

# Guoyi Xu

Work Address: 500 W 120<sup>th</sup> St., Rm 1339, New York, NY, 10027, United States

Email: [gx2163@columbia.edu](mailto:gx2163@columbia.edu) / [gx36@cornell.edu](mailto:gx36@cornell.edu) | Phone: +1-(607) 379-8077

Google Scholar Page: [https://scholar.google.com/citations?user=olg3\\_5EAAAAJ&hl=en](https://scholar.google.com/citations?user=olg3_5EAAAAJ&hl=en)

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## EDUCATION

- Cornell University**, Ithaca, NY, United States 08/2018 – 08/2023  
**Ph.D.** in Electrical and Computer Engineering  
**Dissertation: Radio-Frequency Systems for Indoor Sensing and Localization**  
Research topics: Indoor object detection; device-free target locating; radio-frequency identification (RFID); RFID precision localization.  
Courses: Radio Frequency Systems; Inverse Methods in the Natural Sciences; Digital Communication System Design; Fundamentals of Data Compression; Random Signals in Communications and Signal Processing
- University of Electronic Science and Technology of China (UESTC)**, Chengdu, China 09/2014 – 06/2018  
**B.S.** in Electrical Engineering; **Cumulative GPA: 3.94/4.0; Major GPA: 4.0/4.0**  
Core Courses: Calculus; Linear Algebra; Probability Theory and Statistical Estimations; Semiconductor Physics; Fundamental of Analog Circuits; Digital Logic and Circuits; EDA Technology; Integrated Circuits Fabrication
- University of California, Berkeley**, Berkeley, CA, United States 01/2017 – 05/2017  
Concurrent Enrollment Undergraduate Student in Electrical Engineering; **GPA: 3.74/4.0**  
Courses: Microelectronic Devices and Circuits; Introduction to Communication Networks; Linear Integrated Circuits; Integrated Circuits for Communications

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## RESEARCH EXPERIENCE

- Postdoctoral Research Scientist, Department of Electrical Engineering, Columbia University**, New York, NY, United States  
Advisor: Prof. Harish Krishnaswamy
- Project: Joint Communications and Sensing (ongoing)** 09/2023 – present
- ◆ Developed a 60 GHz OFDM system using Universal Software Radio Peripheral (USRP) X310 (Ettus Research, Austin, TX, USA) and mmWave front end products (EVK06002, SiTime Semiconductors AB, Kista, Stockholm, Sweden). Implemented the physical layer OFDM communication system, and calibrated frequency offsets due to asynchronous local oscillators (LO) of multiple mmWave front end modules.
  - ◆ Working on developing sensing techniques using OFDM waveforms.
- Project: Digital Beamforming and Cross-Layer Digital Signal Processing for Real-time antenna-to-compute testbed (ReACT), Center for Ubiquitous Connectivity (CubiC), sponsored by Semiconductor Research Corporation (SRC) and DARPA (ongoing)** 09/2023 – present
- ◆ Responsible for developing advanced real-time digital signal processing algorithms for hybrid beamforming of next-generation wireless networks.
- Graduate Research Assistant, School of Electrical and Computer Engineering, Cornell University**, Ithaca, NY, United States  
Advisor: Prof. Edwin C. Kan
- Project: Zero-Bandwidth Precision Locating for Harmonic RFID Tag Through Building Materials** 06/2021 – 11/2021, 06/2022 – 08/2023
- ◆ Established the precision locating system with a PCB harmonic tag and Universal Software Radio Peripheral (USRP) radio transceivers. Performed on-site phase calibration using external hardware connections for repeatable phase measurements.
  - ◆ Characterized the differential phase-distance curves using spline fitting for reference tag locations, and devised a distance searching algorithm given differential phases of non-reference tag locations, from non-monotonic phase-distance curves.
  - ◆ Performed voxel tree searching to generate 3D locations from differential distances of multiple channels.
  - ◆ Devised an ambiguity-free algorithm to remove location ambiguity by leveraging channel redundancy in spatially diverse Tx/Rx antennas, where ambiguity due to non-monotonicity in phase-distance curves and wavelength cycles were eliminated.
  - ◆ Achieved mm-level locating accuracy, with > 90% being < 2 mm, at 1.8 GHz second harmonic carrier frequency.
- Project: Indoor RF Occupant Counting by RFID and Deep Learning, a DoE ARPA-E project** 06/2021 – 11/2021
- ◆ Established the indoor occupant counting system using a commercial off-the-shelf (COTS) RFID reader and passive tags, where tags were deployed internally to simulate wall and furniture installations.
  - ◆ Collected backscattered signals from tags including the Received Signal Strength Indicator (RSSI) and phase, for 0-4 occupants with standing and sitting postures, under various internal tag placements.
  - ◆ Selected training and testing datasets, performed cross-validation, and trained a 2D convolutional neural network model.

