Zhenlin An

Website: anplus.github.io
Email: an.zhenlin@outlook.com
LinkedIn: zhenlin-an-209500b4

Biography

My research interests are broadly including wireless systems and networking, mobile computing, wireless sensing, and wireless security and privacy. Currently, I focus on NextG AI-driven wireless channel modeling and prediction, digital twin and wireless localization.

- Keywords: Wireless Systems and Networking, Indoor Localization and Wireless Sensing, Acoustic, Embedded System, Low-power IoT Systems, Wireless Security

Education

The Hong Kong Polytechnic University Hong Kong SAR, China
Ph.D. in Computer Science 2017.9–2021.10

- Chief Supervisor: Dr. Lei Yang, Co-supervisor: Prof. Jiannong Cao (IEEE Fellow)
- Thesis: "On Cross-Technology Mutualism in the Internet of Things: Communication and Localization"

Dalian University of Technology Dalian, China
B.E. degree in Electronic Engineering and Information System 2013.9–2017.7

- Supervisor: Prof. Chengan Guo

Professional Experience

University of Pittsburgh Pittsburgh, PA, US
Postdoctoral Associate at Department of Computer Science 2024.7-Present

- Advised by Dr. Longfei Shangguan, Prof. Kyle Jamieson (InterDigtial: **John Kaewell** and **Philip Pietraski**)

Princeton University Princeton, NJ, US
Postdoctoral Research Associate at Department of Computer Science 2023.12-2024.7

- Advised by Prof. Kyle Jamieson, Dr. Longfei Shangguan (InterDigtial: **John Kaewell** and **Philip Pietraski**)
- Develop a full-differentiable ray tracing system and neural networks for radio environment model and channel prediction using tensorflow and Nvidia Sionna.

The Hong Kong Polytechnic University Hong Kong SAR, China
Postdoctoral Fellow Advised by Dr. Lei Yang, funded by Postdoc Matching Fund 2021.11-2023.11

- Multi-modality Deep learning localization system for BLE and RFID
- Design neural RF ray tracing for channel prediction and localization: Best paper runner-up in MobiCom'23.
- Wireless Security (hardware fingerprints for RFID and NFC (Develop an USRP-emulated RFID reader to collect raw backscatter data and classification algorithm.); inaudible command injection on wireless charger.
- Develop acoustic backscatter hardware and software. PZT-based acoustic energy harvest and communication.

Huawei Technolgoies Shenzhen, Guangdong, CN
Research Intern in 2012 2020.6-2020.12

- Develop CNN based RFID localization platform with distributed antenna array. (One patent)
- Develop beamforming algorithm for RFID systems in complex warehouses (reading rate > 99.9%). (One patent)

The Hong Kong Polytechnic University Hong Kong SAR, China
Research Intern at Department of Computing 2016.11-2017.3

- Advised by Dr. Lei Yang

Research Projects

1. **Wireless Sensing and Digital Twin**
   - Physics-guided AI wireless channel estimation and radio environment modelling (MobiCom'23, MobiSys'24)
   - Deep learning and Antenna Array Localization Platform (MobiSys'20, INFOCOM'22, TOSN'22)
   - Ultrasound Positioning System for smartphone (MobiCom'19 and TMC'20)
   - Multi-modal Sensing: fusing RF and image sensor (SECON'20, TOSN'22)

2. **Backscatter Communication and Sensing System**
   - Acoustic Backscatter System for RF-disable environment (e.g., Structure Health Monitoring) (SIGCOMM'22)
   - High throughput RFID MAC layer design (MobiCom'17, TON'19, INFOCOM'19, TON'20, NSDI'24)
   - Long Range Backscatter Communication (INFOCOM'21, INFOCOM'23)

3. **Cross-technology Communication System**
   - Transformer NN for PHY translation: WiFi to ZigBee and BLE (Sensys'23)
   - NFC to Camera Communication (MobiCom'23), Fusing NFC Antenna and QRCodes (MobiCom'21)
   - AM Radio and UHF RFID communication (INFOCOM'20, TON'22)
   - WiFi and UHF RFID communication (MobiCom'18, TON'20)

