Ammar Ratnani

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Education

Stanford **|** M.S. in Computer Science — Sept. 2023 - Jun. 2025

- *Coursework:* Embedded Operating Systems, Networking, Computer Architecture, VLSI Design
- *Concentration:* Systems
- *GPA:* 4.2

Georgia Institute of Technology **|** B.S. in Computer Science — Aug. 2019 - May 2023

- *Coursework:* Processor Design, Secure Computer Architecture, High-Performance Computing
- *Concentrations:* Systems/Architecture and Theory
- *GPA:* 4.0

Publications

AOS-RISC-V: Towards Always-On Heap Memory Safety — May 2022

Yonghae Kim, Anurag Kar, Siddant Singh, Ammar Ratnani, Jaekyu Lee, Hyesoon Kim
Computer Architecture Research with RISC-V (CARRV)

Research Experience

MINOTAUR / EE 372 **|** *Student Researcher* — Apr. 2025 - Jun. 2025

- Optimized the performance and area of this neural network accelerator
- Analyzed Catapult HLS schedules, Synopsys Design Compiler reports, as well as C++ and Python compiler code, to find performance bottlenecks
- Implemented improvements that improved the performance of MobileBERT and ResNet-18 by 23% and 10% respectively, while reducing the area of the design by 3%
- Devised targeted fixes for softmax and max-pooling, reducing those particular layers' runtimes by 50% and 60% respectively

Embedded Systems Cyber Security VIP **|** *Student Researcher* — Aug. 2021 - Dec. 2022

- Won first place in CSAW's Embedded System Cybersecurity competition on voltage glitching and power side-channel analysis
- Analyzed `malloc` implementations, fuzzing them for vulnerabilities and using those found to gain shell access on the target system
- Modified AFL++'s compiler runtime to circumvent infinite recursion when instrumenting standard library functions
- Won second place in CSAW's Embedded System Cybersecurity competition on exploiting machine learning models and machine learning as a service

AOS-RISC-V **|** *Student Researcher* — Apr. 2022 - May 2022

- Worked on a project to provide pointer bounds-checking in hardware
- Implemented the QARMA block cipher in Scala to verify an existing Chisel codebase
- Created a pipelined functional unit to sign pointers using QARMA, and integrated that into the BOOM's pipeline

Industry Experience

NVIDIA **|** *Software Engineering Intern* — Jun. 2024 - Sept. 2024

- Worked on increasing game performance on the GeForce Now cloud gaming platform, using Windows Performance Toolkit for collection and Python for analysis
- Created a dashboard to display CPU-side bottlenecks, including: parallelism, scheduling, inter-processor communication, hypervisor steal time, and interrupts
- Deep-dived the causes of a performance regression on Rainbow Six: Siege when running on AMD CPUs instead of Intel
- Improved the reliability of automated benchmarks, and even extended them with three new stress-tests and one new game

The Aerospace Corporation **|** *Software Engineering Intern* May 2023 - Aug. 2023

- Developed a fully autonomous ground station to receive images via radio transmission from the NOAA 15, 18, and 19 weather satellites
- Integrated a GNU Radio flowgraph with Python code to demodulate and synchronize Automatic Picture Transmissions in real time on embedded hardware
- Investigated decoding Differential Binary Phase-Shift Keyed transmissions from the NOAA GOES 16 weather satellite
- Constructed a prototype transpiler that ingests SysMLv2 and produces HSFL COSMOS configuration files, looking to use it in a CI/CD pipeline

Green Hills Software **|** *Software Engineering Intern* Jun. 2022 - Aug. 2022

- Diagnosed performance bottlenecks on Windows, obtaining a 25% speedup by eliminating unneeded memory allocations and synchronizations
- Deployed Windows as a guest into Green Hills's hypervisor via PXE using both `wimboot` and Windows Deployment Services
- Patched OVMF to make it compatible with Windows under the hypervisor
- Debugged xHCI USB pass-through in the hypervisor
- Implemented VPN scalability tests, ensuring it can support up to 5000 connections

