Ribhu

Contact Information	Assistant Professor Dept. of Electronics and Electrical Engg. Indian Institute of Technology Guwahati Assam, 781039 India.	Voice: +91-9634274438 +91-361-2583475 Mail: ribhu@outlook.com ribhufec@iitg.ac.in Vidwan-ID : 128339

Research Interests
Signal Processing for wireless communications, 5G/6G Wireless Communications, Adaptive Signal Processing, Detection and Estimation.

Professional Experience

Indian Institute of Technology Guwahati
Department of Electronics and Electrical Engineering
Assistant Professor   April 2017 to Present

Cell Free Massive MIMO
- Channel Models for Cell Free massive MIMO.
- Cell Free massive MIMO systems under channel aging.

Massive MIMO Communications
- Massive MIMO systems under aging channels.
- Massive MIMO systems under reciprocity imperfections.

Physical Layer Data Fusion for Wireless Sensor Networks
- Distributed Co-phasing.

Detection of Causal Relationship between Time Series
- Statistical Tests for the presence of Granger Causality

Indian Institute of Science, Bangalore
Department of Electrical Communication Engineering.
Institute Research Associate   May 2016 to March 2017
Project Associate   Aug 2015 to May 2016
Supervisor: Prof. Chandra R. Murthy
- Massive MIMO Communications Under Channel Aging
- Physical Layer Data Fusion for Wireless Sensor Networks

Sponsored Projects as PI

Completed

- Performance Analysis of Massive MIMO systems under CSI Impairments
  - Funding Agency: Indian Institute of Technology Guwahati, India
  - Budget: 05 Lakhs
  - Duration: August 2017 - July 2019

Sponsored Projects as Co-PI

Ongoing

- Development of signal and channel models, circuits, and antennas for next generation Wireless systems with emphasis on vehicular communications
  - Funding Agency: MeiTy, Government of India
  - Proposed Budget: 476 Lakhs
  - Duration: January 2021 - July 2024

EDUCATION **Indian Institute of Technology Roorkee**, Roorkee, India

Ph.D., Electronics and Communication Engineering   December 2011 - May 2016
- **Thesis Topic**: *Adaptive Techniques for Cyclostationary Spectrum Sensing in Cognitive Radios*
- **Supervisors**: Prof. D. K. Mehra and Prof. Debashis Ghosh

M.Tech., Communication Systems   July 2009 - June 2011
- **Dissertation Topic**: *Sparse Representations of Signals and their Application to Pattern Matching and Information Hiding*
- **Supervisor**: Prof. Debashis Ghosh
- CGPA 8.77 on a scale of 10

Panjab University, Chandigarh, India

B.E., Electronics and Communication Engineering,   July 2005 - May 2009
- *First division with honors*
- Score : 82.74%

HONORS AND
AWARDS
- Presented a tutorial titled "Practical Massive MIMO: Performance bottlenecks and how to overcome them" in ICASSP (IEEE International Conference on Acoustics, Speech and Signal Processing) 2021, with Chandra R. Murthy, Himal A. Suraweera and Erik G. Larsson.
- Awarded one of the two IISc Institute Research Associate positions in the electrical sciences division for the period May 2016 - April 2017.
- Had the highest CGPA in the 2011 graduating class of M.Tech. Communication Systems at IIT Roorkee.
- Stood second in Panjab University in the order of merit in the undergraduate course.

REFEREED
INTERNATIONAL
JOURNAL
PUBLICATIONS

Published

1. Anubhab Chowdhury, **Ribhu Chopra**, and Chandra R. Murthy, "Can Dynamic TDD Enabled Half-Duplex Cell-Free Massive MIMO Outperform Full-Duplex Cellular Massive MIMO?", *IEEE Transactions on Communications*, accepted, May 2022.

2. Sudarshan Mukherjee, and **Ribhu Chopra**, "Performance Analysis of Cell Free Massive MIMO systems in LoS/ NLoS Channels", *IEEE Transactions on Vehicular Technology*, accepted, Mar 2022.

