Pragya Sharma

PHD CANDIDATE · ELECTRICAL AND COMPUTER ENGINEERING

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Education

Cornell University   Ithaca, NY 14853, USA
PHD CANDIDATE
Electrical and Computer Engineering (GPA: 4.06)
ADVISOR: Prof. Edwin C. Kan   August 2015 - Expected August 2020
THESIS: RF Sensor Systems for Indoor People Tracking and Cardiopulmonary Monitoring.

Indian Institute of Technology (IIT), Kharagpur   Kharagpur, WB 721302, India
BACHELOR OF TECHNOLOGY
Electrical Engineering (GPA: 9.34/10)   2011 - 2015

Publications

P. Sharma, X. Hui, J. Zhou, T. Conroy, and E. C. Kan, "Wearable Radio Frequency Sensor for Respiratory Rate, Respiratory Volume, and Heart Rate Monitoring," in *Nature Partner Journal (npj) Digital Medicine*, July 2020.

P. Sharma, G. Xu, X. Hui, D. L. Hysell, and E. C. Kan, "Deep-Learning Based Occupancy Detection and Counting using Ambient RF Sensing." (2020, Submitted)

G. Xu, **P. Sharma**, and E. C. Kan, "Indoor Object Sensing Using Radio-Frequency Identification with Inverse Solutions," at *IEEE Sensors* Conference, 2020. (Accepted)

G. Xu, **P. Sharma**, X. Hui, and E. C. Kan, "3D Device-Free Object Locating Using Passive Radio-Frequency Identification," 2020. (Under Review)

J. Zhou, **P. Sharma**, X. Hui, and E. C. Kan, "A Wireless Wearable RF Sensor for Brumation Study of Chelonians," in *IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology*, 2020.

P. Sharma, X. Hui, and E. C. Kan, "A Wearable RF Sensor for Monitoring Respiratory Patterns," at *IEEE Engineering in Medicine and Biology Society Conference (EMBC)*, Berlin, Germany, 2019.

D. L. Hysell, **P. Sharma**, M. Urco, and M. A. Milla, "Aperture-Synthesis Radar Imaging with Compressive Sensing for Ionospheric Research," in *Radio Science*, vol. 54, 2019.

X. Hui, **P. Sharma,** and E. C. Kan, "Microwave Stethoscope for Heart Sound by Near-Field Coherent Sensing," at *IEEE MTT-S International Microwave Symposium (IMS)*, Boston, MA, 2019.

P. Sharma and E. C. Kan, "Sleep Scoring with a UHF RFID Tag by Near Field Coherent Sensing," at *IEEE MTT-S International Microwave Symposium (IMS)*, Philadelphia, PA, 2018.

Projects

People Counting and Location Estimate Using Ambient Radio Signals   *Cornell University*
Funded by ARPA-E (Department of Energy)
PROFS. EDWIN KAN AND DAVID HYSELL   January 2016 - Present

- Using ambient low-cost passive RFID tag backscattered signal for un-tagged occupancy counting in a room using machine learning, and further estimating their locations and postures using 3D reconstructed image by solving inverse problem and beamforming approaches.
- Using a CNN model for occupant counting with high accuracy of **82%** for up to five occupants in various postures, for untrained locations.
- Demonstrated learning transfer from one room to another unseen-room setups with accuracy of **78 – 80%**, using only a small data for validation.
- Implemented novel sparsity-based OMP and FISTA reconstruction algorithms for high resolution 3D RF imaging, by setting up signal model as a linear inverse problem, giving improved performance than traditional matched-filtering and Capon's method.
- Developed simulation study in CST Microwave Studio to compare relative tag-receiver placement and algorithm performance.
- Designed a background-subtraction calibration algorithm with improved noise-cancellation, detecting one occupant presence with **100%** accuracy and decimeter level accuracy in a 4 m × 4 m room.
- Developed ensemble algorithms to improve the performance and reduce parameter sensitivity for inverse methods with limited bandwidth and spatial diversity.
- Implemented convex optimization and level-set approaches to extract object shape and size from the pixel reflectivity of imaging domain.
- Developed an optimal frequency selection algorithm for a multi-frequency setup to generate improved Fourier-reconstructed image based on K-space sampling.

