoT) networks like real-time response, energy-efficient execution, and cost of computation. Fog is an emerging distributed computing paradigm which is useful for delay-sensitive tasks in IoT network. An offloading strategy decides where to offload the task and a task scheduling strategy chooses an appropriate fog node based on the requirements of the task while meeting the quality of services (QoS) criteria. Although the computational offloading and task scheduling problem has been widely studied, there is very limited research on delay-energy tradeoff. We propose a fog network that follows an M/M/c queue for computational offloading and a differential scalebased Best Worst Method (BWM) for computation of optimal weights in multi-objective task scheduling. The optimization problem minimizes the execution delay while meeting QoS criteria. The numerical experiments show the efficacy for the different QoS criteria.

S5C: Image Processing

Session timeThursday, 02:30 pm until 03:10 pmLocationHall BTalk time20Chaired byProf. Vinod Pankajakshan

02:30 pm: Automated Macular Disease Detection Using Retinal Optical Coherence Tomography Images by Fusion of Deep Learning Networks

Latha V (College of Engineering, Trivandrum, India); Ashok R (College of Engineering, Trivandrum, India); Sreeni K G (College of Engineering, Thiruvananthapuram, INDIA, India)

Abstract: This work proposes a method to improve the automated classification and detection of macular diseases using retinal Optical Coherence Tomography (OCT) images by utilizing the fusion of two pre trained deep learning networks. The concatenation of feature vectors extracted from each of the pre trained deep learning model is performed to obtain a long feature vector of the fused network. The experimental results proved that the fusion of two Deep Convolution Neural Network (DCNN) achieves better classification accuracy compared to the individual DCNN models on the same dataset. The automated retinal OCT image classification can assist the large-scale screening and the diagnosis recommendation for an ophthalmologist.

02:50 pm: Selective Variance Based Kinship Verification in Parent's Childhood and Their Children

Madhu Oruganti (National Institute of Technology RAIPUR, India); Toshanlal Meenpal (NIT Raipur, India); Saikat Majumder (National Institute of Technology Raipur, India)

Abstract: Based on two facial image appearances estimating their kinship is the main aim of the kinship verification. Since a decade of time this problem is attempted by many sophisticated algorithms but still many challenging dimensions are unsolved. Among these, age progression-based kinship verification is one of the obscure parts. The similarities in facial features between parent and their children will be numerous in their childhood. As age progress, child facial features are varied and dispersed from parent facial features. It becomes a challenging task to estimate their kinship. So, a new dimensional database with parent in childhood and their child images is collected. This paper proposes and trains a metric to ensure that the model can predict whether the given pair images are kin or non-kin. In training module, differences of Histogram of Gradient (HoG) features for all combinations of pairs are computed and each pair absolute differences are calculated. Further, selective minimum variances are used to assess the kin similarity features. A global threshold is computed to classify kins and non-kins. After this comprehensive training, testing is also done in a similar way. The computed global threshold in training module is effectively used to estimate kinship verification in testing module. Experimental results are presented and out performed with an accuracy of 82%.

S6A: 5G Communications

Session time Thursday, 04:00 pm until 05:20 pmLocationAuditoriumTalk time20Chaired byProf. Meenakshi Rawat

04:00 pm: *Enhanced Precoding Aided Generalized Spatial Modulation for Massive MIMO Systems*

Kunnathully Sadanandan Sanila (IIT Goa, India); Neelakandan R (IIT Goa, India)

Abstract: Receive spatial modulation (RSM) is one of the most promising paradigms that significantly reduces the receiver's computational complexity. However, to assure the linear
precoding operation at the transmitter side, RSM systems have to be under-determined. We propose a transmission scheme that divides antennas at the transmitter into G t transmit antenna groups (TAGs) and antennas at the receiver into G r receive antenna groups (RAGs) for exploiting the SM concept at the transceiver ends. Additionally, we extend the notion of generalized spatial modulation (GSM) to a new precoding-aided massive multiple-input multiple-output (mMIMO) system and formulate the structure, particularly in an activated antenna group at the transmitter and receiver. We refer to it as an enhanced receive GSM (ERGSM) system. The antenna grouping makes the proposed GRSM based scheme suitable for both the under-determined and over-determined massive MIMO architectures according to the distribution of the number of TAGs and RAGs and thus increases the resilience of the system. We project a low complexity sub-optimal detection algorithm for the proposed scheme. Further, we computed the complex calculations required for the system and compared them to the other conventional techniques. Also, we present numerical results to substantiate our ideas.

04:20 pm: K-Preferential Slotted ALOHA for Ultra Reliable Low Latency Communications

Satyam Agarwal (Indian Institute of Technology Ropar, India); Shubham Pandey (Indian Institute of Technology Ropar, India)

Abstract: Ultra-reliable low-latency communication (URLLC), one of the key component of 5G, provides a set of features required to support mission-critical applications. Slotted ALOHA is one of the most popular mechanism to share a channel among multiple users. However, slotted ALOHA cannot meet high reliability requirements of URLLC when large number of users are present in the network. In this paper, we propose a preferential medium access control scheme to match the high reliability requirement of URLLC. It is ensured by dedicating every K-th slot exclusively for URLLC transmission. We analytically obtain the packet delay distribution and reliability of both the URLLC and regular packets. An optimization problem is framed to maximize the reliability of regular packets subject to meeting the URLLC reliability constraints. Extensive simulations indicate that our proposed K-preferential S-ALOHA protocol can meet the URLLC requirements even when the network traffic is high.

04:40 pm: Uplink Channel Impulse Response Based Secondary Carrier Prediction

Prayag Gowgi (Ericsson Research, India); Vijaya Parampalli Yajnanarayana (Ericsson Research, India)

Abstract: A typical handover problem requires sequence of complex signaling between a UE, the serving, and target base station. In many handover problems the down link based measurements are transferred from a user equipment to a serving base station and the decision on handover is made on these measurements. These measurements together with the signaling between the user equipment and the serving base station is computationally expensive and can potentially drain user equipment battery. Coupled with this, the future networks are densely deployed with multiple frequency layers, rendering current handover mechanisms sub-optimal, necessitating newer methods that can improve energy efficiency. In this study, we will

investigate a ML based approach towards secondary carrier prediction for inter-frequency handover using the up-link reference signals.

05:00 pm: *Phase Calibration of Multiple Software Defined Radio Transmitters for Beamforming in 5G Communication*

Dusari Nageswara Rao (Indian Institute of Technology, Roorkee, India); Meenakshi Rawat (IIT Roorkee, India)

Abstract: Beamforming is the key technique used in 5G communication systems for transmitting/receiving signals only in a particular direction. An accurate phase is needed to apply to the beamforming antenna array to steer the beam in a particular direction. Generally, multiple software-defined radios (SDR) are used for flexible beamforming. Whereas these multiple SDRs contain phase differences in transmitting paths due to nonlinearities in their components and the use of an individual clock and local oscillators (LO). Therefore, this paper presents the methodology to calibrate the phase differences in different transmitting paths of SDR before applying signals to the antenna elements for beamforming. This paper presents the methodology to estimate the phase offset using the cross-covariance method. A method is presented to synchronize multiple SDRs accurately. As a proof of concept, the SDR setup is built with the analog transceiver AD9371 from Analog Devices and ZC706 FPGA board from Xilinx. The measurement results with phase compensation after synchronization achieves an NMSE of around -35 dB between the signals of different transmitter paths. A 1×4 antenna array operating at 2.4 GHz has been designed in simulation, and the main beam is achieved in the desired direction after phase compensation.