Tested the trained model, and achieved  $> 90\%$  and  $> 85\%$  counting accuracies before and after significant tag number reduction, for 0-4 occupants and all tag placements.

**Project: Microwave Indoor Imaging using RFID Coarrays** 02/2021 – 05/2021

- ◆ Studied different synthetic aperture radar (SAR) algorithms, including far-field beamforming and near-field range-migration algorithms, and conducted preliminary studies of microwave imaging based on far-field coarray beamforming by COTS RFID.
- ◆ Achieved decimeter-level imaging resolution with carrier frequency in the 902 – 928 MHz ISM band.

**Project: Indoor RF Imaging and Object Detection by RFID Systems, a DoE ARPA-E project** 09/2018 – 02/2021

- ◆ Established an RF imaging system by COTS RFID reader and passive RFID tags, deployed indoor reader antennas and tags with spatial diversity, and collected backscattered signals.
- ◆ Proposed a novel calibration method to eliminate the line-of-sight (LoS) propagation, background clutter and multipath effects in a Rician channel, to retrieve device-free object reflections.
- ◆ Applied the matched-filtering (MF) algorithm to reconstruct the voxel reflectivity image in both a 1:6 room model and a real-scale room/home setting. Achieved centimeter-level and decimeter-level locating errors, respectively.
- ◆ Used high-gain dipole reader antennas for optimal coverage of surrounding tags, tested and benchmarked multiple inverse solutions for voxel image reconstruction. Improved stability, locating accuracy and computational time by truncated pseudo-inverse with Tikhonov regularization.

**Undergraduate Research Intern, University of California, Berkeley, Berkeley, CA, United States**

Advisor: Prof. Ali M. Niknejad

**Project: Implementation of an FPGA-based COTS RFID Reader, a DARPA SHIELD Project** 09/2017 – 04/2018

- ◆ Participated in the implementation of FPGA modules for an RFID system, including baseband SNR boosting modules (digital DC baseline removal and IQ channel combining) and Manchester and Miller-16 encoding.
- ◆ Implemented an FPGA debugging tool using Opal Kelly FrontPanel®, consisting of a graphical user interface (GUI) as a debugging panel to configure on-board parameters without using signal generators or oscilloscopes.

**Undergraduate Research Assistant, University of Electronic Science and Technology of China, Chengdu, China**

Advisor: Prof. Hua Fan

**Project: Design and Simulation of a 12-bit SAR ADC with unary capacitor sorting and reconfiguration techniques (Undergraduate Thesis)** 12/2017 – 04/2018

- ◆ Implemented a comparator circuit by an operational amplifier and switch arrays, constructed a bubble sorting circuit, and built the RTL (VHDL) module to sort 64 capacitors in a successive approximation register (SAR) analog-to-digital converter (ADC).
- ◆ Performed mixed-signal simulations for the SAR ADC in Cadence, and calculated critical system parameters including the spurious-free dynamic range (SFDR), signal-to-noise ratio (SNR), and the effective number of bits (ENOB).

