Zhenzhe Lin

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RESEARCH INTERESTS

My research interests are broadly in the areas of wireless networking, machine learning driven wireless systems, and mobile computing with a focus on low-power IoT and cyber-physical applications.

- **Wireless Systems and Networking:** high-speed next-generation wireless network architectures (LTE, 5G-NR and mmWave WiFi), ultra-wide-band millimeter wave backscatter communication

- **Machine Learning for Wireless:** transformer-based multi-task learning for channel estimation, interference mitigation, and signal decoding

- **Mobile Computing:** mmWave sensing systems (VR/AR, localization, blockage detection), ubiquitous computing, and cyber-physical systems

EDUCATION

- **George Mason University**, Fairfax, Virginia, USA — **2021 - Expect Jun 2026**
  Ph.D. Candidate, Computer Science

- **Rutgers University**, New Brunswick, New Jersey, USA — **2020**
  Research Assistant, Electrical and Computer Engineering

- **New Jersey Institute of Technology**, Newark, New Jersey, USA — **2018**
  M.S., Electrical Engineering

- **Dalian Maritime University**, Dalian, China — **2016**
  B.E., Electrical Engineering

PUBLICATIONS

- **Zhenzhe Lin**, Yoon Chae, Panneer Selvam Santhalingam, Mingyo Jeong, Parth Pathak, "Wideband Low-complexity High-speed 5G NR Backscatter", in Proceedings of the 24th ACM International Conference on Mobile Systems, Applications, and Services (**MobiSys 2026**), Cambridge, UK

- **Zhenzhe Lin**, Yoon Chae, Mingyo Jeong, Parth Pathak, "B^3: Bistatic Backscatter Beamforming for mmWave IoTs", in Proceedings of the ACM/IEEE International Conference on Embedded Artificial Intelligence and Sensing Systems (**SenSys 2026**), Saint-Malo, France

- Yoon Chae, **Zhenzhe Lin**, Kang Min Bae, Song Min Kim, Parth Pathak, "mmComb: High-speed mmWave Commodity WiFi Backscatter", in Proceedings of the 21st USENIX Symposium on Networked Systems Design and Implementation (**NSDI 2024**), Santa Clara, California, USA

- Yoon Chae, **Zhenzhe Lin**, Parth Pathak, "mmWave WiFi backscatter communication", Commonwealth Cyber Initiative (CCI) Symposium 2024, Richmond, Virginia, USA

- **Zhenzhe Lin**, Yucheng Xie, Xiaonan Guo, Yanzhi Ren, Yingying Chen, Chen Wang, "WiEat: Fine-grained Device-free Eating Monitoring Leveraging Wi-Fi Signals", in Proceedings of the 29th International Conference on Computer Communications and Networks (**ICCCN 2020**), Honolulu, Hawaii, USA

- **Zhenzhe Lin**, Yucheng Xie, Xiaonan Guo, Chen Wang, Yanzhi Ren, Yingying Chen, "WiFi-enabled Automatic Eating Moment Monitoring Using Smartphones", in Proceedings of the 6th EAI International Conference on IoT Technologies for HealthCare (**HealthyIoT 2019**), Braga, Portugal, **Best Paper Award**

RESEARCH EXPERIENCE

Computer Science Department, George Mason University, VA
Research Assistant — **Jan 2021 - Present**

Project: Dual-Task Multi-Head Transformer for Wideband 5G NR Backscatter

- Systematically analyze the limitations of existing backscatter techniques under wideband 5G NR OFDM channels, identifying challenges in channel dependency, synchronization, and demodulation complexity

- Design a dual-task multi-head transformer model that jointly performs channel estimation and backscatter signal decoding, addressing channel-backscatter coupling and low-SINR conditions

- Prototype 5G NR backscatter tags and implement a learning-based receiver, achieving improved BER, throughput, near real-time demodulation, and cross-site generalization in practical deployments

Project: Energy-efficient, Concurrent, Multi-user Beamforming using mmWave Backscatter
- Propose a tag-assisted beamforming system that offloads the beamforming process from client radios to passive mmWave backscatters attached to the clients
- Use a multi-port backscatter tag design to create alternating pulse position modulation (PPM) modulation on the preamble and extraction of mmWave channels from backscatter paths for concurrent multi-tag beamforming
- Implement and evaluate tag prototypes on AR/VR devices, software radios, and COTS APs, determining a high-SNR beam in practical scenarios with multipath, mobility, and blockages