S6B: Antenna Design

Session time Thursday, 04:00 pm until 05:20 pm Location Hall A Talk time 20 Chaired by Prof. Amalendu Patnaik

04:00 pm: Design of a Compact TM01-TE11 Mode Converter Using Periodic Iris Loading

Ashish Chittora (BITS-Pilani, K. K. Birla Goa Campus, India)

Abstract: A compact TM01-TE11 mode converter design is presented in this paper. The design consists of a periodic iris loaded semicircular waveguide section and exhibits maximum conversion efficiency of 99% at 3.5 GHz. Simulated and measured results are presented for comparison and the results are in good agreement with each other. The proposed converter has a symmetric, light-weight structure and very compact design $(0.37*\lambda)$ relative to earlier reported designs. The design has narrowband response and can handle up to 0.3 GW high power signal. The design is most suitable for moving platform and airborne high power microwave systems in defense applications.

04:20 pm: Compact and Wideband Circularly Polarized Quadrature Rectangular Dielectric Resonator Antenna

Abhijeet Gaonkar (NIT Goa, India); Pragati Patel (NIT Goa, India)

Abstract: Compact and wideband Circularly Polarized (CP) Quadrature Rectangular Dielectric Resonator Antenna (QRDRA) is designed and proposed using coaxial feed. The square shaped slots filled with air epsilon r = 1 are introduced to obtain wide impedance bandwidth by reducing effective dielectric constant. The Edge grounding technique is used to miniaturize RDRA to the size $0.2 \lambda c \times 0.2 \lambda c \times 0.2 \lambda c$ at frequency of 5.3 GHz. CP fields are obtained by optimizing feed location at an offset along x and y axis to excite T Ex 111 and T Ey 111 orthogonal modes. The Proposed CP Q-RDRA provides wider 3-dB axial ratio bandwidth (ARBW) ARBW \leq 3dB of 42% (4.5-6.8 GHz), impedance bandwidth S11 \leq -10dB of 72% (3.5-7.3 GHz) respectively. The proposed structure offers LHCP gain of more than 6 dB and radiation efficiency of more than 95% in the complete frequency range of operation. Proposed CP antenna is applicable for C-band, Wi-MAX, WLAN applications

04:40 pm: A Compact Reconfigurable Slot-Loaded Printed Antenna for Future Wireless Applications

Divyanshu Bhardwaj (Indian Institute of Information Technology Guwahati, India); Anamiya Bhattacharya (Indian Space Research Organization, India); Bidisha DasGupta (Indian Institute of Information Technology, India)

Abstract: In this article, one new frequency reconfigurable antenna is presented. The antenna geometry comprises an annular ring shaped slot loaded rectangular patch antenna and two p-i-n diode switches. The antenna operates over 2.4 -8.4 GHz (S band, C band, and partially in X band). The frequency hopping over the mentioned bandwidth is possible by changing switching p-i-n diode states. The proposed antenna can be used for future wireless applications such as an electromagnetic sensor for 5G and also for Cognitive Radio applications.

05:00 pm: An H-Plane Multi-Horn Antenna Using Substrate Integrated Waveguide Technique

Anil Nayak, Mr (IIT Roorkee, India); Vinit Yadav (IIT Roorkee, India); Amalendu Patnaik (IIT Roorkee, India)

Abstract: In this paper, a new H-plane multi-horn antenna is designed for small nonmetallic unmanned aerial vehicle (UAV) application. Four H-plane horn antennas are integrated into a single square substrate using the substrate integrated waveguide (SIW) concept. In fact, they are placed concentrically and directed at the four edges of the substrate. In order to control the resonant frequency at 5.8 GHz and to obtain proper matching, the co-axial connector is placed the center of the structure. The antenna provides the quasi-omnidirectional radiation instead of the directional radiation pattern at the H-plane. The laboratory prototype of the structure is measured to validate the theoretical results. This antenna is suitable for UAV applications.

S6C: Biomedical Image Processing

Session time Thursday, 04:00 pm until 05:20 pm Location Hall B Talk time 20 Chaired by Prof. Samarendra Dandapat

04:00 pm: Transfer Learning-Based Automatic Detection of Acute Lymphocytic Leukemia

Pradeep Kumar Das (National Institute of Technology Rourkela, India); Sukadev Meher (National Institute of Technology, Rourkela, India)

Abstract: In healthcare, microscopic analysis of blood-cells is considered significant in diagnosing acute lymphocytic leukemia (ALL). Manual microscopic analysis is an error-prone and time-taking process. Hence, there is a need for automatic leukemia diagnosis. Transfer learning is becoming an emerging medical image processing technique because of its superior performance in small databases, unlike traditional deep learning techniques. In this paper, we have suggested a new transfer-learning-based automatic ALL detection method. A light-weight, highly computationally efficient SqueezNet is applied to classify malignant and benign with promising classification performance. Channel shuffling and pointwise-group convolution boost its performance and make it faster. The proposed method is validated on the standard ALLIDB1 and ALLIDB2 databases. The experimental results show that in most cases, the proposed ALL detection model outperforms Xception, NasNetMobile, VGG19, and ResNet50 with promising quantitative performance.

04:20 pm: Optimized Bio-Inspired Spiking Neural Models Based Anatomical and Functional Neurological Image Fusion in NSST Domain

Manisha Das (Visvesvaraya National Institute of Technology, Nagpur, India); 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)

Abstract: Fusion of complimentary anatomical and functional information present in multimodal medical images provides improved visualization of various bodily structures and assists radiologist to infer more factual diagnostic interpretations. Inspired by the neuronal assemblies of mammal's visual cortex, spiking neural models such as dual- channel pulse coupled neural network (DCPCNN) and coupled neural P (CNP) system efficiently extract and integrate complimentary information present in the source images. But, these models have various free parameters which are set using hit and trial approach in most of the conventional fusion methods. This paper presents an optimized multi-modal medical image fusion method in non-subsampled sheartlet transform (NSST) domain wherein the free parameters of both DPCNN and CNP system are optimized using multiobjective grey wolf optimization (MOGWO). Extensive experiments are performed on various anatomical-functional images. Subjective and objective result analysis indicate that the proposed method effectively fuse important diagnostic information of the source images and also outperforms other state of the art fusion methods.

04:40 pm: Biomedical Image Retrieval Using Muti-Scale Local Bit-Plane Arbitrary Shaped Patterns

Deepamoni Mahanta (Tezpur University, India); Deepika Hazarika (Tezpur University, India); Vijay Kumar Nath (Tezpur University, India)

Abstract: A biomedical image retrieval technique using novel multi-scale pattern based feature is proposed. The introduced technique, in each scale, employs arbitrary shaped sampling structures in addition to a classical circular sampling structure in local bit-planes for effective texture description, and named as the multi-scale local bit-plane arbitrary-shaped pattern (MS-LBASP). The proposed feature descriptor first downsamples the input image into three different scales. Then the bit planes of each downsampled image are extracted and the corresponding bit-planes are locally encoded, characterizing the local spatial arbitrary and circular shaped structures of texture. The quantization and mean based fusion is utilized to reduce the features. Finally, the relationship between the center-pixel and the fused local bit-plane transformed values are encoded using both sign and magnitude information for better feature description. The experiments were conducted to test the performance of MS-LBASP. Two benchmark computer tomography (CT) image datasets and one magnetic resonance imaging (MRI) image dataset were used in the experiments. Results demonstrate that the MS-LBASP outperforms the existing relevant state of the art image descriptors.