L3Harris **|** *Software Engineering Intern* May 2021 - Aug. 2021

- Administered three platforms running C++ applications on embedded Linux
- Modularized firewall setup scripts to reduce duplicate code while ensuring no regressions were introduced in the process
- Led a move from single-user to multi-user systems, configuring authentication to integrate with both open-source and custom PAM modules

Fraudmarc **|** *Software Engineering Intern* May 2020 - Jul. 2020

- Used Test-Driven Development with a focus on maturing the codebase
- Cut backend test boilerplate by a factor of twelve and reduced average Cypress runtimes three-fold
- Introduced frontend visual testing with Percy to flag uncaught regressions with little to no overhead and few false positives
- Gained familiarity in email protocols by reading IETF RFCs

Institute of Electrical and Electronics Engineers **|** *Simulation Team Member* Aug. 2019 - Apr. 2020

- Created Georgia Tech's submission to Southeastcon 2020: a small robot that moves to collect blocks then stacks as many as it can in a particular order
- Collaborated with subteam members to test the design and guidance of the robot
- Integrated custom electronics code in Python with PyBullet to ensure fidelity when simulating rigid- and soft-body interactions

Teaching Experience

Operating Systems Laboratory **|** *Course Assistant* Jan. 2025 - Mar. 2025

- Assisted 80 students twice a week for seven hours in this application-only course, both by giving high-level overviews of each lab and by helping find errors in student code
- Wrote Assembly and C targeting the Raspberry Pi Zero, an ARM System on Chip
- Debugged driver code for common embedded peripherals, including Timers, UART, I^2C, and SPI, as well as board-specific peripherals, like the debug coprocessor
- Implemented interrupts, context switching, and virtual memory from scratch

Intro. Computer Architecture **|** *Teaching Assistant* Aug. 2020 - May 2022

- Instructed students in this challenging major-specific course, guiding them through circuit building, Assembly, C, and some C++
- Held both one-on-one office hours and group recitations
- Created instructional material for recitations, as well as student assignments: homeworks, quizzes, and the final exam

***Intro. Information Security* |** *Freelance Tutor* Jan. 2020 - Apr. 2020

- Instructed a student in this graduate-level computer security course covering common vulnerabilities and their mitigation
- Moved from low- to high-level exploits, going from buffer overflows in C to cryptography in Python to web-based exploitation in JavaScript and PHP

Honors and Awards

Second Place in NYU's CSAW Embedded Systems Cybersecurity Competition Nov. 2022

- Exploited machine-learning models in black-box and white-box settings
- Performed trojan insertion, data poisoning, and adversarial input generation

Solver of NSA's Codebreaker Challenge Aug. 2022

- Completed all nine challenges in web reverse engineering and cryptography
- Tenth student out of nearly 2000 participants to do this

First Place in NYU's CSAW Embedded Systems Cybersecurity Competition Dec. 2021

- Attacked an ARM microcontroller using power analysis and voltage glitching
- Solved nine binaries, as well as one timed challenge

NSA Codebreaker Challenge High Performer Dec. 2020

- Recognized by the NSA for achievement in binary exploitation and cryptanalysis
- Contributed to making Georgia Tech place second in the challenge

Third Place in NYU's CSAW CTF Competition Nov. 2020

- Performed well in the qualifying round and was accepted to the Mad H@tters' team
- Swept all the cryptography challenges in the final round, placing us third overall

Perfect Score on the AP Computer Science A Exam May 2017

- One of only 112 to receive this honor

Certifications

Amateur/Ham Radio Technician Class License Jul. 2023

Projects

Zynq 7000 HDMI Peripheral: https://github.com/ammrat13/meta-hdmi-dev Mar. 2024 - Jun. 2024

