

# Hyokeun Lee

Ph.D.

Assistant Professor

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## RESEARCH INTERESTS

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- Disaggregated memory, disaggregation, SoC security, Compute-Express Link (CXL), non-volatile memory, memory system, computer architecture

## WORK EXPERIENCE

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- **Department of Electrical and Computer Engineering, Ajou University** *Mar. 2024 - Present*  
*Assistant Professor* Gyeonggi, South Korea
- **Secure and Advanced Computer Architecture Group, North Carolina State University** *Feb. 2023 - Jan. 2024*  
*Postdoctoral researcher* Raleigh  
– Mentor: Dr. Amro Awad
- **Inter-university Research Center, Seoul National University** *Sep. 2021 - Feb. 2023*  
*Postdoctoral researcher* Seoul, South Korea  
– Mentor: Dr. Hyuk-Jae Lee  
– I also served the mandatory military service as a Technical Research Personnel.

## EDUCATION

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- **Seoul National University, Seoul, South Korea** *Sep. 2016-Aug. 2021*  
*Ph.D. Electrical and Computer Engineering*  
– Advisor: Dr. Hyuk-Jae Lee; Co-advisor: Dr. Hyun Kim  
– Dissertation: Mitigating Disturbance Errors and Enhancing RMW Performance for PCM
- **Seoul National University, Seoul, South Korea** *Sep. 2011 - Aug. 2016*  
*B.S. Electrical and Computer Engineering*

## RESEARCH PROJECTS

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- **Enabling Secure and Efficient Sharing of Accelerators in Expeditionary Systems**  
*Sponsor: Office of Naval Research, United States*  
– Mar. 2023 - Jan. 2024  
– Development of secure hardware in an accelerator-rich architecture  
– Development of secure GPU with CXL memory expansion  
– Mentoring students research
- **Towards Secure, Crash Recoverable and High-Performance Memory Systems in Future Expeditionary Tactical Systems**  
*Sponsor: Office of Naval Research, United States*  
– Mar. 2023 - Jan. 2024  
– Development of user-transparent secure compiler  
– Mentoring students research
- **Parallel Architecture for Native Data-Graph Analytics Operation**  
*Sponsor: AMD Research, United States*  
– Mar. 2023 - Jan. 2024  
– Development of high-performance and secure access control in disaggregated memory systems  
– Mentoring students research
- **Optimization of Type-3 Compute Express Link (CXL) Add-In Card (AIC) Memory**  
*Sponsor: SK Hynix*  
– Feb. 2022 - Jan. 2023  
– Developed an in-house simulation platform for CXL memory devices  
– Broke down the performance of the CXL-attached system under various scenarios  
– Optimization of memory-centric workloads (e.g., NLP) on the CXL-attached system

## •Development of Open Convergence Memory Solution and Platform for Next-Generation Memories

Sponsor: Ministry of Trade, Industry & Energy (MOTIE), South Korea

- April. 2020 - Dec. 2022
- Developed a high-performance and low-power PCM-based computer architecture for CNN inference
- Developed reliable PCM-based systems

## •DRAM/PRAM Heterogeneous Memory Architecture and Controller IC Design Technology R&D

Sponsor: Ministry of Trade, Industry & Energy (MOTIE), South Korea

- July. 2017 - Dec. 2021
- Constructed reliable PRAM technologies concerning endurance and write/read disturbance errors
- Developed an FPGA-based heterogeneous memory system emulation platform

## •Architecture Exploration of a Hardwired PCM Controller

Sponsor: SK Hynix

- July. 2020 - June. 2021
- Characterized the performance of the in-house PCM controller simulator developed in the previous year
- Minimized the performance overhead of accessing the DRAM-based address translation table in the PCM controller

## •PRAM Memory Scheduler Modeling and its Verification against RTL

Sponsor: SK Hynix

- July. 2019 - June. 2020
- Developed an in-house, functional- and cycle-accurate PCM controller simulator
- Validated functionality and cycle accuracy against the industrial RTL simulation trace

## •Schemes for Managing Metadata in PCRAM Software Wear-leveling

Sponsor: SK Hynix

- July. 2017 - June. 2018
- Developed a PCRAM simulation environment using NVMain and gem5
- Minimized the performance overhead of the read-modify-write module in a PCRAM system
- Enhanced the lifetime of PCRAM with the table-based and static wear-leveling