4. **IoT Security & Privacy**
   - Inaudible Command Injection and Protection (S&P'23)
   - Hardware Fingerprint Authentication in UHF RFID tag (MobiCom'22, SECON'23) and NFC (INFOCOM'23)

Awards and Honours

• **Best Paper Award Runner-up, ACM MobiCom**	2023
• Graduate Award, ACM MobiCom	2023
• **Best Paper Award, IEEE SECON**	2023
• **ACM SIGBED China Doctoral Dissertation Award**	2022
• Best Demo Award Runner-up (2/20), ACM MobiCom	2022
• **Best Paper Award (1/129), IEEE SECON**	2020
• Best-In-Session Presentation Award, IEEE INFOCOM	2019
• Student Travel Grant, IEEE INFOCOM	2019
• Best Demo Award Runner-up (2/27), ACM MobiCom	2018
• Outstanding Graduate, Dalian University of Technology	2017
• Meritorious Winner, Interdisciplinary Contest in Modeling (ICM)	2016
• Gold Award, International Visual Designer for Arduino Competition, Labcenter Electronics	2016

Publications

[†]Co-primary author, [‡] Co-corresponding author, Google Scholar Page

Conference Articles

1. **Zhenlin An**, Longfei Shangguan, John Kaewell, Philip Pietraski, Kyle Jamieson
   RadioTwin: A Digital Building Material Twin for Wideband, Cross-link, Cross-band Wireless Channel Prediction
   In Submission, 2024

2. Zheng Gong, **Zhenlin An**[‡], Donghui Dai, Jingyu Tong, Sicong Liao, Lei Yang[‡]
   Enabling Cross-Medium Wireless Networks with Miniature Mechanical Antennas
   In Proc. of **ACM MobiCom**, Washington, D.C., USA, 2024.

3. Jingyu Tong, **Zhenlin An**, Xiaopeng Zhao, Sicong Liao, Lei Yang
   In-Sensor Machine Learning: Radio Frequency Neural Networks for Wireless Sensing
   In Proc. of **ACM MobiHoc**, 2024.

4. Xueyuan Yang, **Zhenlin An**, Qingrui Pan, Lei Yang, Dangyuan Lei, Yulong Fan
   Binary Optical Machine Learning: Million-Scale Physical Neural Networks with Nano Neurons
   In Proc. of **ACM MobiCom**, Washington, D.C., USA, 2024.

5. Donghui Dai, **Zhenlin An**[‡], Zheng Gong, Qingrui Pan, Lei Yang[‡]
   RFID+: Spatially Controllable Identification of UHF RFIDs via Controlled Magnetic Fields
   In **USENIX NSDI**, Santa Clara, USA, 2024.

6. Xiaopeng Zhao, Shen Wang, **Zhenlin An**, Lei Yang
   Crowdsourced Geospatial Intelligence: Constructing 3D Urban Maps with Satellitic Radiance Fields
   In Proc. of **ACM IMWUT/UbiComp**, 2024.

7. Yanni Yang, Genglin Wang, **Zhenlin An**, Pengfei Hu, Xiuzhen Cheng, Guoming Zhang
   RF-Parrot: Wireless Eavesdropping on Wired Audio
   In Proc. of **IEEE INFOCOM** 2024.

8. Xiaopeng Zhao, Guosheng Wang, **Zhenlin An**, Qingrui Pan, Lei Yang
   Understanding Localization by a Tailored GPT
   In Proc. of **ACM MobiSys**, Tokyo, Japan, 2024.

9. Donghui Dai[†], **Zhenlin An**[†], Lei Yang
   Inducing Wireless Chargers to Voice Out for Inaudible Command Attacks
   In **IEEE Security & Privacy (Oakland)** 2023.

10. Xiaopeng Zhao, **Zhenlin An**[‡], Qingrui Pan, Lei Yang[‡]
    NeRF2: Neural Radio-Frequency Radiance Fields
    In Proc. of **ACM MobiCom**, Madrid, Spain, Oct 2-6, 2023. (**Best Paper Award Runner-up**)

11. Donghui Dai, **Zhenlin An**[‡], Qingrui Pan, Lei Yang[‡]
    MagCode: NFC-Enabled Barcodes for NFC-Disabled Smartphones
    In Proc. of **ACM MobiCom**, Madrid, Spain, Oct 2-6, 2023.

