

# PAN HAO 潘昊

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## Self Introduction

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My name is Pan Hao, and I am a **Senior Researcher** at Microsoft Research Asia. Prior to this, I obtained my Ph.D. in Computer Science and Technology in March 2022 from Shanghai Jiao Tong University and completed my undergraduate studies at the Yingcai Honors College, University of Electronic Science and Technology of China, in June 2016. My research interests include mobile computing, wireless communication, intelligent sensing, human-computer interaction, and computer vision. To date, I have published a total of **11** high-quality academic papers as *the first author (including corresponding author)*, including **5 ACM MobiCom**; and I have been granted 4 Chinese invention patents and 1 U.S. invention patent.

## Education Background

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### Shanghai Jiao Tong University

#### School of Electronic Information and Electrical Engineering

2016.9-2022.3

Department of Computer Science and Engineering

Mentors: Professor Guangtao Xue and Associate Professor Yi-Chao Chen

### University of Electronic Science and Technology of China

#### Yingcai Honors College

2012.9-2016.7

Major: Information and Communication Engineering & Computer Science.

## Research Experience

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### 1. Electromagnetic Side Channel-based Wireless Sensing and Communication

**1.1 MagneComm:** Developed a secure near-field communication system utilizing electromagnetic side-channel signals. The system encodes electromagnetic channels by software-controlled CPU operations at the transmitter and decodes using a magnetic sensor at the receiver, achieving functionality similar to NFC hardware modules. This work was presented at **ACM MobiCom 2017 (accept rate = 15.7%)**.

**1.2 MagPrint:** Designed a deep learning algorithm based on time series to analyze unique electromagnetic side-channel signals generated by different user interactions with mobile devices (e.g., touch, swipe, button presses) for user authentication. This work was presented at **IEEE INFOCOM 2020**.

**1.3 MagThief:** Employed mobile phone magnetic sensor readings to sense user behavior on mobile apps. Considering multi-app usage scenarios, a region-based CNN model was designed for multi-label app classification to obtain user privacy data related to app usage, providing data for applications like user profiling. This work was presented at **IEEE SECON 2021**.

**1.4 MagDefender:** Utilized electromagnetic radiation signals from built-in cameras and microphones in mobile devices to detect eavesdropping activities (photo-taking, video, and audio recording) by malicious software and operating systems, using a built-in magnetic sensor. This work was presented at **IEEE SECON 2022**.

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## 2. Secure Communication System Based on Nonlinearity of Light

**2.1 mQRCode:** Designed a high-security QR code communication system using optical nonlinear superposition properties. An encryption algorithm was devised to hide information in QR code patterns displayed on screen pixel arrays, exploiting the spatial frequency of color filter arrays in cameras. The original QR code information is decoded using a camera at the correct capture position, enabling secure optical communication. This work was presented at **ACM MobiCom 2019** and **IEEE INFOCOM 2023**.

## 3. Novel Human-Computer Interaction System Based on Acoustic Tracking

**3.1 MagicInput:** Employed acoustic radar technology to achieve high-precision, real-time tracking of user finger movements in mobile devices using built-in speakers and microphones. A data augmentation algorithm was designed to convert the MNIST image dataset into a tracking trajectory dataset, enabling text input through finger movements in mid-air. This system supports multiple languages and requires no training, representing a new type of human-computer interaction. The work was published at **ACM IPSN 2021 (accept rate = 21.2%)**.

## 4. Camera Enhancement Techniques Based on Optical Image Stabilization

**4.1 OISSR:** Developed a super-resolution imaging technique based on optical image stabilization. By altering MEMS gyroscope readings using sound waves from the built-in smartphone speaker, effective control over the camera lens position within the camera module was achieved. This, combined with prior knowledge of lens movement, facilitated the super-resolution imaging technique. The work was published at **ACM Multimedia 2022**.

**4.2 DoCam:** Introduced a depth estimation system based on optical image stabilization. The system controls the lens position within the camera module by changing gyroscope readings with sound wave signals from the phone's speaker. An SfOM algorithm designed with lens motion priors accurately recovered camera pose information, allowing for high-precision depth estimation. This work was presented at **ACM MobiCom 2022 (accept rate = 17.8%)**.