Project: High-speed mmWave Commodity WiFi Backscatter
- Propose a mmWave commodity WiFi backscatter system where the tags can seamlessly integrate into mmWave WiFi networks
- Develop a self-interference suppression solution that can use beamforming and nulling to significantly improve SINR otherwise weak mmWave backscatter signal reception
- Implement a custom tag prototype and commodity off-the-shelf 60 Ghz 802.11ad devices that can achieve a maximum data rate of 55 Mbps with BER lower than 10^{-3} up to 5.5 m range

Wireless Information Network Laboratory (WINLAB), Rutgers University, NJ
Research Assistant   **Sep 2019 - Dec 2020**

Project: Environment-invariant Suspicious Object Detection Using WiFi
- Implement a system to detect human carried suspicious objects concealed in baggage using channel state information (CSI) obtained from commodity WiFi devices
- Propose an environment-invariant model that uses adversarial learning to extract environment-independent features from WiFi signals collected at different times and environments
- Exploit CSI dynamic patterns to differentiate static and dynamic components to identify material types of the sensing targets under moving scenarios (e.g., objects carried with a conveyor belt)

Project: RFID-based Heart Rate Variability Measurement
- Leverage RFID tag array attached to chest of subjects to continuously sense human heartbeats and estimate heart rate variability (HRV)
- Model reflection and moving effects to capture the relationship between the RF-signals extracted from RFID tag array and corresponding movements from the heartbeats or respiration
- Utilize wavelet-based signal denoising and signal fusion approaches to remove interference of the RF signals and extract Inter-beat Interval (IBI) for HRV assessment

Project: mmWave-based 3D Skeleton Posture Reconstruction
- Implemented a 3D skeleton posture reconstruction system to extract spatial features from joint-related mmWave signals and localize skeletal joints in 3D space
- Designed a domain discriminator to remove user- and environment-specific characteristics entangled in mmWave signals to achieve skeleton reconstruction across different domains
- Built a convectional neural network with domain discriminator for 3D skeletal reconstruction that can achieve better performance than existing work with an average joint error of around 30mm

Research Intern   **Aug 2018 - Aug 2019**

Project: WiFi-based Eating Activity Monitoring
- Developed a device-free eating monitoring system based on channel state information (CSI) to automatically track people's eating activity
- Proposed a soft decision-based approach and adopted machine learning methods to identify eating motions associated with different utensils

- Designed a minute motion reconstruction method to capture movements of facial muscles and developed a power spectral density method to derive the chewing and swallowing statistics

  Project: Deep Neural Network Aided BCH Decoder
- Leveraged deep neural network to obtain individual scaling parameters for normalized min-sum algorithms
- Compressed the DNN-aided channel decoders by weight sharing to avoid the major disadvantage of computation and storage overhead
- Implemented the RTL design and reduced 2.59 times of memory saving compared with conventional BCH decoders, improved convergence rate by 6 times with similar decoding performance

TEACHING EXPERIENCE
- CS 531 Fundamentals of Systems Programming, Teaching Assistant, George Mason University   Fall 2022
- CS 112 Introduction to Computer Programming, Teaching Assistant, George Mason University   Spring 2021
- 16:332:583 Semiconductor Device I, Teaching Assistant, Rutgers University   Fall 2020
- 14:332:465 Physical Electronics, Teaching Assistant, Rutgers University   Fall 2020
- WINLAB Summer Internship Program, Mentor, Rutgers University   Summer 2020
- ECE Senior Design Capstone Projects, Mentor, Rutgers University   Spring 2020

TECHNICAL SKILLS
Programming Languages: MATLAB, Python, C++, Verilog, VHDL, Java, LaTeX
Frameworks: PyTorch, TensorFlow, FPGA, Arduino

HONORS & AWARDS
- **Best Paper Award**, HealthyIoT - 6th EAI International Conference on IoT Technologies for HealthCare   2019
- **Second Prize**, 8th Annual National Conference on Undergraduate Innovation and Entrepreneurship   2015