

Kyuin Lee

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EDUCATION

- University of Wisconsin–Madison** *Madison, WI*
Ph.D. in Electrical and Computer Engineering Sep 2017–Present
Advisor: Younghyun Kim
- Carnegie Mellon University** *Pittsburgh, PA*
M.S. in Electrical and Computer Engineering Sep 2016–May 2017
Advisor: Anthony Rowe
- B.S. in Electrical and Computer Engineering Sep 2010–May 2016

RESEARCH INTERESTS

Embedded systems, Security and privacy, Mobile computing, Internet-of-Things

AWARDS & HONORS

- ECE Fall Dissertator Travel Award**, UW-Madison 2021
- Student Research Grants Competition**, UW-Madison 2019
- Richard Newton Young Fellow Award**, Design Automation Conference 2019
- NSF Travel Grant**, International Conference on Computer Design 2018
- Best Demonstration Award in SIGDA University Demo**, Design Automation Conference 2018
- ECE Wisconsin Distinguished Graduate Fellowship**, UW-Madison 2017
- Osher Lifelong Learning Institute Award**, Meeting of the Minds Research Symposium 2017

PUBLICATIONS

- [9] Jakob Veselsky, Jack West, Isaac Ahlgren, Abhinav Goel, Wenxin Jiang, **Kyuin Lee**, Younghyun Kim, James Davis, George K. Thiruvathukal, and Neil Klingensmith, “**Establishing Trust in Vehicle-to-Vehicle Coordination: A Sensor Fusion Approach**,” To be appeared in *Proceedings of the Workshop on Data-Driven and Intelligent Cyber-Physical Systems (DI-CPS)*, 2022
- [8] **Kyuin Lee**, Yucheng Yang, Omkar Prabhune, Aishwarya Lekshmi Chithra, Jack West, Kassem Fawaz, Neil Klingensmith, Suman Banerjee, and Younghyun Kim, “**AeroKey: Using Ambient Electromagnetic Radiation for Secure and Usable Wireless Device Authentication**,” To be appeared in *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (IMWUT)*, Vol. 6, No. 1, 2022 (To be presented at the ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp) 2022)
- [7] **Kyuin Lee**, and Younghyun Kim, “**Balancing Security and Usability of Zero-interaction Pairing and Authentication for the Internet-of-Things**,” in *Proceedings of the Workshop on CPS & IoT Security and Privacy (CPSIoTSec)*, pp. 29–34, Virtual, 2021
- [6] Yucheng Yang*, **Kyuin Lee***, Younghyun Kim, and Kassem Fawaz, “**PEDRO: Secure Pedestrian Mobility Verification in V2P Communication using COTS Mobile Devices**,” in *Proceedings of the Workshop on CPS & IoT Security and Privacy (CPSIoTSec)*, pp. 41–46, Virtual, 2021 (*Equal contribution by Yang and Lee)
- [5] Jack West, **Kyuin Lee**, Suman Banerjee, Younghyun Kim, George K. Thiruvathukal, and Neil Klingensmith, “**Moonshine: An Online Randomness Distiller for Zero-Involvement Authentication**,” in *Proceedings of ACM International Conference on Information Processing in Sensor Networks (IPSN)*, pp. 93–105, Virtual, 2021
- [4] **Kyuin Lee**, Neil Klingensmith, Dong He, Suman Banerjee, and Younghyun Kim, “**ivPair: Context-Based Fast Intra-Vehicle Device Pairing for Secure Wireless Connectivity**,” in *Proceedings of ACM Conference on Security and Privacy in Wireless and Mobile Networks (WiSec)*, pp. 25–30, Linz, Austria, 2020
 **Patent pending**