3. Anubhab Chowdhury, Pradip Sasmal, Chandra R. Murthy and **Ribhu Chopra**, "On the Performance of Distributed Antenna Array Systems With Quasi-Orthogonal Pilots", in *IEEE Transactions on Vehicular Technology*, vol. 71, no. 3, pp. 3326-3331, March 2022.

4. Irina. M. Baby, Kumar Appaiah and **Ribhu Chopra**, "Optimal Channel Tracking and Power Allocation for Time Varying FDD Massive MIMO Systems", in *IEEE Transactions on Communications*, vol. 70, no. 2, pp. 1229-1244, Feb. 2022.

5. **Ribhu Chopra** and Chandra R. Murthy, "Data Aided MSE-Optimal Time Varying Channel Tracking in Massive MIMO Systems," in *IEEE Transactions on Signal Processing*, vol. 69, pp. 4219-4233, 2021, (accepted Apr. 2021).

6. T. Van Chien, Anatsios. K. Papazafeiropoulos, L. T. Tu, **Ribhu Chopra**, S. Chatzinotas and B. Ottersten, "Outage Probability Analysis of IRS-Assisted Systems Under Spatially Correlated Channels," in *IEEE Wireless Communications Letters*, vol. 10, no. 8, pp. 1815-1819, Aug. 2021.

7. Achal Dave*, Sachit Kuhar*, **Ribhu Chopra**, "Deep Learning based Semi-blind Tracking for Aging Wireless Communication Channels", *Wireless Personal Communications*, vol 119 No. 3, pp. 2695-2706, Aug. 2021.

8. **Ribhu Chopra**, Chandra R. Murthy and A. K. Papazafeiropoulos, "Uplink Performance Analysis of Cell-Free mMIMO Systems Under Channel Aging," in *IEEE Communications Letters*, vol. 25, no. 7, pp. 2206-2210, Jul. 2021.

9. Vishwamittar, Priyanka Batra, and **Ribhu Chopra**, "Stochastic resonance in two coupled fractional oscillators with potential and coupling parameters subjected to quadratic asymmetric dichotomous noise", in *Physica A: Statistical Mechanics and its Applications*, Volume 561, 2021, 125148, ISSN 0378-4371.

10. **Soumendu Ghosh** and Ribhu Chopra, "Downlink Pilots for Hybrid Massive MIMO Under Reciprocity Imperfections," in *IEEE Communications Letters*, vol. 24, no. 10, pp. 2334-2338, Oct. 2020.

11. **Ribhu Chopra**, Chandra R. Murthy, Himal A. Suraweera, and Erik G. Larsson "BER Analysis of Massive MIMO Systems in the Presence of Imperfect Channel Reciprocity", *IEEE Transactions on Signal Processing*, vol. 68, no. 1, pp. 3132-3145, 2020 (accepted Apr. 2020).

12. Anubhab Chowdhury, and **Ribhu Chopra**, "Frame Structrues for Massive MIMO under Aging Channels", *Wireless Personal Communications*, vol. 111, Apr. 2020, pp 2659-2669.

13. **Ribhu Chopra**, Chandra R. Murthy and Ramesh Annavajjala, "Physical Layer Security in Wireless Sensor Networks Using Distributed Co-Phasing," in *IEEE Transactions on Information Forensics and Security*, vol. 14, no. 10, pp. 2662-2675, Oct. 2019.

14. Soumendu Ghosh, and **Ribhu Chopra**, "Training for Massive MIMO systems under aging channels with different user mobilities", *Physical Communication*, vol. 39, pp 1-8, Aug 2019.

15. **Ribhu Chopra**, Chandra R. Murthy, Himal A. Suraweera, and Erik. G. Larsson, "Analysis of Non-Orthogonal Training in Massive MIMO under Channel Aging with SIC Receivers", *IEEE Signal Processing Letters*, vol. 26, no. 2, pp. 282-286, Feb. 2019.

