MATTHEW S. AI

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EDUCATION

Bachelor of Science, Electrical and Computer Engineering (ECE) Expected **May 2024**
University of Southern California (USC) Los Angeles, CA
Viterbi School of Engineering GPA: 3.968/4.000
Senior Thesis (in progress): *An FPGA-Based Feedback System for Sub-Microsecond Frequency-Tracking to Measure Dispersive Shifts Beyond the Resonance Linewidth* (working title)
Thesis Advisor: Eli M. Levenson-Falk

HONORS, AWARDS, & FELLOWSHIPS

USC ECE Ming Hsieh Institute Undergraduate Scholarship: $2,000 2023 – Present
Best Undergraduate Poster, 12th Annual USC Electrical Engineering Research Festival Oct 2022
USC Provost's Research Fellowship: $5,000 (cumulative) 2022 – Present
USC Presidential Scholarship: $127,000 (half-tuition for 4 years) 2020 – Present
National Merit College Sponsored Scholarship: $4,000 2020 – Present
USC Viterbi School of Engineering Dean's List 2020 – Present

RESEARCH EXPERIENCE

Undergraduate Researcher, Levenson-Falk Lab Jan 2023 – Present
Departments of Physics and Electrical Engineering, USC Los Angeles, CA

- Building an FPGA-based, real-time, continuous feedback system that can track a superconducting device's changing resonance frequency, enabling dispersive measurements beyond the resonance linewidth. Working in team of three to verify system on a custom resonator. Pursuing eventual use on a nanoSQUID quasiparticle-trapping device; applications to qubit readout to be explored.
- Gained expertise in simulating and programming Quantum Machines' OPX unit, including simulating pulse timing, and optimizing bit-level computations for speed.
- Simulated resonator *S*-parameters in Ansys HFSS, modeled quantum devices in Qiskit Metal, added graphical user interface (GUI) to Python measurement scripts.

Undergraduate Researcher, supervised by Prof. Daniel Lidar Apr 2022 – Present
Department of Electrical Engineering, USC Los Angeles, CA

- Attempted to improve known bounds of graph-theoretical Ramsey numbers using a quantum annealer and evaluating the quantum scaling of the Ramsey number problem.
- Independently self-studied quantum information and adiabatic quantum computation; successfully implemented quantum algorithms and replicated results from prior literature, collected novel results beyond the scope of previous work in the area.
- Self-learned advanced Python programming concepts and wrote custom modifications to D-Wave's Python API to gather specific, advanced data needed from the annealer.
- Presented poster at 2022 USC Electrical Engineering Research Festival and won Best Undergraduate Poster award.

Undergraduate Research Assistant, Cronin Research Lab Apr 2022 – Dec 2022
Department of Electrical Engineering, USC Los Angeles, CA

- Collected pressure data on high-voltage, cold-plasma-assisted combustion of pressurized hydrogen, methane, and ethylene.

TEACHING EXPERIENCE

Undergraduate Course Producer, Dept. of Electrical and Computer Eng. Aug 2021 - Present
University of Southern California Los Angeles, CA

- EE 370L, Electromagnetics for Engineering Systems: upper-division course, 60 students, lecturing on material in laboratory sessions, hosting office hours, grading over 100 lab reports.
- EE 141L, Applied Linear Algebra for Engineering: introductory mathematics course, 50 students, taught MATLAB skills to students for interactive laboratory assignments.

PROFESSIONAL & EXTRACURRICULAR EXPERIENCE

Space Systems Engineering Intern, Northrop Grumman Corp. May 2021 – Aug 2022

- Studied research papers on space satellite clock synchronization with subject matter experts to understand the relativistic physics involved.
- Implemented C++ simulation of space clock behavior and cross-satellite timing synchronization, debugged legacy flight software in MS Visual Studio, and reconstructed dozens of files to fill in for missing, necessary functions lost from the legacy codebase.
- Completed satellite RF link budgets, analyzed waveguide cross-guide coupler calibration data. Wrote MATLAB scripts to process calibration logs of antenna aiming/gimbaling.

