Gaurav Duggal

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Education

- **Virginia Tech**, Blacksburg, VA, USA: PhD in ECE at Wireless@VT — Fall 2021-Present
- **IIIT, Delhi, India**: Mtech. in Communications and Signal Processing — Fall 2017-2019
- **BITS Hyderabad, India**: B.E. Hons. Electrical and Electronics — Fall 2009-2013

Research Interests

Wireless Communications, Wireless Positioning, Radar Signal Processing, Machine Learning, Signal Estimation and Detection

Professional Experience

- Research Intern, *Samsung Research America*, Plano, Texas (SMI-lab) — May,2023-Aug,2023

  Worked on an end-to-end physics based synthetic radar data generation and machine learning pipeline that is used to generate synthetic and realistic radar data for human activities. The generated data was used to train machine learning algorithms for human activity recognition and performance was validated on real radar data. Submitted two patent applications related to this.
- Research Intern, *Samsung Research America*, Plano, Texas (SMI-lab) — May,2022-Aug,2022

  Worked on DSP and machine learning algorithms for an Ultra WideBand (UWB) Radar-based gesture recognition pipeline.
- Engineer, *Qualcomm* , India (RF software team) — Jul,2017-Aug,2019

  Worked on algorithms that managed the RF front end of Qualcomm modems and also RF front end resource allocation algorithms.
- Research Intern, *Hertzwell*, Singapore — Dec,2018-Feb,2019

  Developed an end-to-end automotive MIMO radar signal processing including waveform design, ground clutter modelling, automotive target modelling and receiver effects modelling.
- Member of Technical Staff, *Tonbo Imaging*, India — May,2015-Jun,2016

  Developed embedded firmware for a thermal imaging camera system used by Defence Forces across the globe.
- Embedded Electronics Engineer, *Ducere Technologies*, India — Jul,2013-Apr,2015

  Implemented prototypes of wearable technology-based design ideas using basic physics and electronics.

Publications

[1] G. Duggal, R. M. Buehrer, H. S. Dhillon, and J. H. Reed, "Indoor positioning by Exploiting Diffraction," ***[*Under Review]*** *IEEE Journal of Special Areas in Communications*, 2023.

[2] G. Duggal, R. M. Buehrer, J. H. Reed, and N. Tripathi, "Line-of-Sight Probability for Outdoor-to-Indoor UAV-Assisted Emergency Networks," in *ICC 2023 - IEEE International Conference on Communications*, 2023.

[3] G. Duggal, S. Vishwakarma, K. V. Mishra, and S. S. Ram, "Doppler-resilient 802.11ad-based ultrashort range automotive joint radar-communications system," *IEEE Transactions on Aerospace and Electronic Systems*, 2020.

[4] N. Pandey, G. Duggal, and S. S. Ram, "Database of simulated inverse synthetic aperture radar images for short range automotive radar," in *2020 IEEE International Radar Conference (RADAR)*, 2020.

[5] G. Duggal, S. Sundar Ram, and K. V. Mishra, "Micro-doppler and micro-range detection via doppler-resilient 802.11ad-based vehicle-to-pedestrian radar," in *2019 IEEE Radar Conference (RadarConf)*, 2019.

[6] S. Verma, A. V. G. Madhav, and G. Duggal, "Structural health monitoring of concrete structures using electromechanical impedance technique," in *2013 International Conference on Advances in Technology and Engineering (ICATE)*, 2013.

Awards and Scholarships

- NIJ FY23 Graduate Research Fellowship - Awarded $166,500 graduate research fellowship towards PhD by the Department of Justice for writing a research proposal titled "Next Generation Emergency Networks", 2023
- IEEE ComSoc Travel Grant - Awarded $1250 travel grant to present paper at ICC 2023, Rome,Italy.
- Samsung Research America, Best Poster Award 3rd position - 'Synthetic Radar Pipeline for Human Activity Recognition' Aug 2023
- Qualcomm Innovation Fellowship 2022 - finalist - Joint radar-communication based wireless localisation
- Secured a scholarship amounting to 960 UK pounds per month for 3 months for a research internship at Cranfield University, United Kingdom, 2012

Projects

- MIMO-Course - MATLAB simulations, Instructor: Prof. R. Michael Buehrer
  - Simulated, Jakes channel model with known temporal and spatial autocorrelation properties
  - Simulated various transmit and receive side diversity algorithms - Maximal Ratio Combining, Eigen-beamforming, Maximal ratio transmission, TX antenna selection.
  - Simulated various spatial multiplexing techniques including Alamouti space-time block codes, MMSE, Zeo Forcing, SIC+MMSE.
  - Simulated OFDM with cyclic prefix in frequency selective channels and exploited frequency diversity using BCH codes. [Code]
- Business Plan on - A High Quality Wireless Video Streaming Module for Drones, Instructor: Prof. J.H Reed
  - Identified a business opportunity and proposed an idea for a wireless video streaming product for the Cinematography using Drones industry. [Proposal]
- Orthogonal Time Frequency Space waveform simulation. Instructor: Prof. J.H Reed
  - Simulated the OTFS waveform which included going from the Delay-Doppler domain to the Time Frequency domain at the transmitter. This was then passed through a channel and then from Time-Frequency domain back to Delay-Doppler domain. [Code]
- Micro Doppler Radar using HB100 and RCWL-0516, Personal Project
  - Implemented a Doppler radar in hardware by amplifying the received baseband signals from an RF front end (HB100) and then using an opamp-based active amplifier circuit with adjustable gain.
  - Sampled the amplified signal using an Arduino ADC and used Serial to send this data to the computer.
  - The digitally sampled signals were processed using an Short time Fourier Transform (STFT) algorithm with a hamming window in Python code. We can see micro Doppler features of the target ceiling fan - blades in the spectrogram output [Code], [Video]
- ADS-B Receiver and Antenna Design to Track Aircraft, Dr. SS Ram, Assoc Prof, IIITD
  - Designed and Constructed a portable Automatic Dependent Surveillance-Broadcast (ADS-B) radio receiver using a Software Defined Radio and an embedded computer to track commercial aircraft
  - Implemented a Matched Filter in the preamble detection stage of the ADSB receiver code. Implemented 1 bit error correction for the adsb packet.
  - Constructed a phased array antenna based on a paper in the Antennas and Propagation journal, for the system to improve aircraft tracking up to the horizon (400km). [Presentation]

Coursework

Multi-Channel Communications (MIMO), Deep Learning, Information Theory, Software Defined Radios, Stochastic Signals & Systems, Radar Systems, Reinforcement Learning, Data Structures and Algorithms.

Technical Skills

Programming: C, C++, Python
Scientific Computing Environment: MATLAB
ML libraries: PyTorch, Keras
Version Management: Git