Kumar Vijay Mishra (S’08-M’15-SM’18) obtained a Ph.D. in electrical engineering and M.S. in mathematics from The University of Iowa in 2015, and M.S. in electrical engineering from Colorado State University in 2012, while working on NASA’s Global Precipitation Mission Ground Validation (GPM-GV) weather radars. He received his B. Tech. *summa cum laude* (Gold Medal, Honors) in electronics and communication engineering from the National Institute of Technology, Hamirpur (NITH), India in 2003. He is currently Senior Fellow at the United States Army Research Laboratory (ARL), Adelphi; Technical Adviser to Singapore-based automotive radar start-up Hertzwell and Boston-based imaging radar startup Aura Intelligent Systems; and honorary Research Fellow at SnT - Interdisciplinary Centre for Security, Reliability and Trust, University of Luxembourg. Previously, he had research appointments at Electronics and Radar Development Establishment (LRDE), Defence Research and Development Organisation (DRDO) Bengaluru; IIHR - Hydroscience & Engineering, Iowa City, IA; Mitsubishi Electric Research Labs, Cambridge, MA; Qualcomm, San Jose; and Technion - Israel Institute of Technology.

Dr. Mishra is the Distinguished Lecturer of the IEEE Communications Society (2023-2024), IEEE Aerospace and Electronic Systems Society (AESS) (2023-2024), IEEE Vehicular Technology Society (2023-2024), IEEE Geoscience and Remote Sensing Society (2024-2025), and IEEE Future Networks Initiative (2022). He is the recipient of the IET Premium Best Paper Prize (2021), U. S. National Academies Harry Diamond Distinguished Fellowship (2018-2021), American Geophysical Union Editors' Citation for Excellence (2019), Royal Meteorological Society Quarterly Journal Editor's Prize (2017), Viterbi Postdoctoral Fellowship (2015, 2016), Lady Davis Postdoctoral Fellowship (2017), DRDO LRDE Scientist of the Year Award (2006), NITH Director’s Gold Medal (2003), and NITH Best Student Award (2003). He has received Best Paper Awards at IEEE MLSP 2019 and IEEE ACES Symposium 2019.

Dr. Mishra is Chair (2023-present) of the Synthetic Apertures Technical Working Group of the IEEE Signal Processing Society (SPS) and Vice-Chair (2021-present) of the IEEE Synthetic Aperture Standards Committee, which is the first SPS standards committee. He is the Chair (2023-2026) of the International Union of Radio Science (URSI) Commission C. He has been an elected member of three technical committees of IEEE SPS: SPCOM, SAM, and ASPS, and IEEE AESS Radar Systems Panel. Since 2020, he has been Associate Editor of IEEE Transactions on Aerospace and Electronic Systems, where he was awarded Outstanding Editor recognition in 2021. He has been a lead/guest editor of several special issues in journals such as IEEE Signal Processing Magazine, IEEE Journal of Selected Topics in Signal Processing, and IEEE Journal on Selected Areas in Communications. He is the lead co-editor of three upcoming books on radar: *Signal Processing for Joint Radar-Communications* (Wiley-IEEE Press), *Next-Generation Cognitive Radar Systems* (IET Press Radar, Electromagnetics & Signal Processing Technologies Series), and *Advances in Weather Radar Volumes 1, 2 & 3* (IET Press Radar, Electromagnetics & Signal Processing Technologies Series). His research interests include radar systems, signal processing, remote sensing, and electromagnetics.

IEEE GRSS Distinguished Lecturer Nomination

List of proposed talks

Topic #1: Signal Processing for Joint Radar-Communications

Abstract: In this talk, we focus on the recent developments toward integrated sensing and communications (ISAC). We consider a broad definition of coexistence, which covers ISAC, collaborative communications, and sensing with interference. Toward fully realizing the coexistence of the two systems, optimization of resources for both new/futuristic sensing and wireless communications modalities is crucial. These synergistic approaches that exploit the interplay between state sensing and communications are both driving factors and opportunities for many current signal processing and information-theoretic techniques. In addition, a large body of prior works considers colocated ISAC systems while distributed systems remain relatively unexamined. Building on the existing approaches, the tutorial focuses on highlighting emerging scenarios in collaborative and distributed ISAC, particularly at mm-Wave and THz frequencies, highly dynamic vehicular/automotive environments that would benefit from information exchange between the two systems. It presents the architectures and possible methodologies for mutually beneficial distributed co-existence and co-design, including sensor fusion and heterogeneously distributed radar and communications. The tutorial also considers recent developments such as the deployment of intelligent reflecting surfaces (IRS) in ISAC, 5G systems, passive internet-of-things, and ISAC secrecy rate optimization. This tutorial aims to draw the attention of the radar, communications, and signal processing communities toward an emerging area, which can benefit from the cross-fertilization of ideas in distributed systems.