Respiratory Pattern Monitoring with RF Near-Field Coherent Sensing (NCS)   *Cornell University*
Funded by National Institutes of Health (NIH), Department of Defense (DoD) CDMRP Discovery Award
PROF. EDWIN KAN, DR. ANA KRIEGER   August 2016 - Present

- Developed an over-clothing cardiopulmonary sensor by a software-defined radio to collect detailed respiratory and heartbeat waveforms.

- Designed and implemented a testing protocol to perform human study (**N = 30**) on simulated breathing disorders and central and obstructive sleep apnea.
- Implemented a tuning-free peak-detection algorithm to identify respiratory disorder with broad frequency range of 2-40 breaths per minute (BPM), which achieved high respiratory rate accuracy of **94.8%** (RMSE: 2.9 BPM) and respiratory volume accuracy of **77.5%** (RMSE: 0.11 L).
- Designed a semi-supervised support-vector machine (SVM) outlier-classification algorithm to detect motion artifacts with an accuracy of **91%**.
- Designed and implemented a bed-integrated sensor for sleep apnea detection in collaboration with Cornell Weill medical sleep center. The sensor is invisible to the user with improved antenna design and placement to measure chest motion. (Ongoing)
- Programmed an attention test protocol on PsyToolkit for a large-scale human study to evaluate stress/attention using both respiratory and heartbeat characteristics from the NCS sensor. (Ongoing)

Accuracy and Resources Trade-off in Machine Learning Algorithms   Cornell University
COURSE: CS 6780 ADVANCED MACHINE LEARNING   March - May 2019

- Developed approximation techniques to tackle constrained-resource issues with large training data and limited CPU, memory and energy availability, specifically in mobile devices.
- Implemented different approximation techniques including parameter pruning, loop perforation and quantization at both training and inference in machine learning algorithms including regression, neural networks and SVM in TensorFlow.

Online Trainable Near-Field Communication (NFC) Reader   Maxim Integrated, Dallas
INTERNSHIP: MAXIM INTEGRATED (MICROS, SECURITY AND SOFTWARE BU)   May - July 2017

- Programmed an NFC reader model including analog frontend and digital baseband processing in Python. Implemented new modulation protocols on output of the existing hardware to predict future challenges.
- Performed intelligent digital data demodulation using a simple neural network architecture in Python using Keras library, which achieved a test error of **1%** under optimal conditions and **11%** with low coupling efficiency and high noise.
- Implemented a real-time trainable setup for testing the experimental data from the reader, resulting in a low test error of **< 2%**.

Low-Voltage Arc Detection and Sensor Placement   IIT Kharagpur
PROF. AUROBINDA ROUTRAY   May 2014 - April 2015

- Developed an algorithm for low-voltage (230 V, 50 Hz) arc characterization and classification from other spikes using k-means clustering of PSD spectral distance measurements, achieving high accuracy **> 96%**.
- Developed an algorithm to estimate optimal sensor number and location for arc detection using bipartite graph approach with high accuracy, which achieved cost reduction by **24.8%**.

Awards

2015	**George W. Holbrook Jr.'52**, Graduate Research Award.	Cornell University
2015	**Best Signal Processing Project**, for B.Tech. project in Department of Electrical Engineering.	IIT Kharagpur
2011	**Inspire Scholarship**, among top 2% candidates in IIT Joint Entrance Examination (0.45 million applicants).	IIT Kharagpur
2011	**Certificate of Merit in Chemistry** for being among top 0.1% candidates in Chemistry in All India Senior School Certificate Examination (12th grade).	Delhi
2009	**Indian Prime Minister's Guest**, at Republic Day parade, for excellent performance in All India Secondary School Certificate Examination (10th grade), with 97.08% score.	Delhi

Teaching Experience

ECE 4960, Scientific and Numerical Computation, Teaching Assistant.   Spring 2018

ECE 4880, Radio Frequency Systems, assisted lab development and headed sessions.   Fall 2016

Technical Skills

Programming: MATLAB, Python (PyTorch, TensorFlow, Keras, Pandas), C, C++.

Tools: CST Microwave Studio, LabVIEW.

Relevant Courses

Wireless and RF System: RF Systems, Wireless Communications, Advanced High Speed and RF Integrated Circuits.

Algorithms and Data Processing: Inverse Methods in Natural Sciences, Scientific and Numerical Computation, Advanced Machine Learning, Digital Signal Processing, Digital Image Processing.