

Chiranjib Saha

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CONTACT INFORMATION

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RESEARCH INTERESTS

Wireless communications; 5G networks; Heterogeneous cellular networks (HetNets); LTE/LTE-A, WiFi; Internet of Things (IoT); Device-to-device (D2D) communications; Integrated access and backhaul (IAB) design; Spectrum sharing; Machine learning; Signal processing; Stochastic geometry.

EDUCATION

Virginia Tech, Blacksburg, VA, USA. Ph.D. in Electrical and Computer Engineering **Aug. 2015- Present**

- **Expected Graduation: May, 2020**
- Advisor: Harpreet S. Dhillon
- Dissertation: “Advances in Stochastic Geometry for Cellular Networks”
- Current GPA: 3.87

Jadavpur University, India. B.E. in Electronics and Telecommunication Engineering **2011-2015**

- Final year Project Topic: Gesture driven control of an Arduino based robot using Kinect
- Advisor: Amit Konar
- CGPA: 9.22

PROFESSIONAL EXPERIENCE

Virginia Tech, Blacksburg, VA

Graduate Research Assistant

- **Machine Learning and stochastic geometry** **Feb. 2019-Present**
 - * Studying subset selection problems in wireless networks, connection with determinantal point processes used both in machine learning and stochastic geometry.
 - * Application of the submodular optimization framework to signal processing problems, e.g., antenna selection in a pulsed Radar system.
- **Modeling and analysis of mm-wave IAB networks** **May 2017-Present**
 - * Proposed new stochastic geometry-based model for mmWave IAB-enabled HetNet
 - * Load modeling, coverage and data-rate analysis, studying resource partition strategies in IAB.
- **3GPP-inspired stochastic geometry models for HetNets** **Sep. 2015-May 2017**
 - * Proposed new stochastic geometry-based models closely resembling 3GPP HetNet models, coverage analysis and model comparisons.
- **Performance analysis of D2D-enabled cellular networks** **Jan. 2016-May 2016**
 - * Proposed new spatial models for D2D communication in user hotspots, analyzed downlink coverage and rate trends.

Samsung Research America, Plano, TX

May 2019-Aug. 2019

Research Intern

- **Localization in Ultra-wide band (UWB) systems**
 - * Studied and designed localization algorithms (e.g. nonlinear least squares and extended Kalman filter). Designed anchor selection and placement optimization heuristics.
 - * Filed for 4 disclosure of inventions (DOIs).
 - * Received the *best intern poster presentation award*.

Nokia Bell Labs, Naperville, IL

May 2018-Jul. 2018

Research Intern

- **Beamforming and beam tracking in 3GPP new radio**
 - * Studied beam tracking when a mm-wave receiver is moving along a trajectory in an urban environment. Integrated spatially correlated channels from a ray tracer to the link and system level simulator of 5G new radio (NR). *Selected for distinguished Bell Labs Summer Internship Project.*

– Day-ahead thermal scheduling Problems

- * Used multi-objective optimization algorithms for generator scheduling in a thermal power plant. Results published in *IEEE Trans. on Ind. Informat.*

PUBLICATIONS

Book

- H. S. Dhillon, **C. Saha**, and M. Afshang, *Poisson Cluster Processes: Theory and Applications to Wireless Networks*, Cambridge university press, under preparation.

Journals

- [J11] **C. Saha** and H. S. Dhillon, “On the Load Distribution of a Cellular Network with User Clustering”, submitted to *IEEE Wireless Commun. Letters*.
- [J10] **C. Saha** and H. S. Dhillon, “Millimeter Wave Integrated Access and Backhaul in 5G: Performance Analysis and Design Insights”, in *IEEE Journal on Sel. Areas in Commun.*, to appear, available online: arxiv.org/abs/1902.06300.
- [J9] **C. Saha**, H. S. Dhillon, N. Miyoshi, and J. G. Andrews, “Unified Analysis of HetNets using Poisson Cluster Process under Max-Power Association”, in *IEEE Trans. on Wireless Commun.*, Aug. 2019.
- [J8] **C. Saha**, M. Afshang and H. S. Dhillon, “Bandwidth Partitioning and Downlink Analysis in Millimeter Wave Integrated Access and Backhaul for 5G,” in *IEEE Trans on Wireless Commun.*, Dec. 2018.
- [J7] M. Afshang, **C. Saha**, and H. S. Dhillon “Equi-coverage Contours in Cellular Networks”, in *IEEE Wireless Commun. Letters*, Oct. 2018.
- [J6] **C. Saha**, M. Afshang, H. S. Dhillon, “3GPP-inspired HetNet model using Poisson cluster process: sum-product functionals and downlink coverage”, in *IEEE Trans. on Commun.*, May 2018.
- [J5] M. Afshang, **C. Saha**, and H. S. Dhillon, “Nearest-neighbor and contact distance distributions for Matérn cluster process”, in *IEEE Commun. Letters*, Dec. 2017.
- [J4] M. Afshang, **C. Saha**, H. S. Dhillon, “Nearest-neighbor and contact distance distributions for Thomas cluster process”, in *IEEE Wireless Commun. Letters*, Dec. 2016.
- [J3] **C. Saha**, M. Afshang, and H. S. Dhillon, “Enriched K -tier HetNet model to enable the analysis of user-centric small cell deployments”, in *IEEE Trans. on Wireless Commun.*, Mar. 2016.
- [J2] **C. Saha**, K. Pal, S. Mukherjee, S. Das, “A fuzzy rule based penalty function approach for solving constrained optimization”, in *IEEE Trans. on Cybern.*, Dec. 2016.
- [J1] A. Trivedi, D. Srinivasan, K. Pal, **C. Saha** and T. Reindl, “Enhanced multiobjective evolutionary algorithm based on decomposition for solving the unit commitment problem”, in *IEEE Trans. on Ind. Informat.*, Dec. 2015.