## •Management on Non-volatile Memory Systems

Sponsor: SK Hynix

- Sep. 2016 - June. 2017
- Developed a hot address-based wear-leveling for PRAM

## •Development of Parallel Processing Techniques for Computational Imaging

Sponsor: Korea Electrotechnology Research Institute (KERI), South Korea

- Sep. 2016 - Nov. 2017
- Developed an algorithm for improving the image quality under surgery environment
- Accelerated the above algorithm using FPGA

## PUBLICATIONS

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#: co-first author; \*: (co-)corresponding author

### •Conference

- Jihoon Jang, Hyokeun Lee\*, Hyun Kim\*, "EDeN: Enabling Low-Power CNN Inference on Edge Devices Using Prefetcher-Assisted NVM Systems," ACM/IEEE International Symposium on Lower Power Electronics and Design (ISLPED), Aug. 2024.
- Debpratim Adak, Hyokeun Lee, Ben Feinberg, Gwendolyn Voskuilen, Clayton Hughes, Huiyang Zhou, Amro Awad, "SEFsim: A Statistically-Guided Fast DRAM Simulator," IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS), May. 2024 (Poster).
- Rahaf Abdullah, Hyokeun Lee, Huiyang Zhou, Amro Awad, "Salus: Efficient Security Support for CXL-Expanded GPU Memory," International Symposium on High-Performance Computer Architecture (HPCA), Mar. 2024.
- Faiz Alam#, Hyokeun Lee#, Abhishek Bhattacharjee, Amro Awad, "CryptoMMU: Enabling Scalable and Secure Access Control of Third-Party Accelerators," IEEE/ACM International Symposium on Microarchitecture (MICRO), Oct-Nov. 2023 (**Best Paper Candidate**).
- Hyokeun Lee, Kwanseok Choi, Hyuk-Jae Lee, Jaewoong Sim, "SDM: Sharing-enabled Disaggregated Memory System with Cache Coherent Compute Express Link," International Conference on Parallel Architectures and Compilation Techniques (PACT), Oct. 2023.
- Shubham Nema, Shiva Kaushik Chunduru, Charan Kodigal, Gwendolyn Voskuilen, Scott Himmert, Hyokeun Lee, Amro Awad, Clayton Hughes, "ERAS: A Flexible and Scalable Framework for Seamless Integration of RTL models with Structural Simulation Toolkit," IEEE International Symposium on Workload Characterization (IISWC), Oct. 2023 (Poster).

- Hyokeun Lee, Hyungsuk Kim, Seokbo Shim, Seungyong Lee, Dosun Hong, Hyuk-Jae Lee, Hyun Kim, "*PCMCsim: An Accurate Phase-Change Memory Controller Simulator and its Performance Analysis*," IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS), May. 2022.
- Hyeon Gi Seong, Hyokeun Lee, Hyun Kim, Hyuk-Jae Lee, "*Analysis of Hardware Prefetchers Suitable for CNN Applications*," IEEE/IEIE International Conference on Consumer Electronics-Asia (ICCE-Asia), Nov. 2021.
- Hyokeun Lee, Seungyong Lee, Moonsoo Kim, Hyun Kim, Hyuk-Jae Lee, "*IMDB: A Low-Cost In-Module Disturbance Barrier for Mitigating Write Disturbance Errors in Phase-Change Memory*," Design Automation Conference (DAC, *work-in-progress session*), July. 2020.
- Hyokeun Lee, Donghyeon Lee, Hyuk-Jae Lee, "*A Predictive Initialization of Hidden State Parameters in a Hidden Markov Model for Hand Gesture Recognition*," IEEE/IEIE International Conference on Consumer Electronics-Asia (ICCE-Asia), June. 2018.