- Wrote an HDMI framebuffer peripheral in Vitis HLS and Verilog
- Integrated this "soft" peripheral with the "hard" processor on this FPGA SoC over AXI4
- Demonstrated the peripheral's functionality with a video player operating over a user-space driver
- Committed to the peripheral's design with a kernel module, integrated into Linux via Yocto and demonstrated by running X11

Replicating TCP Hijacking in NAT-Enabled Networks: https://github.com/peytonl7/cs244 Mar. 2024 - Jun. 2024

- Demonstrated remotely manipulating a router's `conntrack` state from an attacker on the same local network in order to hijack existing TCP sessions
- Set up a TUN Device on Linux to send raw IP packets from user-space, bypassing the kernel's networking stack entirely
- Performed the attack both on an AWS VPC and on physical routers

LLVM Cross-Compiler for the LC-3.2: https://github.com/lc-3-2 Feb. 2023 - Sept. 2023

- Assisted in defining the Instruction Set Architecture (ISA) for the LC-3.2: a 32-bit byte-addressable variant of the LC-3, a popular pedagogical ISA
- Constructed a backend for LLVM 17.0.1 to allow the compiler to output assembly code for the new architecture
- Ported the `newlib` C library to use LC-3.2 system calls to allow for a development experience closer to that of a hosted environment
- Ported `coremark` to the LC-3.2, thereby verifying the correctness of the backend and the C library

Zynq 7000 DRAM Speed Testing: https://github.com/ammrat13/pynqz2-ram-tester Jul. 2022

- Designed a hardware module in SpinalHDL to measure the latency and throughput of DRAM transactions on this SoC FPGA
- Interacted with memory over AXI4 and with the processor over AXI4-Lite MMIO
- Created bare-metal driver code for the peripheral in C and Assembly

Sudo in UserSpace: https://github.com/ammrat13/sus Oct. 2021 - Dec. 2021

- Experimented with running most of `sudo`'s logic as an unprivileged user
- Configured Linux permissions to ensure isolation between the user and root access
- Achieved feature-completeness, utilizing Rust and its build tools

Gameboy Advance Cross-Compilation: https://github.com/ammrat13/gba-cross-lib-doc Apr. 2020 - May 2021

- Compiled a GCC-based toolchain to target the GBA with Assembly, C, and some C++
- Packaged the toolchain into Docker containers for end-users and for testing in CI/CD
- Wrote a C runtime from scratch

Open Source Contributions

PureDOOM: github.com/Daivuk/PureDOOM/pull/5 Jun. 2023

Corrected the logic that aggregated DOOM's original C files into a header-only library

Nim: github.com/nim-lang/Nim/issues/21027 Dec. 2022

Discovered and reported a segmentation fault in the semantic analysis stage of this language's compiler

OVMF: edk2.groups.io/g/devel/message/91993 Jul. 2022

Altered this UEFI firmware's SMBIOS handler to, should hardware detection fail, pass sensible defaults instead of no data at all

hangover: github.com/emeryberger/hangover/pull/2 Mar. 2022

Fixed many spurious segmentation faults and aborts in this C++ framework for fuzzing `malloc` implementations

cmocka: gitlab.com/cmocka/cmocka/-/merge_requests/36 Mar. 2021

Propagated failure messages to test output instead of dumping them to standard-out

IEEE SoutheastCon 2020: github.com/ncgadgetry/southeastcon2020/issues/1 Oct. 2019

Corrected an off-by-one error in the score calculation logic for the Student Hardware Competition at this annual event

Gentoo Linux: forums.gentoo.org/viewtopic-p-8341586.html Jun. 2019

Wrote a patch resolving compiler errors that prevented some users from installing Blender

Languages and Frameworks

Proficient: C, Python, Linux, Git
Competent: C++, Rust, Verilog
Familiar: CUDA, Go, Java, GNU Radio, SQL, Vitis HLS, Catapult HLS