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## PUBLICATIONS

- 1) **Guoyi Xu** and Edwin C. Kan, “Leveraging spatial diversity for ambiguity-free ultra-narrowband phase-based 3D localization”, *IEEE Internet of Things Journal*, Mar. 2024.
- 2) **Guoyi Xu** and Edwin C. Kan, “Phase offset calibration in multi-channel radio-frequency transceivers”, *IEEE Journal of Microwaves*, vol. 4, no. 1, pp. 111-122, Jan. 2024.
- 3) **Guoyi Xu** and Edwin C. Kan, “Occupant counting using ambient RFID and deep learning”, *2024 IEEE Topical Conf. Wireless Sensors and Sensor Networks (WiSNet)*, San Antonio, TX, USA, Jan. 21-24, 2024 (Best Paper Finalist).
- 4) **Guoyi Xu** and Edwin C. Kan, “Ambiguity-free 3D millimeter-precision RFID tag localization inside building materials”, *2023 IEEE RFID Conf.*, Seattle, WA, USA, June 13-15, 2023 (Best Paper Finalist).
- 5) **Guoyi Xu**, Pragma Sharma, Edwin C. Kan, and David L. Hysell, “Indoor object sensing using radio-frequency identification with inverse methods”, *IEEE Sensors Journal*, vol. 22, no. 12, pp. 11336-11344, June 2021, doi: 10.1109/JSEN.2021.3086700.
- 6) **Guoyi Xu**, Pragma Sharma, Xiaonan Hui and Edwin C. Kan, “3D indoor device-free object detection by passive radio-frequency identification”, *IEEE Trans. Instrumentation and Measurement*, vol. 70, pp. 1-13, Feb. 2021, doi: 10.1109/TIM.2021.3059309.
- 7) **Guoyi Xu**, Pragma Sharma, and Edwin C. Kan, “Indoor object sensing using radio-frequency identification with inverse solutions”, *2020 IEEE Sensors Conference*, Rotterdam, Netherlands, Oct. 25-28, 2020, doi: 10.1109/SENSOR47125.2020.9278594.
- 8) Pragma Sharma, **Guoyi Xu**, Xiaonan Hui, David L. Hysell, and Edwin C. Kan, “Deep-learning based occupant counting ambient RF sensing”, *IEEE Sensors Journal*, vol. 21, no. 6, pp. 8564-8574, Dec. 2020, doi: 10.1109/JSEN.2020.3045035.
- 9) Zijiang Zhang, **Guoyi Xu**, and Edwin C. Kan, “Outlooks for RFID-based autonomous retails and factories”, *IEEE J. Radio Frequency Identification*, vol. 7, pp. 12-19, Oct. 2022.
- 10) Jianlin Zhou, Thomas B. Conroy, **Guoyi Xu**, and Edwin C. Kan, “Morphology transformation and content selection of near-field RF sensing by complex vector injection”, *IEEE J. Electromagnetics, RF and Microwaves in Medicine and Biology*, vol. 6, no. 4, pp. 555-565, Aug. 2022.

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## REVIEWER ACTIVITIES

- ◆ I am currently serving as the reviewer for *IEEE Internet of Things Journal*, *IEEE Microwave and Wireless Technology Letters*, *IEEE Journal on Selected Areas in Sensors*, and *IEEE Communications Magazine*.
- ◆ In 2023, I served as the reviewer for *IEEE Transactions on Microwave Theory and Techniques*, *IEEE Sensors Journal*, and *IEEE Sensors Conference (2023)*.
- ◆ In 2022, I served as the reviewer for *IEEE Transactions on Microwave Theory and Techniques* and *IEEE Instrumentation & Measurement Magazine*.
- ◆ In 2021, I served as the reviewer for *IEEE Journal of Radio Frequency Identification*, *IEEE Instrumentation & Measurement Magazine*, and *IET Renewable Power Generation*.

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## TEACHING

**Graduate Teaching Assistant for ECE-4880/5690 “Radio Frequency Systems”**

**School of Electrical and Computer Engineering, Cornell University, Ithaca, NY, United States**

Fall 2021 & 2022

**Course Instructor: Prof. Edwin C. Kan**

- ◆ Instructed undergraduate/graduate students in lab sessions through projects such as: VNA de-embedding; characterizing two-port RF modules; building signal chains with baseband signal processing and frequency conversion, etc.
- ◆ Held in-depth discussions on important concepts, including: transmission lines, nonlinearities, matrix representations for two-port networks, free-space propagation, multi-path, superheterodyne, IQ modulation/demodulation, etc.

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## INTERNSHIP

**MathWorks, Inc., Natick, MA, United States**

01/2022 – 05/2022

**Project: HDL data type support for MATLAB/Simulink co-simulation with HDL simulators.**

- ◆ Constructed MATLAB/Simulink co-simulation testbench prototypes to investigate unsupported HDL data types.
- ◆ Implemented C++ source codes for HDL data type support for MATLAB/Simulink co-simulation
- ◆ Performed unit testing, and conducted RFAIN writing and review according to MathWorks’ guidelines.

**Project: Quality Engineering work for HDL Verifier’s new feature for co-simulation.**

- ◆ Reviewed the new feature during pre-release.
- ◆ Wrote automated unit tests for the new co-simulation features of HDL Verifier.

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## TECHNICAL SKILLS

- ◆ Programming: MATLAB, Python, C++, Java, Verilog/SystemVerilog, VHDL
- ◆ Software/Platforms: MATLAB, Simulink, LabVIEW, Pytorch, CST Studio, ModelSim/QuestaSim, Cadence