Conference Proceedings

- [C9] **C. Saha** and H. S. Dhillon, “Interference Characterization in Wireless Networks: A Determinantal Learning Approach”, in *Proc. IEEE Int. Workshop in Machine Learning for Sig. Processing*, Pittsburgh, PA, Oct. 2019.
- [C8] **C. Saha** and H. S. Dhillon, “Machine Learning meets Stochastic Geometry: Determinantal Subset Selection for Wireless Networks”, in *Proc. IEEE Globecom*, Waikoloa, HI, Dec. 2019.
- [C7] **C. Saha** and H. S. Dhillon, “On Load Balancing in Millimeter Wave HetNets with Integrated Access and Backhaul”, in *Proc. IEEE Globecom*, Waikoloa, HI, Dec. 2019.
- [C6] **C. Saha**, M. Afshang, and H. S. Dhillon, “Integrated mmWave access and backhaul in 5G: Bandwidth partitioning and downlink analysis”, in *Proc. IEEE ICC*, Kansas city, KS, 2018.
- [C5] **C. Saha**, M. Afshang, and H. S. Dhillon, “Poisson cluster process: Bridging the gap between PPP and 3GPP HetNet models”, in *Proc., ITA*, San Diego, CA, 2017.
- [C4] **C. Saha** and H. S. Dhillon, “D2D underlaid cellular networks with user clusters: Load balancing and downlink rate analysis”, in *Proc. IEEE WCNC*, San Francisco, CA, Mar. 2017.
- [C3] **C. Saha** and H. S. Dhillon, “Downlink coverage probability of K -tier HetNets with general non-uniform user distributions”, in *Proc. IEEE ICC*, Kuala Lumpur, 2016.
- [C2] **C. Saha**, D. Goswami, S. Saha, A. Konar, A. Lekova and A. K. Nagar, “A novel gesture driven fuzzy interface system for car racing game”, in *Proc. FUZZ-IEEE*, Istanbul, 2015.

- [C1] K. Pal, **C. Saha**, S. Das, C. A. Coello Coello, “Dynamic constrained optimization with offspring repair based gravitational search algorithm”, in *Proc. IEEE CEC*, Cancún, Mexico, Jun., 2013.

SELECTED GRADUATE COURSE PROJECTS

Hybrid Precoding for Massive MU-MIMO

Fall 2018

- Investigated the design of hybrid beamformers in a downlink multi-user massive MIMO scenario. Compared the performance under finite resolution phase shifters.

Fitting point processes to cellular network topology

Fall 2016

- Fitted point processes from Gibbs process family to analyze the location patterns of base stations in different urban regions of UK for four major telecom operators.

Software design of digital transmitter and receiver

Spring 2016

- MATLAB implementation of fundamental building blocks of a digital trans-receiver, e.g. modulation-coding schemes, pulse-shaping, OFDM and BER analysis for AWGN and fading channels.

Comparative study and analysis of MIMO techniques

Fall 2015

- Implemented SU-MIMO receivers based on pre-coding, zero-forcing (ZF), successive interference cancellation (SIC) algorithms to compare performances of multiplexing schemes.
- Analyzed antenna diversity techniques and DOA algorithms such as MUSIC, ESPRIT.

OFDM Channel Estimation and Receiver Algorithms

Fall 2015

- Performed OFDM channel estimation using LS and MMSE approaches and implemented receiver algorithms including ZF, MMSE and SIC.
- Simulated OFDM in frequency selective channels to capture performance.

OTHER POSITIONS OF RESPONSIBILITY

Reviewer of *IEEE Transactions on Wireless Communications*, *IEEE Transactions on Communications*, *IEEE Wireless Communications Letters*, *IEEE Communication Letters*, *IEEE Journal on Selected Areas in Communication*

GRADUATE COURSES UNDERTAKEN

Multichannel communications, Stochastic signals and systems, Information theory, Advanced digital communication, Measure and probability, Spatial statistics, Error control coding, Graph theory, Bayesian statistics.

AWARDS

- Wireless@VT Fellowship, 2015.
- IEEE ComSoc student travel grant, 2016.
- Received best intern poster award at Samsung Research America, 2019.

SKILLS

- COMMUNICATION PROTOCOLS: 5G/NR, LTE/LTE-A, GSM, CDMA2000, WCDMA, WiFi - IEEE 802.11 a/b/g/n, TCP/IP etc.
- ALGORITHMS: Transmitter/Receiver structures for MIMO and OFDM/Single Carrier Wireless systems; Water-Filling based Power Control; Linear/Non-Linear Integer programming; Convex Optimization; Back propagation and Artificial Neural Networks, Bayesian filtering (e.g. Kalman filter, extended Kalman filter, particle filter).
- PROGRAMMING LANGUAGES: C, C++, R, MATLAB, Mathematica, Python, Java
- SCRIPTING LANGUAGES: HTML5, L^AT_EX

REFERENCE

Harpreet S. Dhillon	Assistant Professor Virginia Tech	hdhillon@vt.edu
Amitava Ghosh	Head, Radio Interface Group at Nokia Bell Labs	amitava.ghosh@nokia-bell-labs.com
Boon Loong Ng.	Research Director, Samsung Research America	b.ng@samsung.com