12. Sicong Liao, **Zhenlin An**, Qingrui Pan, Xiaopeng Zhao, Jingyu Tong, Lei Yang[‡]
    XiTuXi: Sealing the Gaps in Cross-Technology Communication by Neural Machine Transition
    In Proc. of **ACM Sensys**, Istanbul, Turkiye, Nov 13-15, 2023.

13. Xueyuan Yang, **Zhenlin An**, Xiaopeng Zhao, Lei Yang
    Transfer Beamforming via Beamforming for Transfer
    In Proc. of **IEEE INFOCOM**, New York area, USA, May 17 - 20, 2023.

14. Yanni Yang, Jiannong Cao, **Zhenlin An**, Yanwen Wang, Pengfei Hu, Guoming Zhang
    NFChain: A Practical Fingerprinting Scheme for NFC Tag Authentication
    In Proc. of **IEEE INFOCOM**, New York area, USA, May 17 - 20, 2023.

15. Qingrui Pan, **Zhenlin An**, Xiaopeng Zhao, Lei Yang
    Revisiting Backscatter Frequency Drifts for Fingerprinting RFIDs: A Perspective of Frequency Resolution
    In Proc. of **IEEE SECON**, Madrid, Spain, Sep. 11-14, 2023.(**Best Paper Award**)

16. 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**, Sydney, Australia, Oct 17-22, 2022.

17. Zheng Gong[†], Lubing Han[†], **Zhenlin An**[‡], Lei Yang[‡], Siqi Ding, Yu Xiang
    Empowering Smart Buildings with Self-Sensing Concrete for Structural Health Monitoring
    In Proc. of **ACM SIGCOMM**, Amsterdam, the Netherlands, Aug 22-26, 2022.

18. Qingrui Pan, **Zhenlin An**, Xiaopeng Zhao and Lei Yang
    LSAB: Enhancing Spatio-Temporal Efficiency of AoA Tracking Systems
    In Proc. of **IEEE INFOCOM**, 2-5 May 2022.

19. **Zhenlin An**, Qiongzheng Lin, Xiaopeng Zhao, Lei Yang, Dongjiang Zheng, Guiqing Wu, Shan Chang
One Tag, Two Codes: Identifying Optical Barcodes with NFC
In Proc. of **ACM MobiCom**, New Orleands, USA, Oct 25-29, 2021.

20. **Zhenlin An**, Qiongzheng Lin, Qingrui Pan, Lei Yang
Turbocharging Deep Backscatter Through Constructive Power Surges with a Single RF Source
In Proc. of **IEEE INFOCOM**, May 10-13 2021.

21. **Zhenlin An**†, Qiongzheng Lin†, Ping Li, Lei Yang
General-Purpose Deep Tracking Platform across Protocols for the Internet of Things
In Proc. of **ACM MobiSys**, Toronto, Canada, June 15-19, 2020.

22. **Zhenlin An**, Qiongzheng Lin, Lei Yang, Lei Xie
Activating Wireless Voice for E-Toll Collection Systems with Zero Start-up Cost
In Proc. of **IEEE INFOCOM**, Beijing, China, April 27-30 2020.

23. Qiongzheng Lin, Lei Yang, **Zhenlin An**, Yi Guo, Ping Li
RFCamera: Identifying RFIDs in Pixel Dimension
In Proc. of **IEEE SECON**, Combo, Italy, June 22-25, 2020. (**Best Paper Award**)

24. Qiongzheng Lin†, **Zhenlin An**†, Lei Yang
Rebooting Ultrasonic Positioning Systems for Ultrasound-Incapable Smart Devices
In Proc. of **ACM MobiCom**, Los Cabos, Mexico, Oct 21-25, 2019.

25. **Zhenlin An**, Qiongzheng Lin, Lei Yang, Wei Lou
Embracing Tag Collisions: Acquiring Bloom Filters across RFIDs in Physical Layer
In Proc. of **IEEE INFOCOM**, Paris, April 29 - May 2, 2019.

26. Ping Li, **Zhenlin An**, Lei Yang, Panlong Yang
Towards Physical-Layer Vibration Sensing with RFIDs
In Proc. of **IEEE INFOCOM**, Paris, France, April 29 - May 2, 2019.