Topic #2: Sparse Reconstruction for Radar Remote Sensing

Abstract: Recently, several novel approaches to radar signal processing have been introduced which allow the radar to perform signal detection and parameter estimation from much fewer measurements than that required by Nyquist sampling. These reduced-rate radars exploit the fact that the target scene is sparse in time, frequency, or other domains, facilitating the use of compressed sensing methods in signal recovery. These techniques may also be applied on full-rate samples to facilitate reduced-rate processing on the sampled signal. Recent developments in reduced-rate sampling break the link between common radar design trade-offs such as range resolution and transmit bandwidth; dwell time and Doppler resolution; spatial resolution and number of antenna elements; continuous-wave radar sweep time and range resolution. Several pulse-Doppler radar systems are based on these principles. The temporal sub-Nyquist processing estimates the target locations using less bandwidth than conventional systems. Without impairing Doppler resolution, these systems also reduce the dwell time by transmitting interleaved radar pulses in a scarce manner within a coherent processing interval or "slow time". Extensions to the spatial domain have been proposed in the context of multiple-input-multiple-output array radars where few antenna elements are used without degradation in angular resolution. Recently, these concepts have also been applied to imaging systems such as synthetic aperture radar (SAR), inverse SAR (ISAR), and interferometric SAR (InSAR). In fact, SAR was one of the first applications of CS methods. The SAR imaging data are not naturally sparse in the

range-time domain. However, they are often sparse in other domains, such as wavelets. The motivation to apply reduced-rate methods is to address the challenge of oversampled data for the SAR processing challenge. This lecture introduces the audience to reduced-rate sampling methods to various radar applications.

Topic #3: Deep learning for mmWave and THz beamforming applications

Abstract: The millimeter-wave (mm-Wave) massive MIMO communications/radar employ hybrid analog-digital beamforming architectures to reduce the cost-power-size-hardware overheads. Lately, there is also a gradual push to move from the millimeter-wave (mmWave) to Terahertz (THz) frequencies for short-range communications and radar applications to exploit very wide THz bandwidths. At THz, ultramassive MIMO is an enabling technology to exploit even wider bandwidth while employing thousands of antennas. The design of the hybrid beamforming techniques requires the solution to difficult nonconvex optimization problems that involve a common performance metric as a cost function and several constraints related to the employed communication regime and the adopted architecture of the hybrid system(s). There is no standard methodology for solving such problems and usually, the derivation of an efficient solution is a very challenging task. Since optimization-based approaches suffer from high computational complexity and their performance strongly relies on the perfect channel condition, we introduce deep learning (DL) techniques that provide robust performance while designing a hybrid beamformer. In this lecture, the audience will learn about applying DL to various aspects of hybrid beamforming including channel estimation, antenna selection, wideband beamforming, and spatial modulation. In addition, we will examine these concepts in the context of joint radar-communications architectures.

Topic #4: Metasurface antennas for radar and communications

Abstract: In recent years, metasurfaces (MTSs) have shown promising abilities to control and manipulate electromagnetic (EM) waves through modified surface boundary conditions. These surfaces are electrically thin and comprise an array of spatially varying sub-wavelength scattering elements (or meta-atoms). Through careful engineering of each meta-atom, MTSs can transform an incident EM wave into an arbitrarily tailored transmitted or reflected wavefront. Recent developments in MTSs have opened exciting new opportunities in antenna design, as well as communications and radar systems. Reconfigurable MTSs - wherein meta-atoms are embedded with active components - lead to the development of low-cost, lightweight, and compact systems that can produce programmable radiation patterns, jointly perform multi-function communications, and enable advanced radars for next-generation military platforms. This talk will introduce reconfigurable MTSs and their various applications in designing simplified communications and radar systems, wherein the RF aperture and transceiver are integrated within the MTS. For example, dynamic reconfiguration of the MTS aperture in a wireless communications transmitter facilitates beam steering, frequency agility, and phase modulation without conventional front-end devices such as phase-shifters, mixers, and switches. In a synthetic aperture radar (SAR), MTSs have potential to achieve directive beams for traditional stripmap and spotlight SAR imaging modes using a low-cost compact aperture without mechanical gimbles or conventional phase-shifters. Additionally, MTSs can generate diverse radiation patterns for innovative holographic computational imaging modes, such as diverse pattern stripmap SAR. Space-time coding of MTSs has potential to realize frequency translation to achieve Doppler spoofing of reflected radar signals. Finally, we will present our recent work on reconfigurable MTS control, MTS-enabled direct signal modulation, and deep learning-based MTS design.