## 5. Wireless Communication System Enhancement Using Passive Metasurfaces

**5.1 PMSat:** Introduced a low-cost, dynamic beam-scanning and focusing ground station system for low Earth orbit (LEO) satellite communications, integrating small phased array antennas with passive metasurface technology. Compared to large phased arrays and active metasurfaces, this system cleverly combines the programmability of small phased arrays with the wavefront manipulation capabilities of passive metasurfaces to create an extremely low-cost antenna system capable of beamforming and steering. It supports dynamic scanning to track the real-time position of LEO satellites and enhance channel quality. This work was published at **ACM MobiCom 2023 (accept rate = 24.4%)**.

**5.2 AutoMS:** Proposed a near-zero-cost 60GHz millimeter-wave Wi-Fi coverage enhancement technique. By designing a wireless environment channel model based on ray tracing and an optimization model for passive metasurfaces, which are automatically optimized and deployed in known 3D environments. This passive metasurface technology effectively covers millimeter-wave signal dead zones, precisely controlling the beams produced by millimeter-wave access

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points (APs) and avoiding dynamic environmental interference. The system achieved a 20dB signal strength gain in dead zones and more than tripled throughput across the deployment space. This research has been accepted at **ACM MobiCom 2024 (accept rate = 23.1%)**.

## Working Experience

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**Huawei Future Network Lab, Hong Kong (Internship)** 2015.8-2016.4

Manager: Gong Zhang | Mentor: John C.S. Lui (ACM/IEEE Fellow, CUHK Professor)

**Microsoft Research Asia (Senior Research)** 2022.3-Now

Manager: Lili Qiu (ACM/IEEE/NAI Fellow, UT Austin Professor, MSRA Assistant Managing Director)

## Academic Service

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**IEEE ICDCS 2024** Technical Committee Member (Internet of Things Track)

**IEEE MSN 2023** Technical Program Committee Member (Security, Privacy, Trust, and Blockchain Track)

**IEEE ToN/IEEE TMC/IEEE JASC/ACM UbiComp** Reviewer

## Teaching Experience

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Teaching Assistant | SJTU, Computer Networks (XO33517, Undergraduate), Fall 2019

Teaching Assistant | SJTU, Mobile Intelligent Sensing and Computing (CS28014, Graduate), Fall 2018

## Awards

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**2022** ACM China Doctoral Dissertation Award (Nominee)

**2022** Shanghai Computer Society Outstanding Doctoral Thesis Award

**2021** World Artificial Intelligence Conference (WAIC) Young Scientist Best Paper Award  
Nominee (Top 10)

**2017 & 2016** 3rd & 2nd Next Generation Internet Technology Innovation Competition, National  
First Prize

**2014** 20th National College Student Electronic Design Competition, Sichuan Provincial  
Second Prize

## Paper List (Partial)

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[1] Ruichun Ma, Shicheng Zheng, **Hao Pan\***, Lili Qiu, Xingyu Chen, Liangyu Liu, Yihong Liu, Wenjun Hu, Ju Ren. "Automated Optimization of mmWave Coverage using Low-cost Metasurfaces". Accepted in **ACM MobiCom 2024**. (Hao Pan is the corresponding author)

[2] Lili Chen, Bozhong Yu, Yongjian Fu, Ju Ren, **Hao Pan**, Jeremy Gummesson, Yaoxue Zhang. "Pushing Wireless Charging from Station to Travel". Accepted in **ACM MobiCom 2024**.

[3] **Hao Pan**, Lili Qiu. "Passive Metasurface-Based LEO Ground Station Design". Accepted in **TSINGHUA SCIENCE AND TECHNOLOGY 2024**.

[4] **Hao Pan**, Lili Qiu, Bei Ouyang, Shicheng Zheng, Yongzhao Zhang, Yi-Chao Chen, Guangtao Xue. "PMSat: Optimizing Passive Metasurface for Low Earth Orbit Satellite Communication". Published in **ACM MobiCom 2023**.

