

Pan Qingrui

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Summary

I am a final year PhD candidate in the Department of Computing at Hong Kong Polytechnic University, focusing on fingerprinting work related to RFID systems, specifically indoor localization and hardware fingerprint for security issues. My research interests also include AIoT, wireless sensing, and backscatter communication. With published papers in top-tier conferences and journals, I am passionate about advancing the field of wireless communication and AIoT.

Education

The Hong Kong Polytechnic University

Ph.D. in Computer Science

Hong Kong

Sept 2019 - Current

- Chief Supervisor: Dr. Lei Yang, Co-supervisor: Prof. Bin Xiao
- Expected to graduate before Oct 2023.

City University of Hong Kong

B.E. in Information Engineering

Hong Kong

Sept 2013 - May 2017

- Bachelor of Engineering in Information Engineering with First Class Honours

Research Project and Publication

Sparse Antenna Array for AoA Tracking Systems

Hong Kong

Hong Kong Polytechnic University

Sep 2019 - Sep 2020

- Designed a sparse antenna array in a spiral manner to reduce the number of elements in a large-sized uniform planar array. Evaluated the spiral sparse antenna array on an 8×8 uniform planar array and achieved similar performance with only 12.5% of the antenna elements.
- Built a prototype using Impinj Speedway readers and an 8-channel hub, and attached the antenna elements to a customized acrylic board. The sparse antenna array provided over 40% performance improvement compared to existing sparse arrays.
- **Publication:**
 1. **Qingrui Pan**, Zhenlin An, Qiongzhen Lin, Lei Yang, "LSAB: Enhancing Spatio-Temporal Efficiency of AoA Tracking Systems", in Proc. of IEEE INFOCOM, 2022. (CCF A, accepted rate: 19.9%)
 2. **Qingrui Pan**, Zhenlin An, Qiongzhen Lin, and Lei Yang, "LSAB: Enhancing Spatio-Temporal Efficiency of AoA Tracking Systems," ACM Transactions on Sensor Networks, 2022.

Large-Scale Physical-layer Identifications of RFIDs

Hong Kong

Hong Kong Polytechnic University

Dec 2020 - Aug 2021

- Proposed a new hardware fingerprint called RF-DNA, consisting of a single-helix chain made up of millions of Dual Natural Attributes (DNA), each representing a unique intrinsic response of a tag.
- Collected RF-DNA instances from 16,000 tags using a customized automatic acquisition machine built with USRP.
- Improved the mean accuracy of identification in large scale datasets to 95.98%.
- **Publication:**
 1. **Qingrui Pan**, Zhenlin An, Xueyuan Yang, Xiaopeng Zhao, Lei Yang, "RF-DNA: Large-Scale Physical-layer Identifications of RFIDs via Dual Natural Attributes", In Proc. of ACM MobiCom, 2022 (CCF A, accepted rate: 17.6%)
 2. **Qingrui Pan**, Zhenlin An, Xueyuan Yang, Xiaopeng Zhao, Lei Yang, "Fingerprinting RFIDs with RF-DNA", IEEE/ACM Transactions on Networking (Under Review)

Revisiting Backscatter Frequency Drifts for Fingerprinting RFIDs

Hong Kong

Hong Kong Polytechnic University

Sep 2021 - Sep 2022

- Developed a practical solution to enhance the frequency resolution of backscatter frequency drift (BFD) without hardware or protocol modifications.
- Collected BFDs from over 7,000 tags of nine different models using a custom automatic acquisition machine. Showed that high-resolution BFD distinguishability significantly increased to 99.4%, while the identification accuracy improved to 94%.
- **Publication:**
 1. **Qingrui Pan**, Zhenlin An, Xueyuan Yang, Xiaopeng Zhao, Lei Yang, "Revisiting Backscatter Frequency Drifts for Fingerprinting RFIDs: A Perspective of Frequency Resolution", In Proc. of IEEE SECON, 2023 (Under Review)