05:00 pm: Detection of Myocardial Infarction from 12 Lead ECG Images

Ravi Kumar Sanjay Sane (Indian Institute of Technology Guwahati, India); Pharvesh Salman Choudhary (IIT Guwahati, India); L N Sharma (IIT Guwahati, India); Samarendra Dandapat (Indian Institute of Technology Guwahati, India)

Abstract: Electrocardiogram(ECG) is one of the most frequently used modality by cardiologists across the globe to detect any heart function abnormalities. In hospitals, ECG results are printed on paper by the ECG machines, which then is analysed by an expert. This work proposes a onedimensional convolutional neural network(CNN) framework for automated myocardial infarction (MI) detection from multi-lead ECG signals extracted from ECG images. The model is developed using PTB diagnostic database consisting of 148 ECGs of (MI) cases. The results verify the efficacy of the proposed method with accuracy, sensitivity and precision of 86.21%, 89.19%, and 91.30%, respectively. The work is also compared with other state-of-the-art approaches for MI detection using ECG images.

Friday, July 30th, 2021

NCC 2021: 2021 National Conference on Communications (NCC)

S8A: Channel Capacity and Fixed Point Analysis

Session time Friday, 09:00 am until 10:20 amLocationHall ATalk time20Chaired byProf. Krishna Jagannathan

09:00 am: Numerically Computable Lower Bounds on the Capacity of the $..(1,\infty)$..-RLL Input-Constrained Binary Erasure Channel

V. Arvind Rameshwar (Indian Institute of Science, Bengaluru, India); Navin Kashyap (Indian Institute of Science, India)

Abstract: The paper considers the binary erasure channel (BEC) with the inputs to the channel obeying the ..(1,\infty)..-runlength limited (RLL) constraint, which forbids input sequences with consecutive ones. We derive a lower bound on the capacity of the channel, by considering the mutual information rate between the inputs and the outputs when the input distribution is first-order Markov. Further, we present a numerical algorithm for numerically computing the lower bound derived. The algorithm is based on ideas from stochastic approximation theory, and falls under the category of two-timescale stochastic approximation algorithms. We provide numerical evaluations of the lower bound, and characterize the input distribution that achieves the bound. We observe that our numerical results align with those obtained using the sampling-based scheme of Arnold et al. (2006). Furthermore, we note that our lower bound expression recovers the series expansion type lower bound discussed in Corollary 5 of Li and Han (2018). We also derive an alternative single-parameter optimization problem as a lower bound on the capacity, and demonstrate that this new bound is better than the linear lower bound shown in Li and Han (2018) and Rameshwar and Kashyap (2020), for ..\epsilon > 0.77.., where ..\epsilon.. is the erasure probability of the channel.

09:20 am: Commitment over Compound Binary Symmetric Channels

Anuj Kumar Yadav (Indian Institute of Technology Patna, India); Manideep Mamindlapally (Indian Institute of Technology Kharagpur, India); Amitalok J. Budkuley (Indian Institute of Technology Kharagpur, India); Manoj Mishra (National Institute of Science Education and Research, Bhubaneswar, Homi Bhabha National Institute, India)

Abstract: In the commitment problem, two mutually distrustful parties Alice and Bob interact in a two-phase protocol, viz., commit and reveal phase, to achieve commitment over a bit string that Alice possesses. The protocol successfully achieves commitment if, firstly, Alice can

commit to sharing a string with Bob, with the guarantee that this string remains hidden from Bob until she chooses to reveal it to him. Secondly, when Alice does reveal a string, Bob is able to detect precisely whether the revealed string is different from the one Alice committed to sharing. Information-theoretically secure commitment is impossible if Alice and Bob communicate only noiselessly; however, communication using a noisy channel can be a resource to realize commitment. Even though a noisy channel may be available, it is possible that the corresponding channel law is imprecisely known or poorly characterized. We define and study a compoundbinary symmetric channel (compound-BSC) which models such a scenario. A compound-BSC is a BSC whose transition probability is fixed but unknown to either party; the set of potential values which this transition probability can take, though, is known to both parties a priori. In this work, we completely characterize the maximum commitment throughput or commitment capacity of a compound-BSC. We provide an optimal, computationally-efficient scheme for our achievability, and we derive a converse for general alphabet compound DMCs, which is then specialized for compound-BSCs.

09:40 am: Capacity of Photonic Erasure Channels with Detector Dead Times

Jaswanthi Mandalapu (Indian Institute of Technology, Madras, India); Krishna P Jagannathan (Indian Institute of Technology Madras, India)

Abstract: We consider a photonic communication system wherein the photon detector suffers a random 'dead time' following each successful photon detection. If subsequent photon arrivals occur during the dead time, the information contained in the photons is assumed to be erased. We refer to such channels as photonic erasure channels and derive fundamental limits on the rate at which classical information can be transmitted on such channels. We assume photon arrivals according to a Poisson process, and consider two classes of detectors - paralyzable and nonparalyzable. We derive explicit expressions for the capacity of photonic erasure channels, for any general distribution of the dead times of the detector. For a photonic erasure channel with a nonparalyzable detector, we show that the capacity depends only on the expected dead time. On the other hand, with a paralyzable detector, the channel capacity depends on the dead time distribution through its Laplace transform.

10:00 am: The Four Levels of Fixed-Points in Mean-Field Models

Sarath Yasodharan (Indian Institute of Science, India); Rajesh Sundaresan (Indian Institute of Science, India)

Abstract: The fixed-point analysis refers to the study of fixed-points that arise in the context of complex systems with many interacting entities. In this expository paper, we describe four levels of fixed-points in mean-field interacting particle systems. These four levels are (i) the macroscopic observables of the system, (ii) the probability distribution over states of a particle at equilibrium, (iii) the time evolution of the probability distribution over states of a particle, and (iv) the probability distribution over trajectories. We then discuss relationships among the fixed-points at these four levels. Finally, we describe some issues that arise in the fixed-point analysis when the system possesses multiple fixed-points at the level of distribution over states, and how one goes beyond the fixed-point analysis to tackle such issues.

S8C: Audio Processing

Session time Friday, 09:00 am until 10:20 amLocation Hall BTalk time 20Chaired by Prof. Vipul Arora

09:00 am: Binaural Reproduction of HOA Signal Using Sparse Multiple Measurement Vector Projections

Gyanajyoti Routray (Indian Institute of Technology Kanpur, India); Priyadarshini Dwivedi (Indian Institute of Technology, Kanpur, India); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

Abstract: Higher order Ambisonics (HOA) is one of the most promising technology in the reproduction of spatial audio in terms of spatial resolution. However binaural reproduction of spatial audio is ubiquitously used in several popular applications like AR. A novel method for binaural reproduction of HOA signals using sparse plane wave expansion is proposed in this paper. Unlike the parametric methods, the proposed method does not require prior information about the number of the discrete sources. The plane wave expansion of the encoded signals is obtained in the spherical harmonics domain using the multiple measurement vector projections, while upscaling of the input encoded signal is done to preserve the spatial resolution. Head-related transfer function (HRTF) cues are subsequently used to develop the binaural decoder. Unlike the virtual loudspeakers based approach it provides more accuracy in terms of spatial resolution as it removes the diffuse component. The efficacy of this method is illustrated using objective and subjective evaluations.