- [3] Younghyun Kim, Joshua San Miguel, Setareh Behroozi, Tianen Chen, **Kyuin Lee**, Yongwoo Lee, Jingjie Li, and Di Wu, “**Approximate Hardware Techniques for Energy-Quality Scaling Across the System,**” in *Proceedings of IEIE/IEEE International Conference on Electronics, Information, and Communication (ICEIC)*, pp. 1–5, Barcelona, Spain, 2020
- [2] **Kyuin Lee**, Neil Klingensmith, Suman Banerjee, and Younghyun Kim, “**VoltKey: Continuous Secret Key Generation based on Power Line Noise for Zero-Involvement Pairing and Authentication,**” in *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (IMWUT)*, Vol. 3, No. 3, pp. 93:1–93:26, 2019 (Presented at the ACM International Joint Conference on Pervasive and Ubiquitous Computing (**UbiComp**) 2019)
[Patent pending](#)
- [1] **Kyuin Lee**, Vijay Raghunathan, Anand Raghunathan, and Younghyun Kim, “**SyncVibe: Fast and Secure Device Pairing through Physical Vibration on Commodity Smartphones,**” in *Proceedings of IEEE International Conference on Computer Design (ICCD)*, pp. 234–241, Orlando, FL, 2018

**DEMOS
& FORUMS**

- [4] **Kyuin Lee**, “**Secure and Usable Zero-interaction Pairing and Authentication Methods for the Internet-of-Things,**” *Ph.D. Forum @ Design Automation Conference*, Virtual, 2021
- [3] **Kyuin Lee**, “**Secure Pairing Methods for Ubiquitous IoT Devices,**” *Richard Newton Young Student @ Design Automation Conference*, San Francisco, CA, 2018
- [2] Yongwoo Lee, and **Kyuin Lee**, “**CampPUF: Physically Unclonable Function based on CMOS Image Sensor Fixed Pattern Noise,**” *SIGDA University Demonstration @ Design Automation Conference*, San Francisco, CA, 2018
[Best Demonstration Award](#)
- [1] **Kyuin Lee**, and Shihan Wang, “**Preventing Epidemics Via Sensing and Learning Mosquito Behaviors,**” *Meeting of the Minds Research Symposium*, Pittsburgh, PA, 2017
[Osher Lifelong Learning Institute Award](#)

PATENTS

- [2] **Kyuin Lee**, Younghyun Kim, Suman Banerjee, and Neil Klingensmith, “**Pairing Apparatus Using Secret Key Based on Power Line Noise,**” U.S. Patent and Trademark Office Application No. 17/217,630, 2021
- [1] **Kyuin Lee**, Younghyun Kim, Suman Banerjee, and Neil Klingensmith, “**Context-based Pairing Apparatus and Method Thereof,**” U.S. Patent and Trademark Office Application No. 17/217,655, 2021

**RESEARCH
EXPERIENCE**

- Wisconsin Embedded Systems and Computing Lab** *UW-Madison* Sep 2017–Present
Graduate Research Assistant, Prof. Younghyun Kim
- Investigating and developing series of secure and usable device authentication (or pairing) methods leveraging various environmental contexts to prove coexistence of mobile and IoT devices.
 - Proposed SyncVibe, fast and convenient device pairing protocol to transmit and receive pairing information utilizing vibration motor and accelerometer.
 - Designed and implemented clock recovery technique to maximize data transmission accuracy and throughput under timing jitter of Android OS.
 - Developed automated testing scripts to capture and analyze vibration waveform representing various bit patterns.
 - Implemented the prototype using commercial off-the-shelf smartphone and microcontroller (MCU) to evaluate it under various environments and transmission media.
 - Proposed ivPair, usable in-vehicle device pairing protocol, to derive secure pairing pin using simultaneously measured vibration within the vehicle.
 - Designed and implemented signal alignment technique to solve sampling frequency mismatch between commercial mobile devices.
 - Implemented pin extraction method to extract identical pins from varying locations within the vehicle.
 - Evaluated the prototype built with accelerometer and MCU on different vehicle and road types.

- Proposed IoT device authentication method named VoltKey, which leverages spatiotemporal randomness in the 120 V power line to authenticate devices connected to identical power line.
 - Designed and implemented key extraction and sampling rate estimation algorithm to extract identical random bits from predictable power line waveform.
 - Implemented custom hardware prototype capable of noise measurement, key extraction, and supplying power to existing IoT devices.
 - Evaluated the prototype on real-world environment within home, office, and lab under different attack scenarios.
- Proposed mobile and IoT device authentication method named AeroKey, which uses randomness in the ambient electromagnetic radiation (EMR) to authenticate proximate devices.
 - Designed and implemented key extraction algorithm to extract identical keys from noisy EMR measurements using commercial MCU.
 - Evaluated the performance of the prototype within home, and lab environment under varying attack scenarios.
- Proposed pedestrian mobility verification mechanism named PEDRO, where only moving pedestrians can be admitted to the vehicular ad hoc network.
 - Implemented simulation framework to derive optimal round-trip time of wireless signal that results in robust security against different attack scenarios.
 - Evaluated the performance of PEDRO in real-world road settings to verify the simulation results.
- Provided solutions to address current limitations of zero-interaction authentication works such as proximity control and predictability of the generated keys.