27. **Zhenlin An**, Qiongzheng Lin, Lei Yang
Cross-Frequency Communication: Near-Field Identification of UHF RFIDs with WiFi!
In Proc. of **ACM MobiCom**, New Delhi, India, Oct 29 - Nov 2, 2018.

28. Lei Yang, Qiongzheng Lin, Chunhui Duan, **Zhenlin An**
Analog On-tag Hashing: Towards Selective Reading as Hash Primitives for COTS Gen2 RFID Systems
In Proc. of **ACM MobiCom**, Snowbird, UT, USA, Oct. 16-20, 2017.

Journal Articles

29. Donghui Dai, **Zhenlin An**, Qingrui Pan, Lei Yang
Harnessing NFC to Generate Standard Optical Barcodes for NFC-Missing Smartphones
in **IEEE Transactions on Mobile Computing**, 2024.

30. Yanni Yang, **Zhenlin An**, Jiannong Cao, Yanwen Wang, Pengfei Hu, Guoming Zhang, Xiuzhen Cheng
Jump out of Resonance: A Practical NFC Tag Fingerprinting Scheme
in **IEEE Transactions on Mobile Computing**, 2024.

31. Xiaopeng Zhao, **Zhenlin An**, Qingrui Pan, Lei Yang
Understanding Wireless Channels Through NeRF2
in **ACM GetMobile (Research Highlights)**, 2024.

32. Xiaopeng Zhao, Shen Wang, **Zhenlin An**, Lei Yang
Crowdsourced Geospatial Intelligence: Constructing 3D Urban Maps with Satellitic Radiance Fields
in **Proc. of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies**, 2024.

33. Yanni Yang, Pengfei Hu, Jun Luo, **Zhenlin An**✉, Jiannong Cao, Dongxiao Yu, Xiuzhen Cheng
Romeo: Fault Detection of Rotating Machinery Via Fine-Grained Mmwave Velocity Signature
in **IEEE Transactions on Mobile Computing**, 2024.

34. Xiaopeng Zhao, Guosheng Wang, **Zhenlin An** , Qingrui Pan , Qiongzheng Lin, and Lei Yang
Pushing the Boundaries of High-Precision AoA Estimation with Enhanced Phase Estimation Protocol
in **IEEE Internet of Things Journal**, 2024.

35. Qingrui Pan, **Zhenlin An**, Xiaopeng Zhao, Lei Yang
The Power of Precision: High-Resolution Backscatter Frequency Drift in RFID Identification
in **IEEE Transactions on Mobile Computing**, 2023.

36. Xueyuan Yang, **Zhenlin An**, Xiaopeng Zhao, Lei Yang
Transfer Beamforming via Beamforming for Transfer
in **IEEE Transactions on Mobile Computing**, Oct 2023.

37. Yue Yu, Yepeng Yao, Zhewei Liu, **Zhenlin An**, Biyu Chen, Liang Chen, Ruizhi Chen
A Bi-LSTM approach for modelling movement uncertainty of crowdsourced human trajectories under complex urban environments, in **International Journal of Applied Earth Observation and Geoinformation**, Aug 2023.

38. **Zhenlin An**, Qiongzheng Lin, Lei Yang, Lei Xie
Tagcaster: Activating Wireless Voice of Electronic Toll Collection Systems with Zero Start-up Cost
in **IEEE/ACM Transactions on Networking** (IEEE/ACM ToN), Apr 2022.

39. Qingrui Pan, **Zhenlin An**, Qiongzheng Lin, Lei Yang
LSAB: Enhancing Spatio-Temporal Efficiency of AoA Tracking Systems
in **ACM Transactions on Sensor Network** (ACM TOSN), Apr 2022.

40. **Zhenlin An**[†], Qiongzheng Lin[†], Lei Yang, Yi Guo and Ping Li
Localizing RFIDs in Pixel Dimensions
in **ACM Transactions on Sensor Network** (ACM TOSN), Feb 2022.

41. **Zhenlin An**, Lei Yang, Qiongzheng Lin
Identifying UHF RFIDs in Range of Readers with WiFi
in **IEEE/ACM Transactions on Networking** (IEEE/ACM ToN), Feb 2021.