16. **Ribhu Chopra**, Chandra R. Murthy, and Govindan Rangarajan, "Statistical Tests for Detecting Granger Causality," *IEEE Transactions on Signal Processing*, vol. 66, no. 22, pp. 5803-5816, Nov.15, 2018.

17. **Ribhu Chopra**, Chandra R. Murthy, Himal A. Suraweera, and Erik G. Larsson "Performance Analysis of FDD Massive MIMO Systems under Channel Aging" *IEEE Transactions on Wireless Communications*, vol. 17, no. 2, pp. 1094-1108, Feb. 2018.

18. **Ribhu Chopra**, Ramesh Annavajjala, and Chandra R. Murthy "Distributed Co-Phasing with Autonomous Constellation Selection" in *IEEE Transactions on Signal Processing*, vol. 65, no. 21, pp. 5798-5811, 1 Nov.1, 2017.

19. **Ribhu Chopra**, Debashis Ghosh, and D. K. Mehra, "Spectrum sensing for OFDM Signals Using Pilot Induced Cyclostationarity in the Presence of Cyclic Frequency Offset" in *Physical Communication (Elsevier)*, Volume 24, pp. 182-194, September 2017.

20. **Ribhu Chopra**, Chandra R. Murthy, and Ramesh Annavajjala, "Multi-Stream distributed Co-Phasing" in *IEEE Transactions on Signal Processing*, vol. 65, no. 4, pp. 1042-1057, Feb.15, 2017.

21. **Ribhu Chopra**, Chandra R. Murthy, and Himal A. Suraweera, "On the Throughput of Large MIMO Beamforming Systems with Channel Aging" in *IEEE Signal Processing Letters*, vol. 23, no. 11, pp. 1523-1527, Nov. 2016.

22. **Ribhu Chopra**, Debashis Ghosh, and D.K. Mehra, " Performance evaluation of FRESH filter based spectrum sensing for cyclostationary signals", *Physical Communication(Elsevier)*, Volume 20, September 2016, Pages 17-32, ISSN 1874-4907.

23. **Ribhu Chopra**, Debashis Ghosh and D. K. Mehra, "FRESH Filter-Based Spectrum Sensing in the Presence of Cyclic Frequency Offset" in *IEEE Wireless Communications Letters*, vol. 5, no. 2, pp. 124-127, Apr 2016.

24. **Ribhu Chopra**, Debashis Ghosh, and D. K. Mehra, "Spectrum Sensing for Cognitive Radios Based on Space-Time FRESH Filtering" *IEEE Transactions on Wireless Communications*, vol.13, no.7, pp.3903-3913, July 2014.

25. Ajay Khunteta, Debashis Ghosh and **Ribhu**, "A Fuzzy Approach to Image Exposure Level Estimation and Contrast Enhancement in Dark Images via Exposure Level Optimization" *International Journal of Latest Trends in Engineering, Science and Technology*, Volume 1, Issue 5, Apr 2014.

Submitted

1. Sai Manikanta Rishi Rani, **Ribhu Chopra**, and Kumar Appaiah "Downlink Performance analysis of Cell Free massive MIMO systems under LoS/ NLoS channels", submitted to IEEE Transactions on Green Communications and Networking Technology, Jan 2022.

Under Preparation

1. **Ribhu Chopra**, and Chandra R. Murthy, "Adaptive Time Varying Channel Tracking in Massive MIMO Systems".

Conference Publications

Published

1. Anubhab Chowdhury, **Ribhu Chopra**, Chandra R Murthy, Himal A Suraweera, "On the Achievable Rates of Full-Duplex Massive MIMO Systems Under Channel Aging", *2019 IEEE 20th International Workshop on Signal Processing Advances in Wireless Communications (SPAWC) (IEEE SPAWC 2019)*, (Cannes, France), July 2019.

