Nation-wide Community-based Mobile Edge Sensing and Computing Testbeds

Project Webpage: *https://data-website.github.io/*

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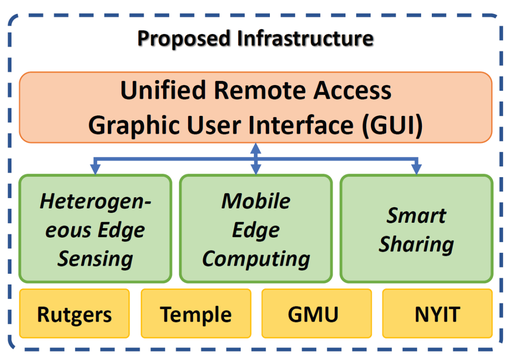
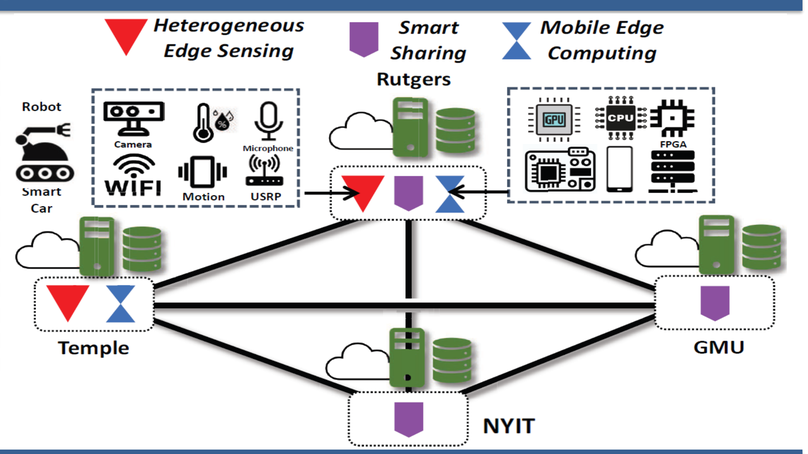
Project Objective & Testbed Design and Development

- **Heterogeneous Edge Sensing:** enabling data collection, model training, and privacy-preserving federated learning on mobile edge devices with heterogeneous sensors
- **Mobile Edge Computing**: supporting research in hardware software co-design and deep learning optimization for heterogeneous power-constrained mobile edge devices
- **Smart Sharing:** enabling smart sharing for research in environment-invariant modeling, privacy-preserved data searching, and cross-objective model sharing beyond individual research groups' capacity

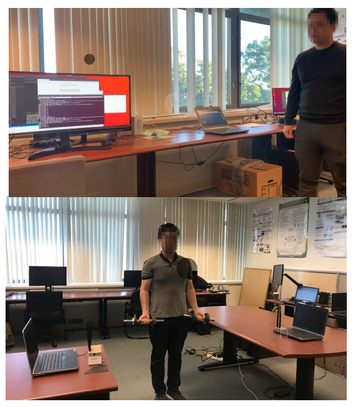




WiFi Sensing Testbed

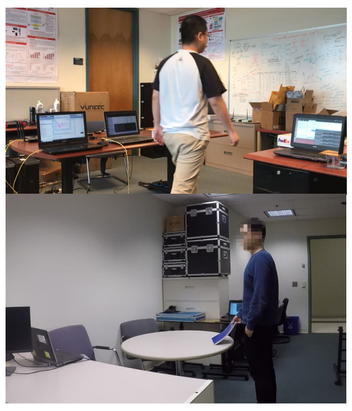
The WiFi sensing testbed includes USRP, wireless access points, laptops (with Intel 5300 and Atheros AR9580), omni-directional and directional antennas, and robotic cars, deployed across diverse environments. The testbed allows researchers to conduct WiFi sensing research spanning a wide range of scenarios and applications.

Activity Recognition for Human and Robots



- Devices: desktops and laptops with omni-directional antenna and Intel 5300 network interface cards
- Developing a fine-grained activity recognition system based on Channel State Information (CSI) extracted from WiFi signals
- **Two Environments and Datasets: office** with **4,079 segments** and **apartment** with **3,513 segments**, from daily activities (e.g., workout and stationary), over a **four-month period**

User Verification and Authentication



- Devices: laptops with omni-directional antenna and Intel 5300 network interface cards
- Developing a device-free user authentication via daily human behavioral patterns captured by WiFi devices
- **Two Environments and Datasets**: **office** with **3336 behavior segments** and **apartment** with **834 behavior segments** from human behavioral patterns (e.g., walking and fetching documents), over a **five-month period**

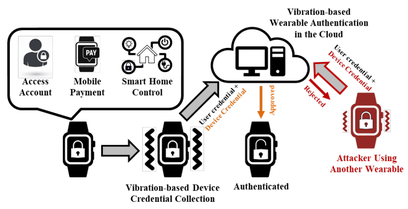
Dangerous Hidden Object Detection

- Devices: laptops with directional antenna (i.e., Aaronia HyperLOG 7060) and orthogonal antennas (i.e., Hawking HD9DP)
- Developing an in-baggage dangerous objects (e.g., guns and homemade bombs) identification system
- **Two Environments and Datasets**: two **offices** and one **lab** with **14 different objects:** fiber: book, magazine; metal: thermal cup, laptop; cotton/polyester: cotton T-shirts, hoodie, polyester pants; water, hidden in **three type of bags**

Vibration Sensing Testbed

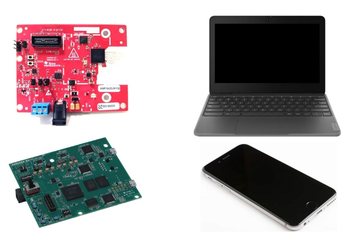
Building a vibration sensing testbed to facilitate data collection for sensing application based on active or passive vibration signals.

