

Chandrashekhar Rai

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Research Interests

Radar Signal Processing, Wireless Communications, Spatial Wideband Systems, Direction of Arrival (DoA)-Time of Arrival (ToA) Estimation, Artificial Intelligence (AI)-enabled Signal Processing.

Education

- 2017-2024 **Ph.D. in G.S.Sanyal School of Telecommunications, Indian Institute of Technology Kharagpur, India**, Thesis: *"Signature Estimation of Spatial Wideband Systems"*. Developed AI-enabled and low-complexity algorithms for DoA-ToA estimation under spatial wideband effects. Addressed beam squint, delay squint, and spectral leakage challenges in extremely low SNR scenarios.
Under the supervision of Prof. Debarati Sen
- 2015-2017 **M.Tech in Communication and Signal Processing Engineering, National Institute of Technology Silchar, India**, Thesis: *"Study and Analysis of Secondary User Capacity Maximization in Cognitive Radio Network"*. Finding optimal threshold for spectrum sensing and primary user SNR using heuristic method- aging leader and challenger-particle swarm optimization (ALC-PSO) for maximizing secondary user capacity.
Under the supervision of Prof. Wasim Arif
- 2010-2014 **B.Tech in Electronics and Communication Engineering, Uttar Pradesh Technical University, India**, Thesis: *"Development of Microcontroller-Based Inverter Control Circuit for Residential Wind Generator Application"*. Simulated power rectifier circuit, DC-DC boost converter, H-Bridge inverter circuit, and SPWM inverter triggering waveform in Simulink. Designed hardware of power rectifier, DC-DC boost converter, and SPWM control circuit using microcontroller AT89S51.
Under the supervision of Prof. Himanshu Tripathi

Professional Experience

2024-Present **Postdoctoral Research Fellow**, *Indian Institute of Technology Delhi*, India
Compressive sensing (CS) based sparse recovery of target parameters-range, velocity, and angle for multiple input multiple output (MIMO) frequency modulated continuous waveform (FMCW) radar systems with sparse antenna and chirps. Examine both the uniform and non-uniform guarantees and establish bounds on the number of measurements and recovery errors. Target detection and range-angle parameter estimation with range-angle coupling (RAC) effect in extremely large scale (XL)- multiple input multiple output (MIMO) radar systems. Proposed CS-based novel algorithm to handle the RAC effect in XL-MIMO FMCW radar.

Publications

Journal Papers

- "Multi-target Range, Doppler and Angle estimation in MIMO-FMCW Radar with Limited Measurements," Rai, Chandrashekhar, Himali Singh, and Arpan Chattopadhyay, *Submitted to Transactions on Signal Processing*, 2025.
- "A Two-Stage Rotation-Based Super-Resolution Signature Estimation for Spatial Wideband Systems," Rai, Chandrashekhar, and Debarati Sen, *Submitted to Transactions on Signal Processing*, 2025.
- "An Artificial Intelligence Enabled Signature Estimation of Dual Wideband Systems in Ultra-Low Signal-to-Noise Ratio," Rai, Chandrashekhar, and Debarati Sen, *Submitted to Transactions on Cognitive Communications and Networking*, 2025.
- "Optimization of secondary user capacity in a centralized cooperative cognitive radio network with primary user under priority," Debnath, Sanjoy, Chandrashekhar Rai, Debarati Sen, Srimanta Baishya, and Wasim Arif, *Engineering Reports* 2, no. 7 (2020): e12188, 2020.

Conference Papers

- "Low Complexity DoA-ToA Signature Estimation for Multi-Antenna Multi-Carrier Systems," Rai, Chandrashekhar, and Debarati Sen, in *ICASSP 2025-2025 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2025, pp. 1-5.
- "Sparse Scatter/Target Detection with Spatial Wideband Uniform Linear Arrays," Rai, Chandrashekhar, and Debarati Sen., in *2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring)*, 2023, pp. 1-5.
- "Signature estimation of dual wideband systems," Rai, Chandrashekhar, and Debarati Sen., in *2022 IEEE 95th Vehicular Technology Conference (VTC2022-Spring)*, 2022, pp. 1-5.

Patents

- "A Decoupling-Based Low-Complexity Method For Scatter Signature Estimation in the Wideband Multi-Antenna Multi-Carrier Systems," Rai, Chandrashekhar and Debarati Sen, Patent Filing Number - 202431073729 (Indian), 19/052,191 (US), Filing Year - 2024.

- “AI-Enabled Real-Time Channel Path Detection with Parameter Estimation Method for GigaHertz / TeraHertz Massive MIMO,” Rai, Chandrashekhar and Debarati Sen, Patent Filing Number - 202431037273 (Indian), 19/023,062 (US), Filing Year - 2024.

Technical and Editorial Service

Reviewer for IEEE Internet of Things Journal, IEEE Signal Processing Letters, and conferences- ICASSP, VTC, Radar Conference, IJCNN.

Technical Skills

Signal Processing: DoA Estimation, ToA Estimation, Beamforming, and Detection Theory

Wireless Systems: MIMO, OFDM, Spatial Wideband Effects, Beam Squint Compensation

AI/Deep Learning: End-to-end AI frameworks, Neural Network-based estimation under low SNR

Tools: MATLAB, Python, TensorFlow/PyTorch, C/C++, LaTeX, Mathematica

Extracurricular Activities

Participated in several workshops and short-courses on radar systems, and wireless communications.

Organized workshops and student mentorship programs during Ph.D. and Postdoc tenure.

Active member of technical societies such as IEEE AESS, SPS, and ComSoc.

References

Prof. Debarati Sen

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Prof. Arpan Chattopadhyay

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