42. Wenzhong Shi, Zhewei Liu, **Zhenlin An**, Pengfei Chen
RegNet: a neural network model for predicting regional desirability with VGI data
in **International Journal of Geographical Information Science** (IJGIS), 2021

43. **Zhenlin An**, Qiongzheng Lin, Lei Yang, Wei Lou and Lei Xie
Acquiring Bloom Filters across Commercial RFIDs in Physical Layer
in **IEEE/ACM Transactions on Networking** (IEEE/ACM ToN), May 2020.

44. **Zhenlin An**[†], Qiongzheng Lin[†], Lei Yang, Yi Guo
Revitalizing Ultrasonic Positioning Systems for Ultrasound-Incapable Smart Devices
in **IEEE Transactions on Mobile Computing** (IEEE TMC), February 2020.

45. Ping Li, **Zhenlin An**, Lei Yang, Panlong Yang, QiongZheng Lin
RFID Harmonic for Vibration Sensing
in **IEEE Transactions on Mobile Computing** (IEEE TMC), January 2019.

46. Qiongzheng Lin, Lei Yang, Chunhui Duan, **Zhenlin An**
Tash: Towards Selective Reading as Hashing Primitives for Gen2 RFIDs
in **IEEE/ACM Transactions on Networking** (IEEE/ACM ToN), April 2019.

Demos

47. Daidong hui, **Zhenlin An**, Qingrui Pan, Lei Yang
Demo: MagCode: Bringing NFC Feature to All Smartphones
In Proc. of **ACM MobiCom**, Madrid, Spain, Oct 2-6, 2023

48. Jingyu Tong, **Zhenlin An**, Xiaopeng Zhao, Sicong Liao, Lei Yang
Demo: Radio Frequency Neural Networks for Wireless Sensing
In Proc. of **ACM MobiCom**, Madrid, Spain, Oct 2-6, 2023 (**Graduate Award**)

49. Daidong hui, **Zhenlin An**, Lei Yang
    Demo: Inducing Wireless Chargers to Voice Out, Project Page
    In Proc. of **ACM MobiCom**, Sydney, Australia, Oct 17-22, 2022 (**Best Demo Award Runner-up**)

50. Zheng Gong, **Zhenlin An**, Jingyu Tong, Donghui Dai, Lei Yang
    Demo: Constructing Smart Buildings with In-concrete Backscatter Networks, Project Page
    In Proc. of **ACM MobiCom**, Sydney, Australia, Oct 17-22, 2022 (**Best Demo Award Runner-up**)

51. **Zhenlin An**, Qiongzheng Lin, Lei Yang
    Demo: Activating Wireless Voice for E-Toll Collection Systems with Zero Start-up Cost
    In Proc. of **ACM MobiCom**, Los Cabos, Mexico, Oct 21-25, 2019

52. **Zhenlin An**, Qiongzheng Lin, Lei Yang
    Demo: Near-Field Identification of UHF RFIDs with WiFi!
    In Proc. of **ACM MobiCom**, New Delhi, India, Oct 29-Nov 2, 2018 (**Best Demo Award Runner-up**)

Patents

53. Donghui Dai, **Zhenlin An**, Qingrui Pan, Lei Yang. CN Patents No. CN116132956B (2023): Near field communication method and system based on camera magnetic field interference

54. Yanni Yang, Sen Jia, Dongxiao Yu, Peng Wang, **Zhenlin An**, Huafeng Xu, Jiannong Cao, Entao Sun, Chao Du. CN Patents No. CN115436938A (2023): Passive signal measuring device and measuring method based on millimeter wave radar

55. Qingrui Pan, **Zhenlin An**, Lei Yang. CN Patents No. CN115377702A (2022): Antenna array optimization method, device, terminal and storage medium

56. **Zhenlin An**, Xueyuan Yang, Lei Yang, Yuan Li, Hong Liu, Jia Jia, Renhui Sun. CN Patents No. CN116263868A (2021): Communication system, communication method and communication device

57. Xiaopeng Zhao, **Zhenlin An**, Lei Yang, Jia Jia, Renhui Sun, Hong Liu. CN Patents No. CN116437435A (2021): Positioning server, positioning method and back reflection communication system