PCB Engineering Co-Lead, USC Rocket Propulsion Laboratory Aug 2020 – May 2022

- Designed and wire-routed printed circuit boards (PCBs) for microcontrollers, FPGAs, analog-to-digital converters, low/band-pass filters and more, in Altium Designer.
- Manually built and troubleshot dozens of these circuit boards, including battery regulators, I^2C lines, and 3rd-party radio systems. Integrated these boards into a fully custom avionics unit that flew on a rocket to 50,000 ft and enabled successful recovery.
- Managed a custom, command-line digital inventory system of over 300 different components sourced from Digi-Key, Mouser, Newark, etc. and orders for several dozen different PCBs.
- Helped design and build RF-based "rangefinder" trilateration system: contributed to schematics, test procedures, firmware programming, and C++ data analysis using Eigen linear algebra library.
- Conducted field tests of RF system to calculate free-space path loss and link budgets from measured attenuations. Provided feedback on manuscript of thesis report on the project. Report link: https://engrxiv.org/preprint/view/1655/

LEADERSHIP & SERVICE

President, USC Chapter of Tau Beta Pi Honor Society (CA Delta) Apr 2023 – Present

- Leading an effort with university administrators and regional chapters to revive USC's 75-year-old chapter of the Tau Beta Pi engineering honor society after it fizzled out during the COVID pandemic years. Managing officers, recruitment, funding, and corporate relations.

USC "Viterbi Impact" Volunteer, K-12 STEM Outreach Center Feb 2023 – Present

- Assisted in hosting a STEM field day for Los Angeles high school students: proctored competitive mathematics event (part of California's statewide "MESA" program).
- Mentored high school summer researchers, including first-generation students: guided them in how to read research papers, shared advice about college and careers in science and engineering.
- Incoming fall 2023 VEX robotics mentor for underrepresented students at local high schools.

Officer and Founding Member, ECE Dept. MHI Undergrad Research Hub Sep 2022 – Present

- Working in a team of five fourth-years to mentor undergraduate ECE researchers, foster a stronger sense of community amongst classmates, and host research-related events, including information sessions, research talks, social gatherings, and pitch nights.

- Invited by MHI department faculty in 2022 as an outstanding junior to help found this initiative alongside a group of college seniors.

POSTERS AND PRESENTATIONS

1. **M. S. Ai** and D. A. Lidar, "Ramsey Number Calculation on a Quantum Annealer", poster presented at the 12th Annual Electrical Engineering Research Festival, University of Southern California, Los Angeles, CA, Oct. 26, 2022. Awarded **Best Undergraduate Poster**. Link to poster: https://drive.google.com/file/d/1TAKh4rLt6G1J5wO6MQv2vaRQvU1TTRGR/view
2. **M. S. Ai**, S. R. Greenfield, D. Kowsari, S. A. Shanto, and E. M. Levenson-Falk, "Tracking Dispersive Shifts Beyond the Resonance Linewidth with Real-Time Measurement-Based Feedback", abstract submitted, poster to be presented at the American Physical Society March Meeting, Minneapolis, MN, Mar. 3-8, 2024.

TECHNICAL SKILLS

Programming (Software, Firmware): Python (NumPy, Matplotlib, SciPy, QUA, Ocean, NetworkX), C, C++ (Eigen, Armadillo), MATLAB, LaTeX, Git, Mathematica, Verilog, Arduino, Raspberry Pi

Engineering Tools: Altium (PCB design software), ANSYS Electronics/Optics (HFSS, Lumerical), Xilinx Vivado, QuestaSim

Lab Equipment: oscilloscopes, VNAs, spectrum analyzers, logic analyzers, soldering tools (irons, paste, flux, etc.), heat guns, benchtop reflow ovens

PROFESSIONAL MEMBERSHIPS

Tau Beta Pi Engineering Honor Society 2023 – Present
Institute of Electrical and Electronic Engineers 2023 – Present