09:20 am: Robustness and Accuracy of Time Delay Estimation in a Live Room

Yegnanarayana B. (International Institute of Information Technology, Hyderabad, India); HVS Narayana Murthy B (Research Center Imarat, India); J v Satyanarayana (DRDO INDIA, India); Vishala Pannala (International Institute of Information Technology (IIIT), Hyderabad, India); Nivedita Chennupati (International Institute of Information Technology Hyderabad, India)

Abstract: Estimation of time delay from the received broadband signals like speech, collected at two or more spatially distributed microphones, has many applications. Methods like the cross-correlation of the signals directly and generalized cross-correlation based methods (GCC and GCC-PHAT) have been used for several years to estimate the time delay. Performance of these methods degrades due to noise, multi-path reflections, and reverberation in a practical environment, like a live room. The estimated time delay is usually robust due to the averaging effect of the delay obtained over several frames in an utterance of a few seconds. The robustness is affected if the varying time delay of a moving speaker is desired. A smaller duration for averaging results in errors in the estimation of the time delay, and a longer duration for averaging results in loss of accuracy. Since the single frequency filtering (SFF) based analysis provides an estimation of the instantaneous time delay, it is possible to study the trade off between accuracy

and robustness. This paper examines this trade-off in determining the number of stationary speakers from mixed signals and in tracking a speaker moving along a straight line path and along a circular path. The results are illustrated for actual data collected in a live room.

09:40 am: Learning Based Method for Robust DOA Estimation Using Co-Prime Circular Conformal Microphone Array

Raj Prakash Gohil (Indian Institute of Technology, Kanpur, India); Gyanajyoti Routray (Indian Institute of Technology Kanpur, India); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

Abstract: Sound source localization in 1-Dimensional(1D) and2-Dimensional(2D) is one of the most familiar problems in signal processing. Various types of microphone arrays and their geometry have been explored to find an optimal solution to this problem. The problem becomes more challenging for a reverberate and noisy environment. Localization of the source both in the azimuth and elevation increases the complexity further. In this paper, a convolutional neural network(CNN) based learning approach has been proposed to estimate the primary source in 2D space. Further, a noble co-prime circular conformal microphone (C3M)geometry has been developed for sound acquisition. The generalized cross-correlation with phase transform (GCC-PHAT)features have been extracted from the C3M recordings, which are the input features for training purposes. The experimental results show that the learning-based estimation is more robust compared to the conventional signal processing approach. The learning-based approach also explores the GCC-PHAT features and can be adapted in an adverse acoustic environment. The performance of the proposed algorithm shows significant improvement in the root mean squared error(RMSE) and mean absolute error(MAE)scores compared to the available state-of-art methods.

10:00 am: Frequency-Anchored Deep Networks for Polyphonic Melody Extraction

Aman Kumar Sharma (IIT Kanpur & Cisco Systems, India); Kavya Ranjan Saxena (IIT, Kanpur, India); Vipul Arora (Indian Institute of Technology, Kanpur, India)

Abstract: Extraction of the predominant melodic line from polyphonic audio containing more than one source playing simultaneously is a challenging task in the field of music information retrieval. The proposed method aims at providing finer F0s, and not coarse notes while using deep classifiers. Frequency-anchored input features extracted from constant Q-transform allow the signatures of melody to be independent of F0. The proposed scheme also takes care of the data imbalance problem across classes, as it uses only two or three output classes as opposed to a large number of notes. Experimental evaluation shows the proposed method outperforms a state-of-the-art deep learning-based melody estimation method.

S9A: Energy Harvesting

Session time Friday, 10:30 am until 11:30 am Location Hall A Talk time20Chaired byProf. Shankar Prakriya

10:30 am: Maximizing the Throughput of an Energy Harvesting Transmitter in the Presence of a Jammer with Fixed Energy

Haseen Rahman (Indian Institute of Technology Bombay, India)

Abstract: Maximizing the data throughput of point-to-point transmitting nodes which harvest exogenous energy is a widely considered problem in literature. In this work, we consider an additive white Gaussian noise channel in the presence of a jamming adversary. The legitimate transmitter is an energy harvesting (EH) node which attempts to maximize the amount of data conveyed before a specified deadline. The jamming node, on the other hand, tries to minimize the transmitter's data throughput by introducing targeted noise. We assume that the jammer has some fixed amount of energy for interfering. When both the nodes know the EH process in advance, known as the offline setting, we compute the actions of each node at the min-max equilibrium. In the online setting, where the energy arrivals are known in a causal manner, we first consider the case without jamming and show that a simple conservative algorithm can achieve at least a quarter of the optimal offline throughput. We then show that the algorithm has the same competitiveness in the presence of an offline jammer as well.

10:50 am: Relay-Aided Bidirectional Communications Between Devices in a Hybrid User Scenario for IoT

Shivam Gujral (Indian Institute of Technology Mandi, India)

Abstract: This paper explores a relay aided bidirectional communications scenario between two users embedded with two different technologies. One of these two energy constrained users is a backscatter device and the other is an energy harvesting (EH) device. The relay node controls the communication process between the two users in such a way that it facilitates in both energy and information cooperation and therefore, acts as a global controller for the model under consideration. Under this setting, we aim to maximize the weighted sum-throughput over a joint set of constraints in the time allocation parameter and the energy and information beamforming vectors. Henceforth, we present an optimal solution for the special case of our problem such that the relay node is equipped with a single antenna. In addition to this, we also present a sub-optimal solution to the generalized case for the multi-antenna relay node. Finally, the numerical simulations demonstrate the evaluation of our system's performance when we vary one of the key parameters of our simulation setting.

11:10 am: On Performance of Battery-Assisted SWIPT with Incremental Relaying and Nonlinear Energy Harvesting

Kamal Agrawal (Indian Institute of Technology Delhi, India); Anand Jee (Indian Institute of Technology, Delhi, India); Shankar Prakriya (Indian Institute of Technology, Delhi, India)

Abstract: This paper investigates the performance of incremental relaying (IR) in a two-hop network with a battery-assisted EH relay. Assuming nonlinear energy harvesting (EH) and timeswitching protocol at relay, expressions are derived for outage probability and throughput in closed-form to show that augmenting the harvested energy by a small amount of battery energy significantly enhances the throughput. We demonstrate that unlike linear EH, nonlinear EH causes loss of diversity, making use of the direct link very important. Further, using the asymptotic expression for the outage probability, we establish concavity of throughput with respect to EH parameter and demonstrate that a judicious choice of the TS parameter is essential in order to maximize the throughput when fixed battery energy is available per signalling interval. Judicious choice of target rate is important to minimize battery energy consumption at the relay. Monte Carlo simulations confirm accuracy of the derived expressions.

S9C: Machine Learning

Session time Friday, 10:30 am until 11:50 am Location Hall B Talk time 20 Chaired by Prof. Soumya Jana

10:30 am: Attention-Based Phonetic Convolutional Recurrent Neural Networks for Language Identification

Ramesh Gundluru (Indian Institute of Technology, Hyderabad, India); Vayyavuru Venkatesh (Indian Institute of Technology Hyderabad, India); Kodukula Sri Rama Murty (Indian Institute of Technology, Hyderabad, India)

Abstract: Language identification is the task of identifying the language of the spoken utterance. Deep neural models such as LSTM-RNN with attention mechanism shown great potential in language identification. The language cues like phonemes and their co-occurrences are an important component while distinguishing the languages. The acoustic feature-based systems do not utilize phonetic information. So the phonetic feature-based LSTM-RNN models have shown improvement over the raw-acoustic features. These methods require a large amount of transcribed speech data to train the phoneme discriminator. Obtaining transcribed speech data for low resource Indian languages is a difficult task. To alleviate this issue, we investigate the usage of pre-trained rich resource phonetic discriminators for low resource target languages to extract the phonetic features. We then trained an attention CRNN based end-to-end utterance level language identification (LID) system with these discriminator with sequence discriminate objective lattice-free maximum mutual information (LF-MMI). We achieved overall 20% absolute improvements over the baseline acoustic features CRNN model. We also investigate the significance of the duration in LID.