58. Qiongzheng Lin, **Zhenlin An**, Lei Yang. CN Patents No. CN113050022B (2019): Image positioning method and device based on rotary antenna and terminal equipment

PROFESSIONAL ACTIVITIES

Referee for submissions to journals:
- ACM/IEEE Transactions on Networking (2018-2024)
- IEEE Transactions on Mobile Computing (2022-2024)
- IEEE Internet of Things Journal (2019-2024)
- IEEE Transactions on Dependable and Secure Computing (2023-2024)
- ACM Transactions on Sensor Networks (2022)
- ACM Transactions on Internet of Things (2023)
- IEEE Embedded Systems Letters (2023)
- IEEE Journal of Radio Frequency Identification (2024)
- IEEE Transactions on Information Forensics and Security (2024)
- IEEE Transactions on Automation Science and Engineering (2024)
- Nature Science Reports (2024)
- International Journal of Communication Systems (2023-2024)
- Journal of Computer Science and Technology (2022)

Referee for submissions to conference:
- 2024 IEEE ICPADS, ICA3PP, ACM MobiCom Artifacts
- 2023 IEEE ICPADS, ACM MobiCom Artifacts, ACM MobiArch
- 2022 IEEE ICPADS, EAI MobiQuitous, ACM SIGCOMM SRC Juror

Editor Service:
- 2024 Electronics, Special Issue: Ubiquitous Computing and Mobile Computing, Information Page
- 2023 Sensors, Special Issue: Signal Processing for Sensors, Information Page

Teaching

- Teaching Assistant at PolyU (Lecturer: Dr. Lei Yang)   Spring 2021
  Web Application Design and Development (COMP 3421)
- Teaching Assistant at PolyU (Lecturer: Dr. Lei Yang)   Fall 2020, Spring 2020
  Internet Computing and Applications (COMP 5322)
- Teaching Assistant at PolyU (Lecturer: Prof. Guiling Wang)   Fall 2019
  Crowdfunding and E-finance (COMP 4141)
- Teaching Assistant at PolyU (Lecturer: Dr. Lei Yang)   Fall 2018
  Enterprise Web and Internet Computing for Managers (COMP 5321)
- Teaching Assistant at PolyU (Lecturer: Dr. Lei Yang)   Spring 2019, Spring 2018, Fall 2017
  Mobile Computing (COMP 4342)
- Teaching Assistant at DUT (Lecturer: Yingjie Zhang)   2014-2017
  Microcomputer Assembly and Commissioning

Fundings

- co-PI: Physical Neural Networks, PolyU Internal Funding, HKD 100M, 2023-2025

Invited Talk

- 2024-10-08, "Neural Radio-Frequency Radiance Fields", Rensselaer Polytechnic Instituter, host: Ish Kumar Jain
- 2024-09-27, "Advancements in Wireless Sensing", Palantir Technologies, host: Dr. Di Wang
- 2024-07-18, "Learning to understand radio environment", Microsoft, host: Prof. Lili Qiu
- 2024-06-18, "RadioTwin", Interdigital Long Island Research Center, host: John Kaewell
- 2023-06-30, "Neural Radio Frequency Radiance Field", Dalian University of Technology, host: Prof. Chi Lin

Skills

- Programming: Python; Matlab; C/C++; Verilog HDL
- Platform: Tensorflow, Pytorch; Microcontroller (MSP430, ESP32, Arduino); PCB design (Altium Designer); Antenna Simulation and Design (CST); Android Studio;
- Tools: VNA, Spectrum Analyzer, USRP and GNU Radio
- Domain Knowledge: array signal processing, wireless networking, machine learning, embedded system

Reference

- Dr. Lei Yang, (Ph.D. Advisor), Email: young@tagsys.org
  Associate Professor in The Hong Kong Polytechnic University
- Dr. Jiannong Cao, (Ph.D. Co-advisor), Email: csjcao@comp.polyu.edu.hk
  Chair Professor in The Hong Kong Polytechnic University
- Dr. Longfei Shangguan, (Postdoc Co-advisor in Princeton), Email: longfei@pitt.edu
  Assistant Professor in University of Pittsburgh