

Mingjie Shen

Elmore Family School of Electrical and Computer Engineering

Purdue University

✉ shen497@purdue.edu

📄 My Webpage

Curriculum Vitae

🐙 Github in LinkedIn 📄 Google Scholar

Research Interests

My research interest is in systems and software security, currently focusing on static analysis and the security of embedded systems.

Education

08/2019–present **PhD student in Electrical and Computer Engineering,**
Purdue University, West Lafayette, USA.

Advisor: Prof. Aravind Machiry

Plan-of-Study GPA: 3.87. Overall GPA: 3.58

09/2015–06/2019 **Bachelor in Computer Science and Technology,**
Nanjing University, Nanjing, China.

Overall GPA: 4.58/5.0 (top 4%). Major GPA: 4.66/5.0

Publications

- 2023 **Mingjie Shen**, James C. Davis, and Aravind Machiry. Towards automated identification of layering violations in embedded applications (wip). In *Proceedings of the 24th ACM SIGPLAN/SIGBED International Conference on Languages, Compilers, and Tools for Embedded Systems*, LCTES 2023, page 143–147, New York, NY, USA, 2023. Association for Computing Machinery.
- 2023 **Mingjie Shen**, Akul Pillai, Brian A. Yuan, James C. Davis, and Aravind Machiry. An empirical study on the use of static analysis tools in open source embedded software, 2023.

Research Experience

Purdue University

03/2023–09/2023 **Finding hundreds of defects in open-source embedded software with CodeQL.**

Supervised by Prof. Aravind Machiry and Prof. James Davis.

- Configured and ran CodeQL on 100+ open-source GitHub repositories for embedded systems.
- Found 500+ defects, e.g. missing null check, uncontrolled allocation size.
- Opened pull requests that fix these defects and got 80+ PRs merged.

07/2022–03/2023 **Automated identification of layering violations in embedded applications.**

Supervised by Prof. Aravind Machiry and Prof. James Davis.

- Developed static analysis tool to detect a class of layering violations called *Non Conventional MMIO Accesses (NCMAs)*, i.e. accessing MMIO without going through Hardware Abstraction Layer (HAL).
- Created a dataset of compilable embedded applications spanning five RTOSes.
- Identified 369 NCMAs and found developers' rationales for committing NCMAs.

09/2021–07/2022 **Using selective memoization to defeat Regular Expression Denial of Service.**

Supervised by Prof. James Davis.

- Implemented memoization scheme in Python regex engine.
- Focused on optimizing the memory overhead of memoization.
- Characterized cases where memoization can reduce the time cost to linear with a constant space cost, and cases with a non-constant space cost.

Nanjing University

09/2018– **Snapshot and deterministic replay for a JIT-optimized full system emulator.**

05/2019 *Supervised by Prof. Yanyan Jiang.*

- Developed a recording system for non-deterministic events, including external input devices and interrupts, within the emulation process, enabling seamless re-execution and replayability through log records.
- Translated guest binary into IR and leveraged intra-basic block dataflow analysis for efficient interpreted execution.
- Supported basic x86 instruction, memory management, interrupts, and simple devices.

Course Projects

Purdue University

01/2023– **Projects in computer network systems (ECE 50863).**

05/2023 *Supervised by Prof. Sanjay Rao.*

- Developed a simplified SDN system with Python-based switches and a controller.
- Designed and implemented a reliable transfer protocol.
- Implemented and evaluated two Adaptive Bit Rate (ABR) algorithms (MPC in SIGCOMM'15 and BBA in SIGCOMM'14).

08/2020– **Building a modern time-sharing operating system (ECE 695).**

12/2020 *Supervised by Prof. Y. Charlie Hu.*

- Implemented Processes Management, Memory Management and File Systems.

08/2019– **C-like language compiler (ECE 573).**

12/2019 *Supervised by Prof. Xiaokang Qiu.*

- Implemented lexical and syntax analysis (using flex and bison), semantic analysis, IR generation, code optimization, and machine code generation.
- Used Linear Scan for register allocation.

Nanjing University

03/2018– **Building a complete computer system from scratch.**

09/2018 *Supervised by Prof. Yanyan Jiang and Prof. Jun Li.*

- Cooperated with two senior undergraduates.
- Designed and implemented a full system stack: an out-of-order MIPS32 processor (on FPGA), a self-built modern operating system, runtime systems (libc, SDL-like multimedia library, etc.), and applications (window manager, terminal emulator, full system x86 emulator, etc.).
- Won *first prize* in 2018 Loongson Cup National Computer System Contest (top 2 out of 24 teams from top-ranked universities).

Skills

C, C++, Python, CodeQL, LLVM, Bash, Git, LaTeX