10:50 am: Spatio-Temporal Prediction of Roadside PM2.5 Based on Sparse Mobile Sensing and Traffic Information

Anand Kakarla (Indian Institute Of Technology Hyderabad, India); Venkata Satish Kumar Reddy Munagala (Indian Institute of Technology Hyderabad, India); Tetsuhiro Ishizaka (Nihon University, Japan); Atsushi Fukuda (Nihon University, Japan); Soumya Jana (Indian Institute of Technology, Hyderabad, India)

Abstract: While real-time management of urban mobility has become common in modern cities, it is now imperative to attempt such management subject to a sustainable emission target. To achieve this, one would require emission estimates at spatio-temporal resolutions that are significantly higher than the usual. In this paper, we consider roadside concentration of PM2.5, and make predictions at high spatio-temporal resolution based on location, time and traffic levels. Specifically, we optimized various machine learning models, including ones involving bagging and boosting, and found Extreme Gradient Boosting (XGBoost, XGB) to be superior. Moreover, the tuned and optimized XGB utilizing traffic information achieved significant gain in terms of multiple performance measures over a reference method ignoring such information, indicating the usefulness of the latter in predicting PM2.5 concentration.

11:10 am: Early Prediction of Human Action by Deep Reinforcement Learning

Hareesh Devarakonda (IIIT Sricity, India); Snehasis Mukherjee (Shiv Nadar University, India)

Abstract: Early action prediction in video is a challenging task where the action of a human performer is expected to be predicted using only the initial few frames. We propose a novel technique for action prediction based on Deep Reinforcement learning, employing a Deep Q-Network (DQN) and the ResNext as the basic CNN architecture. The proposed DQN can predict the actions in videos from features extracted from the first few frames of the video, and the basic CNN model is adjusted by tuning the hyperparameters of the CNN network. The ResNext model is adjusted by tuning the hyperparameters of the CNN network. The ResNext model is adjusted based on the reward provided by the DQN, and the hyperparameters are updated to predict actions. The agent's stopping criteria is higher or equal to the validation accuracy value. The DQN is rewarded based on the sequential input frames and the transition of action states (i.e., prediction of action class for an incremental 10 percent of the video). The visual features extracted from the first 10 percent of the video is forwarded to the next 10 percent of the video for each action state. The proposed method is tested on the UCF101 dataset and has outperformed the state-of-the-art in action prediction.

11:30 am: A Deep Reinforcement Learning Approach for Shared Caching

Pruthvi Trinadh (Indian Institute of Technology Bhubaneswar, India); Anoop Thomas (Indian Institute of Technology Bhubaneswar, India)

Abstract: A client-server network in which multiple clients are connected to a single server possessing files/data through a shared error free link is considered. Each client is associated with a cache memory and demands a file from the server. The server loads the cache memory with a portion of files during off-peak hours to reduce the delivery rate during peak hours. A decentralized placement approach which is more practical for large networks is considered for filling the cache contents. In this paper, the shared caching problem in which each cache can be accessed by multiple clients is considered. A Deep Reinforcement Learning (DRL) based

framework is proposed for optimizing the delivery rate of the requested contents by the users. The system is strategically modelled as a Markov decision process, to deploy our DRL agent and enable it to learn how to make decisions. The DRL agent learns to multicast coded bits from the file library of the server in such a way that the user requests are met with minimum transmissions of these coded bits. It is shown that the proposed DRL based agent outperforms the existing decentralized algorithms for the shared caching problem in terms of normalized delivery rate. For the conventional caching problem which is a special case of the shared caching problem, simulation results show that the proposed DRL agent outperforms the existing algorithms.

S10A: Relays

Session time Friday, 12:00 pm until 01:20 pm Location Hall A Talk time 20 Chaired by Prof. Srikrishna Bhashyam

12:00 pm: Greedy Successive Relaying for the Multicarrier Diamond Relay Channel

Antony Mampilly (IIT Madras, India); Srikrishna Bhashyam (Indian Institute of Technology Madras, India)

Abstract: We propose a new decode-and-forward (DF) protocol called Greedy Successive Relaying (GSR) protocol for the M-relay multicarrier diamond relay channel. We consider the diamond channel with half-duplex relays. The GSR protocol uses two states and the relays are partitioned into two sets, A and B. In the first state of the GSR protocol, the relays in A will receive messages from the source while the relays in B will transmit messages to the destination. In the second state, the role of the relays will be reversed i.e. the relays in A will be transmitting to the destination while the relays in B will be receiving from the source. The GSR protocol takes advantage of:(1) successive relaying to overcome the half-duplex limitation, and (2) greedy subcarrier allocation across relays to exploit the available diversity from all the relays. The proposed GSR protocol performs significantly better than the existing protocols. Furthermore, under a Rayleigh fading model, the gap from the cutset bound is also observed to be bounded at high power.

12:20 pm: Outage Analysis of SWIPT-Enabled Multi-Relay Aided Full Duplex NOMA System Under Partial Relay Selection

Shubham Shinkar (National Institute of Technology Calicut, India); Babu A v (National Institute of Technology Calicut, India)

Abstract: This paper considers a multi-relay aided full duplex (FD) cooperative non-orthogonal multiple access (NOMA) system integrated with simultaneous wireless information and power transfer (SWIPT) technique, which consists of a base station (BS), N FD relays and two downlink NOMA users. We propose variable transmit power allocation (VTPA), where the

power allocation factor at the base station (BS) and the time switching (TS) factor at the selected relay are chosen adaptively so as to improve the performance of the downlink users in the system. Assuming partial relay selection (PRS) scheme, analytical expressions are derived for the outage probabilities (OP) of the downlink users under VTPA and constant transmit power allocation (CTPA) schemes. To gain more insights, we describe the asymptotic OP (AOP) analysis as well. We show that the proposed VTPA scheme can mitigate the outage floor present in FD-NOMA system under CTPA and significantly improve the OP performance of the downlink users.

12:40 pm: Analysis of Multi-Hop Device-To-Device Networks with Half-Duplex Relays

Gourab Ghatak (IIIT Delhi, India)

Abstract: In this paper, we analyze a multi-hop device-to-device (D2D) communication network operating in a region of cellular outage, e.g., in case of a natural disaster. In particular, we assume that the D2D devices operate in a half-duplex manner and can receive signals from or transmit to a single D2D relay. For this system, we characterize a multi-hop D2D transmission protocol wherein we divide the transmission area into multiple regions based on the D2D transmission range. In contrast to the other works present in literature, we have taken into account the probability of a relay being used by another D2D source at the instant when the typical D2D source attempts to connect to it. Then, we derive the signal to interference and noise ratio (SINR) coverage probability for a typical device. Based on this, we define and characterize a performance metric called the availability-coverage product (ACP) to jointly take into account the coverage performance of the devices and the probability of them being used as relays by the other devices in outage. Our analysis highlights several system design insights in terms of the D2D communication range and the optimal number of active devices in the network in terms of the ACP.

01:00 pm: On Outage Probability Analysis of Uplink Cooperative VFD-NOMA over Nakagami-m Faded Channels

Justin Jose (Indian Institute of Technology Indore, India); Parvez Shaik (Indian Institute of Technology Indore, India); Shubham Bisen (Indian Institute of Technology Indore, India); Vimal Bhatia (Indian Institute of Technology Indore, India)

Abstract: Full-duplex (FD) and non-orthogonal multiple access (NOMA) communications are promising technologies which can efficiently utilize the available scarce spectrum in comparison to the traditional half-duplex (HD) and orthogonal multiple access (OMA) techniques. However, due to high residual self-interference (RSI) in the practical FD systems, virtual FD (VFD) relaying has garned appealing research attention in both academia and industry. In this work, we present a study of an uplink VFD-NOMA system with a base station, two relays, and two celledge uplink users, and analyze their performance over generalized Nakagami-m fading channels. Specifically, closed-form expressions of outage probability (OP) for both the users are derived for the considered system model, with the accuracy being verified through rigorous simulations.

