

Guoyi Xu (许郭译)

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Google Scholar Page: https://scholar.google.com/citations?user=olg3_5EAAAAAJ&hl=en

EDUCATION & EXPERIENCES

- Columbia University**, New York, NY, United States 09/2023 – present
Postdoctoral Research Scientist in Electrical Engineering
Advisor: Prof. Harish Krishnaswamy
Research topics: Joint communications and sensing (JCAS); orthogonal frequency-division multiplexing (OFDM); wireless sensing; wireless communications; digital signal processing; millimeter-wave system integration.
- Cornell University**, Ithaca, NY, United States 08/2018 – 08/2023
Ph.D. in Electrical and Computer Engineering
Advisor: Prof. Edwin C. Kan
Committee: Prof. Edwin C. Kan, Prof. David L. Hysell and Prof. Christoph Studer
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

PUBLICATIONS

- 1) **Guoyi Xu** and Harish Krishnaswamy, “OFDM-based joint communication and ranging with improved accuracy by frequency-domain zero-padding: Cramer-Rao lower bound and 60 GHz over-the-air validation” (*under review for IEEE WAMICON 2025*).
- 2) **Guoyi Xu**, Aakash Kapoor, and Edwin C. Kan, “Leveraging spatial diversity for ambiguity-free ultra-narrowband phase-based 3D localization”, *IEEE Internet of Things Journal*, vol. 11, no. 12, pp. 22337-22350, June 2024.
- 3) **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.
- 4) **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).
- 5) **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 (2nd place in Best Paper Finalists).
- 6) **Guoyi Xu**, Pragya Sharma, David L. Hysell, and Edwin C. Kan, “Indoor object sensing using radio-frequency identification with inverse methods”, *IEEE Sensors Journal*, vol. 22, no. 12, pp. 11336-11344, June 2021.
- 7) **Guoyi Xu**, Pragya 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.
- 8) **Guoyi Xu**, Pragya 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.
- 9) Pragya Sharma, **Guoyi Xu**, Xiaonan Hui, David L. Hysell, and Edwin C. Kan, “Deep-learning based occupant counting by ambient RF sensing”, *IEEE Sensors Journal*, vol. 21, no. 6, pp. 8564-8574, Dec. 2020.
- 10) Zijing 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.
- 11) 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.
- 12) Zijing Zhang, Jianlin Zhou, Thomas B. Conroy, Xiaonan Hui, Pragya Sharma, **Guoyi Xu**, Kapil Gangwar, Upekha Delay, Aakash Kapoor, Edwin C. Kan, “Near-field radio sensing for biomedical, biological, and cyberphysical intelligence”, *IEEE Sensor Letters*,

vol. 8, no. 3, Mar. 2024.

- 13) Yue Zhao, **Guoyi Xu**, Yunlong Sun, Boan Pan, Ting Li, "A portable high-density absolute-measure NIRS imager for detecting prefrontal lobe activity under fatigue driving", *Microelectronics Reliability*, vol. 82, pp. 197-203. Mar., 2018.
- 14) Fulin Zhong, Zhenglun Kong, **Guoyi Xu**, Ting Li, "High stability and robustness of a developed novel laser acupuncture theranostic device", *Microelectronic Reliability*, vol. 78, pp. 401-405, Nov. 2017.
- 15) Boan Pan, Ting Li, Yan Li, **Guoyi Xu**, "A reliable integrative autocorrelator device for particle fluctuation rate monitoring", *Microelectronic Reliability*, vol. 78, pp. 280-284, Nov. 2017.

RESEARCH PROJECTS

Postdoctoral Research Scientist, Department of Electrical Engineering, Columbia University, New York, NY, United States

Advisor: Prof. **Harish Krishnaswamy**

Project: Multi-path decomposition using band-limited signals for joint communications and sensing (ongoing)

09/2024 – present

- ◆ Generated the matched filter output function by correlating the over-sampled transmitted and received baseband signals with zero-padded frequency domains, and simulated different multi-path profiles with varying delay separations, particularly those smaller than the original sampling period.
- ◆ Proved mathematically that the QPSK-modulated matched filter output functions are linearly independent functionals by Wronskians, laying the foundation to decompose the merged multi-path response into individual path responses.
- ◆ Formulated the multi-path decomposition problem as a linear inverse problem, and investigated different matrix inversion techniques, particularly those leveraging iterative solutions or sparsity-based solutions to cope with limited computational resources for storing large matrix multiplications.

Project: Millimeter-wave OFDM radar ranging for joint communications and sensing (ongoing)

09/2023 – present

- ◆ Developed a 60 GHz OFDM system using Universal Software Radio Peripheral (USRP) X310 (Ettus Research, Autsin, TX, USA) and mmWave front end platform (EVK06002, Sivers Semiconductors AB, Kista, Stockholm, Sweden).
- ◆ Implemented the physical layer OFDM communication system including Schmidl-Cox synchronization, minimum mean square error (MMSE) channel estimation, correlation-based real-time frequency offset calibration algorithm leveraging pilot subcarriers, and data modulation/demodulation.
- ◆ Developed matched-filter-based sub-sampling-period time delay detection method by padding zeros in the OFDM-modulated frequency domain, to effectively achieve time-domain over-sampling and improve the detection accuracy.
- ◆ Conducted Cramer-Rao lower bound (CRLB) analysis under additive white Gaussian noise (AWGN) for the proposed zero-padding improved matched filter time delay detection method.
- ◆ Experimentally validated the proposed time delay detection method on the 60 GHz OFDM communication system, and achieved 1 – 2 ns time delay detection accuracy for 50 MHz sampling rate (20 ns sampling period).