Turbocharging Deep Backscatter with a Single RF Source

Hong Kong

Hong Kong Polytechnic University

Sep 2019 - Aug 2020

- Proposed a turbocharging solution to power up and communicate with deep backscatter networks (DBNs) through a single augmented RF source.
- Implemented in commodity devices, demonstrated the ability to power up backscatter sensors up to 60m distance in the air (10x longer than commercial off-the-shelf readers) and 50cm-depth underwater (2x deeper than the previous record).
- **Publication:**
 1. Zhenlin An, Qiongzhen Lin, **Qingrui Pan**, Lei Yang, "Turbocharging Deep Backscatter Through Constructive Power Surges with a Single RF Source", In Proc. of IEEE INFOCOM, 2021 (CCF A, accepted rate: 19.9%)

RFID Localization Database and Neural RF Radiance Field

Hong Kong

Hong Kong Polytechnic University

Sep 2020 - Aug 2022

- Built a distributed localization platform with three gateways, each equipped with a 4×4 antenna array.
- Collected a million-scale dataset of phase instances with position labels from four semi-indoor and ten full-indoor environments.
- Proposed NeRF², a neural radio-frequency radiance field trained on the dataset, and demonstrated its performance enhancement of approximately 50%.
- **Publication:**
 1. Xiaopeng Zhao, Zhenlin An, **Qingrui Pan**, Lei Yang, “NeRF2: Neural Radio-Frequency Radiance Fields”, In Proc. of ACM MobiCom, 2023 (CCF A)

Cross-Technology Communication between NFC and Camera

Hong Kong

Hong Kong Polytechnic University

Jan 2022 - Aug 2022

- Proposed a cross-technology communication between NFC and camera using harmless magnetic interference stripes on the CMOS image sensor.
- Developed a proof-of-concept prototype and tested it on 11 smart devices, achieving a maximum throughput of 2.58 kbps (outperforming magnetometer-based solutions by 58 times).
- **Publication:**
 1. Donghui Dai, Zhenlin An, **Qingrui Pan**, Lei Yang, “MagCode: NFC-Enabled Barcodes for NFC-Disabled Smartphones”, In Proc. of ACM MobiCom, 2023 (CCF A)

Work Experience

Huawei Technologies, Co. Ltd

Shenzhen, China

Assistant Researcher

Oct - Dec 2020

- Collaborated in a three-person team to develop a preliminary indoor RFID localization system, locating passive UHF RFID tag with a 4×4 antenna array.
- Generating self-defined Command and transmitting via USRP X310 to challenge the tag, and extract RSS and phase from raw data.
- Creating an interface by Python to illustrate the real-time localization results, localization error less than 10cm.

Moxie Culture Communication, Co.

Shenzhen, China

Content Creator

Nov 2016 - Mar 2019

- Collaborated with a four-person team as the main writer, creating over 20 pieces of non-fiction science comics, with three hundred million views. Collaborated publishing of four books, with total sales of over 600,000 copies.

Technische Hochschule Nürnberg

Nürnberg, Germany

Student Research Assistant

May - July 2016

- Recognized bird species by bird songs, extracting features via Short-time Fourier transform (STFT).
- Creating a graphic user interface by MATLAB, enabling manually cut key segments.

Teaching Experience

COMP2021 Object-Oriented Programming

PolyU, HK

Teaching Assistant

Fall 2019/2020

COMP3421 Web Application Design and Development

PolyU, HK

Teaching Assistant

Spring 2020/2021/2022

ENG2003 Information Technology

PolyU, HK

Teaching Assistant

Fall 2021, Spring 2023

Awards and Scholarships

2022 **INFOCOM Student Conference Grant**, INFOCOM

Virtual

2022 **MobiCom'22 Travel Grant**, MobiCom

Sydney, Australia

2017 **Assistantship under the Teaching Postgraduate Studentship Scheme**, The Hong Kong Polytechnic University

Hong Kong

2016 **Overseas Internship Scheme**, City University of Hong Kong

Hong Kong

2013 **CityU Mainland Student Scholarship Scheme - Full Tuition Scholarship**, City University of Hong Kong

Hong Kong

Skills

Programming	MATLAB, Python, HTML/CSS, Java, SQL, C/C++
Communication	USRP Software Defined Radio, GNU Radio, Ansys HFSS
Miscellaneous	TeX(Texifier/Overleaf), Microsoft Office, Auto CAD, Linux, Git
Media	Adobe Photoshop, OmniGraffle, Adobe Premier, DaVinci Resolve, Adobe Audition, Procreate
Soft Skills	Teamwork, Time Management, Problem-solving, Documentation, Engaging Presentation