Moreover, the performance of the users is compared with the conventional FD-NOMA and FD-OMA schemes.

S10C1: Clustering

Session time Friday, 12:00 pm until 12:40 pm Location Hall B Talk time 20 Chaired by Prof. Dheeraj Kumar

12:00 pm: A Novel Clustering Tendency Assessment Algorithm for WSN Generated Spatio-Temporal Data

Kartik Vishal Deshpande (Indian Institute Of Technology, India); Dheeraj Kumar (IIT Roorkee, India)

Abstract: An algorithm is developed to visually estimate the number of clusters in wireless sensor network (WSN) generated Spatio-temporal (ST) data by separating clusters with non-contiguous sets into multiple contiguous groups in space and time (using non-contiguous to contiguous visual assessment of clustering tendency algorithm (nccVAT)). The proposed algorithm is compared with ST-DBSCAN, ST-OPTICS, and a base algorithm that applies clusiVAT to all the features. To validate nccVAT, we compare Dunn's indices of the clustering generated by various algorithms on a real-life Intel Berkeley Research Laboratory (IBRL) dataset. The algorithm with the highest Dunn's index value is accepted to provide better clusters.

12:20 pm: Dimension Reduction and Clustering of Single Cell Calcium Spiking: Comparison of t-SNE and UMAP

Suman Gare (IIT Hyderabad, India); Soumita Chel (IIT Hyderabad, India); Manohar Kuruba (IIT Hyderabad, India); Soumya Jana (IIT Hyderabad, India); Lopamudra Giri (IIT Hyderabad, India)

Abstract: Time-lapse fluorescent imaging of cytosolic calcium is used to detect cellular activity during preclinical experiments and drug screening studies. However, visualization and analysis of high dimension time series data remain challenging due to the presence of underlying heterogeneity. In this context, we propose t-distribution stochastic neighborhood embedding (t-SNE) and uniform manifold projection and approximation (UMAP) for visualization and analysis. Next, we show the density-based spatial clustering of applications with noise (DBSCAN) can be used to detect various spiking patterns present in calcium dose-response. The proposed framework combining t-SNE and DBSCAN was used to find repeating patterns, detect outliers, and label similar instances present in biological signaling.

S10C2: Detection & Estimation

Session time Friday, 12:40 pm until 01:20 pm

LocationHall BTalk time20Chaired byProf. Rakesh K. Bansal

12:40 pm: Safe Sequential Optimization in Switching Environments

Durgesh Kalwar (Indian Institute of Space Science and Technology, India); Vineeth Bala Sukumaran (Indian Institute of Space Science and Technology, Trivandrum, India)

Abstract: We consider the problem of designing a sequential decision making agent to maximize an unknown time-varying function which switches with time. At each step, the agent receives an observation of the function's value at a point decided by the agent. The observation could be corrupted by noise. The agent is also constrained to take safe decisions with high probability, i.e., the chosen points should have a function value greater than a threshold. For this switching environment, we propose a policy called Adaptive-SafeOpt and evaluate its performance via simulations. The policy incorporates Bayesian optimization and change point detection for the safe sequential optimization problem. We observe that a major challenge in adapting to the switching change is to identify safe decisions when the change point is detected and prevent attraction to local optima.

01:00 pm: Empirical Study of Weight Initializations for COVID-19 Predictions in India

Meenal Narkhede (College of Engineering, Pune, India); Shubham Mane (College of Engineering, Pune, India); Prashant Bartakke (College of Engineering, Pune, India); M Sutaone (College of Engineering, Pune, India)

Abstract: The first case of the novel Coronavirus disease (COVID-19) in India was recorded on 30th January 2020 in Kerela and it has spread across all states in India. The prediction of the number of COVID-19 cases is important for government officials to plan various control strategies. This paper presents a weekly prediction of cumulative number of COVID-19 cases in India. A graded lockdown feature, which describes the status of lockdown, is derived and incorporated in the input dataset as one of the features. For prediction, this paper proposes a model which is a stacking of different deep neural networks which have recurrent connections. Vanishing gradients is a common issue with such networks with recurrent connections. Proper weight initialization of the network is one of the solutions to overcome the vanishing gradients problem. Hence, the weight distributions and convergence performance of some state-of-the-art weight initialization techniques have been analyzed in this paper. The proposed model is initialized with the technique which would aid to avoid the vanishing gradients problem and converge faster to a lower loss. This paper also provides a comparison of the proposed model for univariate and multivariate prediction with other prediction models such as statistical model -Auto-Regressive Integrated Moving Average (ARIMA), and deep learning architectures long short term memory (LSTM), bidirectional LSTM (bi-LSTM) and gated recurrent unit (GRU). The results demonstrate that the proposed model gives better prediction results than these models.

S7A: UAV Communications

Session time Friday, 02:00 pm until 03:20 pm Location Hall A Talk time 20 Chaired by Prof. Chetna Singhal

02:00 pm: Joint Bandwidth and Position Optimization in UAV Networks Deployed for Disaster Scenarios

Neetu R R (IIIT Delhi, India); Akshita Gupta (Indraprastha Institute of Information Technology, India); Gourab Ghatak (IIIT Delhi, India); Anand Srivastava (Indraprastha Institute of Information Technology Delhi, India); Vivek A Bohara (Indraprastha Institute of Information Technology, Delhi (IIIT-Delhi), India)

Abstract: In this paper, we consider a disaster-affected area that has lost cellular connectivity. In such a scenario, we study a unmanned aerial vehicle (UAV) network deployed to restore the user connections to the core network. In particular, we propose a resource partitioning scheme for integrated access and backhaul in the downlink to sustain the user connections. First, we derive an analytical expression for the throughput coverage probability for the access (i.e., UAV to user) and the backhaul (i.e., terrestrial base station (BS) to UAV) links. Then, we investigate the optimal position of the UAV and the optimal partitioning of the frequency resources between the access and the backhaul links, in order to maximize the coverage of the users. Our study highlights that as the number of users in the network and/or their throughput demand increases, the optimal UAV position moves towards the centre of the disaster-affected area. Moreover, in that case, a higher fraction of the available frequency resources must be provisioned for the access links. On the contrary, when the backhaul throughput requirements are high, or in the case of sparsely deployed terrestrial BSs, the optimal UAV position is at the edge of the disaster-affected area. Thus, this study provides key system-design insights to a network operator for deploying emergency areal networks to extend the cellular coverage.

02:20 pm: Trajectory Prediction of UAVs for Relay-Assisted D2D Communication Using Machine Learning

Pradip Kumar Barik (Indian Institute of Technology, Kharagpur, India); Ashu Dayal Chaurasiya (Indian Institute of Technology Kharagpur, India); Raja Datta (Indian Institute of Technology Kharagpur, India); Chetna Singhal (Indian Institute of Technology Kharagpur, India)

Abstract: Device-to-Device (D2D) communication has been proven an efficient technique in the present and upcoming cellular networks for improving network performance. Many a time, a direct D2D link may not be available due to longer distance or poor channel quality between two devices. Multi-hop D2D is an effective solution to overcome this limitation of direct D2D communication. Here relay devices help in forwarding data from transmitters to the receivers through single or multiple hops. However, finding suitable fixed relays and their locations is a complex problem, which does not have an efficient solution. In this paper, we have used UAVs

(drones) that act as relays for forwarding data between two devices. The proposed approach serves more out of direct range D2D users resulting in a reduced churn rate of the system. We find the trajectory of such UAVs with the help of active user prediction using Neural Networks (NN) to serve all the D2D users by increasing the coverage range of D2D communications. We have estimated the number of active D2D users in every zone covered by each drone and intra and inter-drone communication trajectories. It is also shown that the packet loss ratio remains within the acceptable limit for the proposed trajectories of the UAVs by choosing a sufficient buffer length.