[5] Yongzhao Zhang, **Hao Pan**, Yi-Chao Chen, Lili Qiu, Yu Lu, Guangtao Xue, Jiadi Yu, Feng Lyu, Haonan

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- Wang. "Addressing Practical Challenges in Acoustic Sensing to Enable Fast Motion Tracking" . Published in **ACM/IEEE IPSN 2023**.
- [6] Yu Lu, **Hao Pan**\*(corresponding author), Feitong Tan, Yi-Chao Chen, Guangtao Xue. "Effectively Learning Moiré QR Code Decryption from Simulated Data" . Published in **IEEE INFOCOM 2023**.
- [7] **Hao Pan**, Feitong Tan, Yi-Chao Chen, Gaoang Huang, Qingyang Li, Wenhao Li, Guangtao Xue. "DoCam: Depth Sensing with an Optical Image Stabilization Supported RGB Camera" . Published in **ACM MobiCom 2022**.
- [8] **Hao Pan**, Feitong Tan, Wenhao Li, Yi-Chao Chen, Guangtao Xue. "OISSR: Optical Image Stabilization Based Super Resolution on Smartphone Cameras" . Published in **ACM Multimedia 2022**.
- [9] **Hao Pan**, Feitong Tan, Wenhao Li, Yi-Chao Chen, Lanqing Yang, Guangtao Xue, Xiaoyu Ji. "MagDefender: Detecting Eavesdropping on Mobile Devices using the Built-in Magnetometer" . Published in **IEEE SECON 2022**.
- [10] Guangtao Xue , Yijie Li , **Hao Pan** , Lanqing Yang , Yi-Chao Chen , Xiaoyu Ji , Jiadi Yu. "ScreenID: Enhancing QRCode Security by Utilizing Screen Dimming Feature" . Published in **ACM/IEEE ToN 2022**.
- [11] Guangtao Xue, **Hao Pan**\*(corresponding author), Yi-Chao Chen, Xiaoyu Ji, Jiadi Yu. "MagneComm+: Near-Field Electromagnetic Induction Communication with Magnetometer" . Published in **IEEE TMC 2021**.
- [12] Xiaoyu Ji, Yushi Cheng, Wenyuan Xu, Yuehan Chi, **Hao Pan**, Zhuangdi Zhu, Chuang-Wen You, Yi-Chao Chen, Lili Qiu. "No Seeing is Also Believing: Electromagnetic-emission-based Application Guessing Attacks via Smartphones" . Published in **IEEE TMC 2021**.
- [13] **Hao Pan**, Lanqing Yang, Honglu Li, Yi-Chao Chen, Guangtao Xue. "MagThief: Stealing Private App Usage Data on Mobile Devices via Built-in Magnetometer" . Published in **IEEE SECON 2021**.
- [14] **Hao Pan**, Yi-Chao Chen, Qi Ye, Guangtao Xue. "MagicInput: Training-free Multi-lingual Finger Input System using Data Augmentation based on MNISTs" . Published in **ACM/IEEE IPSN 2021**.
- [15] Yijie Li, Yi-Chao Chen, Xiaoyu Ji, **Hao Pan**, Lanqing Yang, Guangtao Xue, Jiadi Yu. "SCREENID: Enhancing QRCode Security by Fingerprinting Screens" . Published in **IEEE INFOCOM 2021**.
- [16] Lanqing Yang, Yi-Chao Chen, **Hao Pan**, Dian Ding, Guangtao Xue, Linghe Kong, Jiadi Yu, Minglu Li. "MagPrint: Deep Learning Based User Fingerprinting Using Electromagnetic Signals" . Published in **IEEE INFOCOM 2020**.
- [17] **Hao Pan**, Yi-Chao Chen, Lanqing Yang, Chuangwen You, Guangtao Xue, Xiaoyu Ji. "mQRCode: Secure QR Code Using Nonlinearity of Spatial Frequency in Light" . Published in **ACM MobiCom 2019**.
- [18] Yushi Cheng, Xiaoyu Ji, Wenyuan Xu, **Hao Pan**, Zhuangdi Zhu, Chuang-Wen You, Yi-Chao Chen, Lili Qiu. "MagAttack: Guessing Application Launching and Operation via Smartphone" . Published in **ACM AsiaCCS 2019**.
- [19] **Hao Pan**, Yi-Chao Chen, Guangtao Xue, Xiaoyu Ji. "Magnecomm: Magnetometer-based near-field communication" . Published in **ACM MobiCom 2017**.