## •Journal

- Hyokeun Lee, Seungyong Lee, Byeongki Song, Moonsoo Kim, Seokbo Shim, Hyuk-Jae Lee, Hyun Kim, "*An In-Module Disturbance Barrier for Mitigating Write Disturbance in Phase-Change Memory*," IEEE Transactions on Computers, April. 2023.
- Hyokeun Lee, Hyuk-Jae Lee, Hyun Kim, "*A Read Disturbance Tolerant Phase Change Memory System for CNN Inference Workloads*," Journal of Semiconductor Technology and Science, Aug. 2022.
- Moonsoo Kim, Hyokeun Lee, Hyun Kim, Hyuk-Jae Lee, "*WL-WD: Wear-Leveling Solution to Mitigate Write Disturbance Errors for Phase-Change Memory*," IEEE Access, Feb. 2022.
- Seungyong Lee, Hyokeun Lee, Hyuk-Jae Lee, Hyun Kim, "*Evaluation of Various Workloads in Filebench Suitable for Phase-change Memory*," IEIE Transactions on Smart Processing & Computing, April. 2021.
- Hyokeun Lee, Hyunmin Jung, Hyuk-Jae Lee, Hyun Kim, "*Bit-width Reduction in Write Counters for Wear Leveling in a Phase-change Memory System*," IEIE Transactions on Smart Processing & Computing, Oct. 2020.
- Jinwoo Park, Hyokeun Lee, Boyeal Kim, Dong-Goo Kang, Seung Oh Jin, Hyun Kim, Hyuk-Jae Lee, "*A Low-Cost and High-Throughput FPGA Implementation of the Retinex Algorithm for Real-Time Video Enhancement*," IEEE Transactions on Very Large Scale Integration Systems, Jan. 2020.
- Hyokeun Lee, Moonsoo Kim, Hyunchul Kim, Hyun Kim, Hyuk-Jae Lee, "*Integration and Boost of a Read-Modify-Write Module in Phase Change Memory System*," IEEE Transactions on Computers, Dec. 2019.
- Sunwoong Kim, Hyunmin Jung, Woojae Shin, Hyokeun Lee, Hyuk-Jae Lee, "*HAD-TWL: Hot Address Detection-based Wear Leveling for Phase-Change Memory Systems with Low Latency*," IEEE Computer Architecture Letters, July. 2019.

## •Patents

- "*Mitigating Write Disturbance Errors of Phase-Change Memory Module*," US Patent, No. 11462266, Oct. 2022. (Granted)
- "*Semiconductor Memory Device Performing Command Merging and Operating Method Thereof*," US Patent, No. 11055025, July. 2021. (Granted)
- "*Semiconductor Device for Managing Cold Addresses of Nonvolatile Memory Device*," US Patent, No. 10877698, Dec. 2020. (Granted)
- "*Semiconductor Device for Managing Wear Leveling Operation of a Nonvolatile Memory Device*," US Patent, No. 10713159, July. 2020. (Granted)

## PROFESSIONAL ACTIVITIES

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### •2024

- Reviewer, Springer The Journal of Supercomputing
- Program Committee, The 42nd IEEE International Conference on Computer Design (ICCD)
- Program Committee, Great Lakes Symposium on VLSI (GLSVLSI)
- Reviewer, International Conference on Electronics, Information, and Communication (ICEIC)

### •2023

- Program Committee, The 41st IEEE International Conference on Computer Design (ICCD)
- Reviewer, IEEE Conference on Artificial Intelligence Circuits and Systems (AICAS)
- Reviewer, IEIE Transactions on Smart Processing and Computing

### •2022

- Session Chair, The 40th IEEE International Conference on Computer Design (ICCD)
- Program Committee, The 40th IEEE International Conference on Computer Design (ICCD)
- Reviewer, Elsevier Microelectronics Journal
- Reviewer, IEEE Conference on Artificial Intelligence Circuits and Systems (AICAS)

### •2021

- Reviewer, Material Research Bulletin, Journal, Elsevier
- Technical Program Committee, IEEE /IEIE International Conference on Consumer Electronics Asia (ICCE-ASIA)
- Reviewer, IEIE Transactions on Smart Processing and Computing

## LECTURES & INVITED TALKS

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- "*Disaggregation and its Security for Large-Scale Computing Systems*," Korea University, South Korea, Aug. 2023.
- "*CXL-enabled Sharing in a Multi-Host Disaggregated Memory System*," Seoul National University GoGE Workshop: Future Generation Security Computing Systems, Aug. 2023.
- "*Introduction to Computer Architecture Simulators and Use of Gem5*," North Carolina State University (ECE 096), United States, Mar. 2023.
- "*Bitwidth Reduction of Write Counters of Wear Leveling in a Phase-Change Memory System*," KSPC, South Korea, Sep. 2022.
- "*Introduction to Computer Architecture Simulators and their Examples*," University of Seoul, South Korea, Jun. 2022.

## AWARDS

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- First Prize in Haedong Best Paper Award (Academic Research Work), South Korea Nov. 2021.

## TECHNICAL SKILLS

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**Programming:** C++, C, Verilog, Python

**Architecture Simulators:** NVMain, PCMCsim, DRAMsim3, McSimA+, MacSim, gem5

**Commercial Software:** ModelSim, Vivado, Quartus

**Hardware Interface (Transaction Level):** AXI-Lite/-Full/-Stream, CXL, PCIe, I2C, JEDEC DDRx

**Languages:** English (Professional working proficiency), Korean (Native), Chinese (Bilingual)