02:40 pm: *Optimal Deployment Strategy for Relay Based UAV Assisted Cooperative Communication for Emergency Applications*

Nelapati Lava Prasad (Indian Institute of Technology Bhubaneswar, India); Chanakya Ajit Ekbote (Indian Institute of Technology Bhubaneswar, India); Barathram. Ramkumar (Indian Institute of Technology Bhubaneswar, India)

Abstract: There has been a lot of research in the last decade on UAV assisted wireless communication networks. Due to its ability of fast deployment, it is seen as a potential solution to establish communication under emergency scenarios like natural disasters. The mobile nature of the UAVs offers a lot of flexibility, which can be harnessed to improve the QoS of a wireless communication network. In this paper UAV assisted cooperative communication to serve different user clusters distributed in a geographical location is considered. These user clusters do not have access to any conventional base station which is typically a scenario under natural disasters. Each cluster is served by two types of UAVs: cluster UAV which hovers on the top of the cluster centroid and relay UAV which relays information between a central base station (CBS) and cluster UAV. To achieve the required QoS, which is serving a maximum number of users with limited available power, two major parameters have to be optimized apart from other parameters. These are the height of the cluster UAV and trajectory of the relay UAV. To solve this problem, a three-step approach is considered in this paper. In the first step, an unsupervised learning algorithm is used to find the horizontal location parameters of cluster UAVs. Then using convex optimization to find the optimal height of the cluster UAV under power constraints and capacity requirement. Finally using a heuristic algorithm to find the optimal trajectory with minimum distance to be traveled by the relay UAVs. The wireless channel considered here is a simple line of sight (LoS) with a path loss. Computer simulations are performed to prove the validity of the proposed approach in comparison with random deployment.

03:00 pm: Optimal Data Transfer in UAV-Assisted Edge-Networks Using 3D Beamforming

Shraddha Tripathi (Indian Institute of Technology Kanpur, India & NCTU Taiwan, Taiwan); Om Jee Pandey (University of Saskatchewan, Canada); Rajesh M Hegde (Indian Institute of Technology Kanpur, India)

Abstract: Reliable and low-latency data transfer to the cell edge users (CEUs) of 5G edgenetwork is a challenging problem. Solution to this problem can enable real-time applications such as remote health-monitoring of patients and target tracking in battle field. In this work, a novel method for optimal data transfer over UAV-assisted edge-networks is proposed. The proposed method utilizes unmanned aerial vehicle (UAV) as a relay node for data transfer between ground base station (GBS) and the CEUs. Additionally, UAV node is designed to be able to perform 3D beamforming leading to improved signal to interference noise ratio (SINR) and high throughput. To obtain optimal data transfer, the CEUs are first geographically clustered using a distance criterion. Subsequently, a joint optimization problem that aims to find the UAV trajectory and the beamforming downtilt angles, while applying minimum latency and maximum throughput constraints is formulated. This joint optimization problem is solved by using an iterative approach. Extensive simulations are then performed to validate this method for network latency and throughput under varying network conditions. The results are motivating enough for the method to be used in medium and large scale edge networks.

S7C: Biomedical Signal Processing & Networks

Session time Friday, 02:00 pm until 03:20 pm Location Hall B Talk time 20 Chaired by Prof. Monika Agrawal

02:00 pm: Brain Source Localization with Covariance Fitting Approaches

Anchal Yadav (Indian Institute of Technology Delhi India, India); Prabhu Babu (CARE, Indian Institute of Technology, Delhi, India); Monika Aggarwal (IIT Delhi, India); Shiv Dutt Joshi (Indian Institute of Technology, Delhi, India)

Abstract: The techniques like fMRI, CT scans, etc are used to localize the activity in the brain. Though these techniques have a high spatial resolution they are very expensive and uncomfortable for the patients. On the other hand, EEG signals can be obtained quite comfortably but suffer from low spatial resolution. A lot of research is being done to effectively extract spatial information from EEG signals. Many inverse techniques like MNE, LORETA, sLORETA, etc are available. All these methods can detect only a few sources and their performance degrades at low SNR. In this paper, covariance-based methods are used to estimate the location of brain activity from EEG signals such as SPICE (sparse iterative covariance-based estimation), and LIKES (likelihood-based estimation of sparse parameters). Intense simulation work has been presented to show that the proposed methods outperform the state-of-the-art methods.

02:20 pm: Performance Analysis of Convolutional Neural Network Based EEG Epileptic Seizure Classification in Presence of Ocular Artifacts

Payal Patel (IIT Bhubaneswar, India); Udit Satija (Indian Institute of Technology (IIT), India)

Abstract: Recently, convolutional neural network (CNN) has played a crucial role in classifying epileptic seizures due to its capability of automatically learning the discriminatory features from the raw electroencephalogram (EEG) data. Moreover, most of the existing methods considered

artifact-free EEG data for extracting features. In this paper, we analyze the impact of ocular artifacts on the performance of CNN in extracting reliable features from the EEG data for seizure classification. Furthermore, we also analyze the robustness of CNN in determining the accurate and reliable features not only from raw EEG data but also from spectral domain EEG data. The performance of the method is evaluated on the EEG signals taken from the Bonn's dataset with different types and levels of ocular artifacts. Performance evaluation results demonstrate that the classification accuracy of the method is degraded significantly under the presence of ocular artifacts. Furthermore, it is observed that the proposed CNN architecture is able to extract the discriminatory features from spectral EEG data more accurately as compared to the raw temporal EEG data.

02:40 pm: Implementation of a Spiking Neuron in CMOS

Iman Burman (Indian Institute of Technology Kharagpur, India); Archita Hore (IIT Kharagpur, India); Ayan Chakraborty (Indian Institute of Technology Khragpur, India); Sharba Bandyopadhyay (IIT Kharagpur, India); Saswat Chakrabarti (G. S. Sanyal School of Telecommunications & Indian Institute of Technology, Kharagpur, India)

Abstract: A spiking neuronal network consumes very low power for computation contrary to conventional VonNeumann architectures. A CMOS based circuit which includes several features of a spiking neuron closely, is presented in this paper. Features such as refractory period, spike height and width, resting potential, spiking threshold, spike frequency adaptation and inter spike interval (ISI) have been incorporated in the circuit. A small set of parameters, chosen carefully control these features in the circuit response. The spiking pattern of the proposed circuit has been matched with selected experimental data of real biological neurons from Allen Institute for Brain Science (AIBS) database.