Wearable Device Authentication

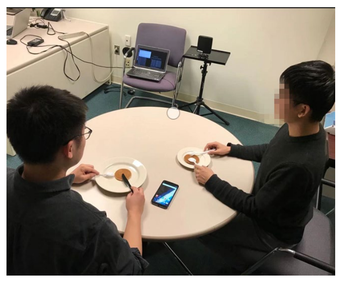


- Device: three Fossil Gen 5 watches and two Moto 360 Gen watches
- Developing a device authentication system that can identify a user's wearable using its vibration-based device credentials
- **Multiple Environments and Datasets**: **on-wrist scenario** with **1680 device credentials** and **on-desk scenario** with **600 device credentials,** over a **4-week period**

Millimeter Wave-based Sensing Testbed



The millimeter-wave-based sensing testbed integrates laptops, smartphones, the AWR1642 mmwave radar sensors, the DCA1000 evaluation modules, and robotic cars.



Multi-person Eating Habit Monitoring

- Devices: AWR1642 mmwave radar sensors and DCA1000 evaluation modules
- Designing a millimeter wave-enabled environment-invariant eating behavior monitoring system
- **Three Environments and Datasets**: **lounge** with **1,000 mmWave segments**, **home** with **1,000 mmWave segments**, **classroom** with **1,000 mmWave segments** from different utensils (i.e., fork, knife, spoon, chopsticks, bare hand) , over a **eight-week period**

Personalized Fitness Assistant

- Devices: AWR1642 mmwave radar sensors and DCA1000 evaluation modules.
- Developing a personalized fitness monitoring system for multi-person environments
- **Two Environments and Datasets**: **classroom** with **5000 mmWave segments** and **lounge** with **2000 mmWave segments**, over a **eight-month period**

RFID Sensing Testbed

The RFID sensing testbed combines various components, including laptops, Impinj R420 RFID reader, and directional antenna Laird S9028PCL

Continuous User Verification

- Device: laptops and RFID reader Impinj R420, equipped with directional antenna Laird S9028PCL
- Utilizing RFID tags attached to users' clothes to capture the unique respiratory patterns for continuous user verification
- **Four Environments and Datasets: bedroom** with **800 segments**, **office** with **1000 segments**, **lab** with **2000 segments**, **corridor** with **500 segments**, over a **five-month period**

Broader Impacts

- Providing essential support for large-scale remote programmable experiments and data/model sharing in the mobile edge sensing and computing
- Connecting individual research groups and speed up interdisciplinary research
- Organizing workshop to discuss the project development and share project datasets with a broader audience
- Launching a dedicated project website and make our datasets publicly available

Publications

1. C. Shi, J. Liu, N. Borodinov, B. Leao and Y. Chen, "Towards Environment-independent Behavior-based User Authentication Using WiFi," 2020 IEEE 17th International Conference on Mobile Ad Hoc and Sensor Systems (MASS), 2020.
2. C. Shi, T. Zhao, Y. Xie, T. Zhang, Y. Wang, X. Guo, and Y. Chen. "Environment-independent in-baggage object identification using wifi signals." In 2021 IEEE 18th International Conference on Mobile Ad Hoc and Smart Systems (MASS), 2021.
3. Y. Xie, R. Jiang, X. Guo, Y. Wang, J. Cheng, and Y. Chen. "mmEat: Millimeter wave-enabled environment-invariant eating behavior monitoring." Smart Health, 2022.
4. Y. Xie, R. Jiang, X. Guo, Y. Wang, J. Cheng, and Y. Chen. "mmFit: Low-Effort Personalized Fitness Monitoring Using Millimeter Wave." In 2022 International Conference on Computer Communications and Networks (ICCCN), 2022.
5. B. Hu, T. Zhao, Y. Wang, J. Cheng, R. Howard, Y. Chen, and H. Wan. 2022. BioTag: robust RFID-based continuous user verification using physiological features from respiration. In Proceedings of the Twenty-Third International Symposium on Theory, Algorithmic Foundations, and Protocol Design for Mobile Networks and Mobile Computing (MobiHoc), 2022.
6. J. Cheng, Z. Wang, Y. Wang, T. Zhao, H. Wan, E. Xie. (2022). WatchID: Wearable Device Authentication via Reprogrammable Vibration. In International Conference on Mobile and Ubiquitous Systems: Computing, Networking, and Services, 2021.