Wireless Sensing and Embedded Systems Lab *CMU* Aug 2016–May 2017
Masters Researcher, Prof. Anthony Rowe

- Designed and implemented battery-operated IoT hardware prototype capable of transmitting object distance measurement through LoRa wide area network.
- Interfaced laser ranging breakout board with ARM Cortex-M3 processor through custom developed printed circuit board.
- Implemented energy efficient firmware on TI-RTOS to periodically measure distance between any outdoor objects.
- Utilized MQTT and protocol buffers to publish messages on LoRa network.

System Level Design Group *CMU* Aug 2016–May 2017
Masters Researcher, Prof. Radu Marculescu

- Connected Raspberry Pi to LoRa network for large-scale mosquito sensing across campus.
- Implemented energy efficient k -nearest neighbors algorithm in C to classify mosquito species using measured wingbeat sound.
- Implemented 3D simulation framework in Python to visualize and analyze mosquito population distribution on campus.
- Connected millions of Twitter posts to Mongo database and deployed interactive web application for scalable social network analysis.

Computational Biology Lab *CMU* Aug 2014–May 2015
Undergraduate Researcher, Prof. Natasa Miskov-Zivanov

- Implemented an algorithm in C to compute probability of cancer cell signaling.
- Built interactive cell signal simulating web application in Python based Django framework.

**WORK
EXPERIENCE**

Samsung Research America *Mountain view, CA* May 2016–Aug 2016
Software Engineering Internship, KNOX Security team

- Implemented flexible inter-component control and data flow graphing tool to track data dependencies within Android applications.
- Reverse engineered and decompiled 50+ system level Android applications without access to the source code.
- Performed dynamic and static analysis on applications of Galaxy Note 7 to detect unauthorized permission vulnerabilities.

- Samsung Data System** *Seoul, Korea* Jun 2011–Aug 2011
Software Engineering Internship, Mobile Solutions team
- Introduced and implemented auto-focusing and edge-detection algorithms in Java for camera module on smartphone.
 - Analyzed noise characteristics of the compressed image using error level analysis method.
 - Converted edge-detection code from Java to C and C++ for device simulation framework.
- LG Electronics** *Seoul, Korea* Jun 2010–Aug 2010
Software Engineering Internship, R&D Security team
- Handled minor security incidents and digital investigation cases.
 - Implemented and presented innovative ideas to create a secure environment for highly confidential R&D projects.

TEACHING EXPERIENCE

- UNIVERSITY OF WISCONSIN–MADISON**
- ECE 353 Introduction to Microprocessor Systems (Teaching assistant) Spring 2019, 2020, 2022
 ECE 751 Embedded Computing Systems (Guest lecturer) Fall 2021
- CARNEGIE MELLON UNIVERSITY**
- 18-549 Embedded Systems Design (Teaching assistant) Spring 2017
 18-349 Real-Time Embedded Systems (Teaching assistant) Fall 2016

SKILLS

- PROGRAMMING LANGUAGES**
- C, C++, Java, Python, Verilog, Scala, SQL
- HARDWARE**
- ARM Cortex-M series, AVR series, Raspberry Pi series
- APPLICATION SOFTWARE**
- MATLAB, EAGLE, Altium, ModelSim, SPICE, Quartus, Bantam, Android Studio

REFERENCES

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- Assistant Professor of Electrical and Computer Engineering
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- Suman Banerjee**, University of Wisconsin–Madison
- Professor of Computer Science
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- Kassem Fawaz**, University of Wisconsin–Madison
- Assistant Professor of Electrical and Computer Engineering
 - kfawaz@wisc.edu
- Neil Klingensmith**, Loyola University Chicago
- Assistant Professor of Computer Science
 - neil@cs.luc.edu