Graduate Research Assistant, School of Electrical and Computer Engineering, Cornell University, Ithaca, NY, United States

Advisor: Prof. **Edwin C. Kan**

Project: Ultra-Narrowband 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 beam azimuth 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 Fourier-based matrix inversion 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 noise stability, locating accuracy and computational time by using Tikhonov regularization with significantly improved matrix multiplication based on truncated singular value decomposition (SVD).

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).

INVITED TALKS

SRC CUBiC scholar-led workshop, virtual 10/24/2024

- ◆ Title: **ReACT: Real-Time Antenna-to-Compute Testbed**
- ◆ Host: Semiconductor Research Corporation (SRC)

◆ Co-presented with Chung-Hsuan Tung, Zhenzhou Qi, and Wei Cheng from Prof. Tingjun Chen's Lab from Duke University

Texas Tech University, Lubbock, TX, United States 09/23/2024

- ◆ Title: **Radio-Frequency Systems and Signal Processing Techniques for Indoor Sensing Tasks**
- ◆ Host: Prof. Changzhi Li

Nokia Bell Labs, virtual 09/06/2024

- ◆ Title: **Estimating Time Delays Using OFDM Pilot Symbols for Joint Communication and Sensing**
- ◆ Host: Dr. Dragan Samardzija

Stanford University, Stanford, CA, United States 05/19/2023

- ◆ Title: **Wireless Sensing Using Radio Signals**
- ◆ Host: Prof. H. Tom Soh

CONFERENCE PRESENTATIONS

IEEE RFID 2024 – The 18th Annual International Conference on RFID, Boston, MA, United States 06/04/2024 – 06/06/2024

- ◆ Poster: **Reducing Reference Points for Millimeter-Precision RFID Tag Localization in Building Structures**

Radio Wireless Week (RWW) 2024, San Antonio, TX, United States 01/21/2023 – 01/24/2023

- ◆ Presentation 1 & Poster: **Device-Free Occupant Counting Using Ambient RFID and Deep Learning**
- ◆ Presentation 2: **Phase Offset Calibration in Multi-Channel Radio Frequency Transceivers**

IEEE RFID 2023 – The 17th Annual International Conference on RFID, Seattle, WA, United States 06/13/2023 – 06/15/2023

- ◆ Presentation: **Ambiguity-Free 3D Millimeter-Precision RFID Tag Localization Inside Building Materials**

ACADEMIC SERVICE & INDEPENDENT REVIEWER ACTIVITIES

Publication Chair

- ◆ IEEE RFID/DTPI/AMES 2025 at Cyber-Physical Radio Week.

- ◆ Conference dates: 04/22/2025 – 04/24/2025.
- ◆ Conference location: Atlanta, GA, United States.

Independent Reviewer Activities

- ◆ *IEEE Open Journal of Engineering in Medicine and Biology* (2024)
- ◆ *IEEE Internet of Things Journal* (2024)
- ◆ *IEEE Journal on Selected Areas in Sensors* (2024)
- ◆ *IEEE Transactions on Intelligent Vehicles* (2024)
- ◆ *IEEE Transactions on Instrumentation and Measurement* (2024)
- ◆ *IEEE Communications Magazine* (2024)
- ◆ *IEEE Microwave and Wireless Technology Letters* (2023, 2024)
- ◆ *IEEE Sensors Conference* (2023, 2024)
- ◆ *IEEE Sensors Journal* (2023)
- ◆ *IEEE Transactions on Microwave Theory and Techniques* (2022, 2023)
- ◆ *IEEE Journal of Radio Frequency Identification* (2021)
- ◆ *IEEE Instrumentation & Measurement Magazine* (2021)
- ◆ *IET Renewable Power Generation* (2021)

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 through lab projects such as: VNA de-embedding; characterizing two-port RF modules; building radio 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, coherence bandwidth and time, superheterodyne, IQ modulation, etc.

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 using SystemVerilog, Verilog and VHDL, and conducted code/product review.

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

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

MENTORSHIP

- ◆ **Yuan Ma** (master’s student at Columbia University), Jun. 2024 – present
Simulation of 2D antenna array sidelobes for beamforming applications at 140 GHz.
- ◆ **Gilles Djomani** (second-year Ph.D. student at Cornell University), Aug. 2022 – Dec. 2022.
Proposal writing for RF imaging on biomedical cavity detection.
- ◆ **Zijing Zhang** (first-year Ph.D. student at Cornell University), Aug. 2019 – Dec. 2019.
RFID imaging experiments.

COMMUNITY SERVICE

Middle School Science Class Talk “Have Some Fun with Science and Engineering”

The Kings Academy, Seymour, TN, United States

Jan. 2019

Host: Mrs. Heidi Sasscer

- ◆ Delivered a speech in a middle school science class on waves of scientific revolutions, scientific discovery and engineering inventions, my passion for science and engineering, my education path as an electrical engineering major college student, my research activities in microwave sensing using electromagnetic wave propagation.
- ◆ Shared my personal experience in middle school with students through after-class conversations, and answered students’ questions on computer, circuits, radio sensing, and electrical engineering in general.

TECHNICAL SKILLS

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