2. **Ribhu Chopra** "Uplink Training for Massive MIMO Systems Under Channel Aging",*2018 International Conference on Signal Processing and Communications* (SPCOM 2018), (Bangalore, India), July 2018.

3. **Ribhu Chopra**, Chandra R. Murthy, and R. Annavajjala, "Multi-Stream distributed Co-Phasing: design and analysis," in *2016 IEEE 17th International Workshop on Signal Processing Advances in Wireless Communications (IEEE SPAWC 2016)*, (Edinburgh, United Kingdom), July 2016.

4. **Ribhu**, Debashis Ghosh, Mehra, D.K., "Cooperative Spectrum Sensing for Cognitive Radios Using Jointly Adaptive FRESH Filters" *National Conference on Communications 2015 (NCC-2015)*, pp.1,6, Mumbai, India, Feb 2015

5. **Ribhu**, Debashis Ghosh, D. K. Mehra, "Cyclostationary spectrum sensing for OFDM signals in the presence of cyclic frequency offset" *2014 International Conference on Signal Processing and Communications (SPCOM)*, vol., no., pp.1,6, 22-25, Bangalore, India, July 2014

6. Debashis Ghosh, **Ribhu**, A. P. Shivaprasad, "Parameter tuning for multi-prototype possibilistic classifier with reject options," *2013 IEEE International Conference on Fuzzy Systems (FUZZ)* , vol., no., pp.1,6, 7-10 July 2013

7. **Ribhu**, Debashis Ghosh, "Dictionary design for sparse signal representations using K-SVD with sparse Bayesian learning" *2012 IEEE 11th International Conference on Signal Processing (ICSP)*, vol.1, no., pp.21,25, 21-25 Oct. 2012

8. **Ribhu**, Debashis Ghosh, "A sparse representation based approach for steganography," *2012 IEEE 11th International Conference on Signal Processing (ICSP)*, vol.3, pp.1678-1681, 21-25 Oct. 2012

9. Ajay Khunteta, Debashis Ghosh, **Ribhu**, "Fuzzy rule-based image exposure level estimation and adaptive gamma correction for contrast enhancement in dark images" *2012 IEEE 11th International Conference on Signal Processing (ICSP)* vol.1, no., pp.667-672, 21-25 Oct. 2012

TEACHING EXPERIENCE	Course Instructor	Summer 2017- Present
	Department of Electrical and Electronics Engineering	
	Indian Institute of Technology Guwahati	

	EE230: Probability and Random Processes	Spring 2022
	EE-330: Digital Communication	Summer 2017, Autumn 2019
	EE-332: Digital Communications	Spring 2021
	EE-333: Communication and DSP Lab	Spring 2021
	EE-525: Optimal and Adaptive Signal Processing	Spring 2018
	EE-539: Communication Systems Design Lab	Spring 2018
	EE-531: Communication Systems Theory	Autumn 2018
	EE-538: Communication Systems Simlation Lab	Autumn 2018
	EE-360: Embedded Systems	Spring 2019, Spring 2020
	EE-721: Selected Topics in Signal Processing	Spring 2020
	EE-331: Principles of Communication	Autumn 2020,2021

	Tutor	Autumn 2017- Present
	Department of Electrical and Electronics Engineering	
	Indian Institute of Technology Guwahati	

	EE-101: Basic Electronics	Autumn 2017, 2019
	EE-230: Principles of Communication	Spring 2019

PROFESSIONAL SERVICE	Served as a reviewer for the following journals
	• IEEE Transactions on Signal Processing
	• IEEE Transactions on Wireless Communications
	• IEEE Transactions on Communications
	• IEEE Transactions on Vehicular Technology
	• IEEE Wireless Communications Letters

- IEEE Communications Letters
- IEEE Wireless Communications Magazine
- IEEE Signal Processing Letters.
- Physical Communication (Elsevier)

Served on the TPC of the following conferences

- SPCOM 2018
- ICC 2019
- NCC 2019

REFERENCES   Will be provided upon request.