03:00 pm: Heart Rate Estimation from RGB Facial Videos Using Robust Face Demarcation and VMD

Arya Deo Mehta (National Institute of Technology, Rourkela, India); Hemant Sharma (National Institute of Technology, Rourkela, India)

Abstract: The recent studies suggest the feasibility of accessing crucial health parameters through contactless means with an RGB camera placed at a distance. As high-quality RGB cameras are getting more cost-effective due to the drastic evolution in imaging technology, the camera-based health monitoring is evoking a considerable interest among researchers. This development may provide a better alternative to the conventional contact-based methods, as it promises a convenient and contactless long term vital sign monitoring solution that doesn't restrict personal mobility. This paper introduces an effective approach towards monitoring heart rate (HR) from facial videos using an RGB camera in wild practical scenarios. The proposed approach introduces the face symmetry-based quality scoring, which is an essential step to ensure quality face detection and avoid false face detections in videos captured in a practical scenario. Further, steps such as feature points generation for optimum masking and variational mode decomposition (VMD) based filtering assist in obtaining a signal dominated mainly by the HR component. Two publicly available datasets comprising the video signals at different frame

rates collected from the subjects with diverse ethnicities and skin tones are used to access the performance of the technique. The proposed approach achieved a mean absolute error of 6.58 beats per minute (BPM) on the COHFACE (Good illumination) dataset class, 9.11 BPM on the COHFACE (Bad illumination) dataset class and 6.37 BPM on the DEAP dataset class outperforming some of the state-of-art methods affirming its effectiveness in the estimation of HR in more realistic scenarios.

S12A: RIS

Session time Friday, 04:40 pm until 05:20 pmLocationAuditoriumTalk time20Chaired byProf. Pravas R Sahu

04:40 pm: Performance Analysis of RIS Assisted Smart Grid HEMS Using RQAM Modulation

Ashish Kumar Padhan (Indian Institute of Technology Bhubaneswar, India); Pravas Ranjan Sahu (Indian Institute of Technology Bhubaneswar, India); Subhransu Samantaray (Indian Institute of Technology, Bhubaneswar, India)

Abstract: In this work, we analyze the performance of a reconfigurable intelligent surface (RIS) assisted radio frequency (RF) system in smart grid application. In a smart grid, the smart meter (SM) plays an important role in communication between the smart devices and the utility control centre (UCC). The UCC can communicate using the RIS assisted communication link to the SM and the SM interact with the smart devices with the communication link based RF communication using the RQAM modulation scheme. Based on the system model, a closed-form expression for the average symbol error rate (ASER) is derived and analyzed by varying the various parameters like the number of reflector in the RIS, traffic intensity, quadrature to in-phase decision distance ratio, and the total number of devices.

05:00 pm: *BER Analysis of RIS Assisted Bidirectional Relay System with Physical Layer Network Coding*

Jeba Triphena (Thiagarajar College of Engineering, Madurai, India); Vetrivel Chelian Thirumavalavan (Thiagarajar College of Engineering, Madurai, India); Thiruvengadam S Jayaraman (Thiagarajar College of Engineering, Madurai, India)

Abstract: Reconfigurable Intelligent Surface (RIS) is one of the latest technologies in bringing a certain amount of control to the rather unpredictable and uncontrollable wireless channel. In this paper, RIS is introduced in a bidirectional system with two source nodes and a Decode and Forward (DF) relay node. It is assumed that there is no direct path between the source nodes. The relay node receives information from source nodes simultaneously. The Physical Layer Network Coding (PLNC) is applied at the relay node to assist in the exchange of information between the source nodes. Analytical expressions are derived for the average probability of errors at the

source nodes and relay node of the proposed RIS-assisted bidirectional relay system. The Bit Error Rate (BER) performance is analyzed using both simulation and analytical forms. It is observed that RIS-assisted PLNC based bidirectional relay system performs better than the conventional PLNC based bidirectional system.

S12B: Security

Session time Friday, 04:40 pm until 05:20 pm Location Hall A Talk time 20 Chaired by Prof. Chandramani Singh

04:40 pm: Order Statistics Based Collision Analysis for PUFs

Girish Vaidya (Indian Institute of Science, India); Chandramani Singh (Indian Institute of Science, India); Prabhakar Venkata T. (Indian Institute of Science, India)

Abstract: Physically unclonable functions (PUFs) exploit the inherent manufacturing variations for generating a device identifier. However, different devices may map to the same identifier causing a "collision". It is imperative to determine the probability of such collisions before a PUF is deployed for an application. We present a framework that computes the collision probabilities based on its inter-device and intra-device variations. This framework could be used for determining the collision probabilities, tuning the PUF attributes as well as to compare different PUF implementations. We demonstrate the use of our framework for real-world applications by comparing the results from our analyses with data from experiments and numerical simulation.

05:00 pm: On Physical Layer Security of Correlated Multiantenna Cognitive Radio Receivers

Brijesh Soni (School of Engineering and Applied Science, Ahmedabad University, India); Dhaval Karshanbhai Patel (School of Engineering and Applied Science-Ahmedabad University, India); Sagar Kavaiya (School of Engineering and Applied Science, Ahmedaad University, India); Mazen Omar Hasna (Qatar University, Qatar); Miguel López-Benítez (University of Liverpool, United Kingdom (Great Britain))

Abstract: In limited space scenarios, the antennas in the multiantenna cognitive radio (CR) system are closely spaced and often experience correlation among them. In this work, the secrecy performance of correlated multiantenna CR receiver over Nakagami-m fading channels with imperfect channel state information is studied and analyzed. We consider the underlay CR paradigm wherein Alice in the secondary network communicates with Bob while Eve tries to overhear the communication. We also consider that the antennas at Bob and Eve are closely spaced and thus uniformly correlated. To this extent, we derive the analytical expressions for the first and second order secrecy measures like secrecy outage probability, average secrecy outage rate & average secrecy outage duration, respectively for the CR receiver. Moreover, in order to

gain insights at high SNR, asymptotic analysis of secrecy outage probability is derived, thus obtaining the secrecy diversity gain of order L_D (i.e., the number of antennas at Bob). Monte Carlo simulations are carried out to validate the proposed analytical framework.

S12C: DSP Algorithms

Session time Friday, 04:40 pm until 05:20 pm Location Hall B Talk time 20 Chaired by Prof. Aditya Siripuram

04:40 pm: Fast DFT Computation for Signals with Spectral Support

Charantej Reddy Pochimireddy (IIT Hyderabad, India); Prabhu Tej V s s (Indian Institute of Technology Hyderabad, India); Aditya Siripuram (Indian Institute of Technology Hyderabad, India)

Abstract: We consider the problem of computing the Discrete Fourier transform (DFT) of an N-length signal which has only k non-zero DFT coefficients at known locations. We say that a set of indices is spectral if there exists a DFT submatrix (square) with those columns that is unitary up to scaling. When the DFT support set is spectral and N is a prime power, we prove that this can be done in O(klogk) operations using k samples provided the DFT support. This is a generalization of a similar recent result for the case when N is a power of 2.

05:00 pm: Improved Hankel Norm Criterion for Interfered Nonlinear Digital Filters Subjected to Hardware Constraints

Srinivasulu Jogi (IIITDM Kancheepuram, India); Priyanka Kokil (Indian Institute of Information Technology Design and Manufacturing, Kancheepuram, India)

Abstract: This article considers the global stability analysis of interfered nonlinear digital filtering schemes implemented with fixed-point arithmetic. The proposed approach uses Hankel norm to verify the reduction of undesired memory effects of previous inputs (ringing) on future responses in nonlinear digital filters with saturation overflow nonlinearity and external disturbance. Also, the proposed criterion verifies the asymptotic stability of nonlinear digital filter without external disturbance. With the obtained results, it is shown that the suggested criterion is less restrictive than the existing criterion in the literature. By using Lyapunov stability theory, sector-based saturation nonlinearity, and Lipschitz continuity, the approach is framed in linear matrix inequality (LMI)-constraints. The efficacy, validity, and reduced conservatism of presented criterion are tested with two numerical examples.

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