Ian Ballinger

Electrical Engineer, **Software Engineer**, Rock Climber

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Linkedin, Google Scholar

About Me

I live and breathe full-stack embedded systems design and fabrication. I'm equally comfortable in Solidworks, Altium, and VSCode to build everything from space-constrained PCBs and device chassis to discrete time LQG or MPC control algorithms and cloud-scale IOT infrastructure. I have been extensively involved with the DARPA funded ADAPTER project as the lead electrical engineer for the Traverso Lab team.

Research Engineer II, Traverso Lab (Summer 2019, Aug. 2020 – Present)
Brigham and Women's Hospital, Harvard Medical School
Multidisciplinary Biomedical Research Lab (BWH/HMS, MechE/MIT):

- **Developed and optimized radio communication systems** for use through tissue and the gastric environment at 2.4GHz, enabling secure remote control of ingestible and implantable medical devices for multi-month applications
- **Built closed loop control and estimation systems** with machine learning, state space, and traditional transfer function model components for use in therapeutic and diagnostic tasks
- **Built full-stack IOT infrastructure** for 100-day live-animal body-area-network experiments with remote monitoring and control of implanted devices using custom BLE hardware, AWS MySQL servers, custom C# .NET glue software, and a Jupyter interface. This system has been deployed across the continental united states with our collaborators and for demonstrations to project sponsors.
- **Executed design integration and CDMO design transfer efforts** for an expedited **FDA Investigational Device Exemption submission** targeting clinical trials in late 2024 for novel ingestible systems.
- **Spearheaded purchase of approx. $800,000 of electronics fabrication tooling** to manage risks associated with 2020s supply chain instability.
- **Directed Electrical Engineering Fabrication Team** to develop fabrication and assembly processes for ultra-small medical devices utilizing flexible PCBs to 0.5/0.5mil trace/space and other state of the art manufacturing techniques.
- **Directed ASIC design teams** to develop ultra-small mixed signal chips for secure wireless communication for implantable devices
- **Hired, trained, and managed employees** for Electrical Engineering R&D in the biomedical engineering sector.
- **Publication Spotlight:** An automated all-in-one system for carbohydrate tracking, glucose monitoring, and insulin delivery, designed and fabricated an insulin delivery system with integrated electrochemical blood glucose sensor and automated dose calculation and administration
- **Publication Spotlight:** Implantable system for chronotherapy, designed and fabricated multi-device implant and wearable system for sleep therapy and real-time vital signs monitoring with closed loop control for drug delivery

BS. Electrical Engineering, UVM
(Aug. 2016 - May 2020)
Minor: Computer Science

Capstone Project:
"Helmholtz Steering for Arbitrary Pose Evaluation":
I worked with *Ascenscion Technology Corp*. to design and realize a calibration verification system for their magnetic sensors used in object tracking applications. This work revolved around Euler rotation sequences, Matlab to custom hardware communication, and the ability to design and fabricate application specific mixed signal circuits.

Relevant coursework:
Linear System Theory
Signals and Systems
Control Systems (classical)
Real Time Control systems (c2d, SS and MPC)
Machine Learning (classical, NN and CDNN methods)
Evolutionary Robotics
Data structures and Algorithms
Embedded Programming (ASM)
Digital Hardware Design (VLSI, verilog)
Communications Systems
Power Electronics
Digital Signal Processing

Languages and Frameworks
C/C++ with Arduino (FreeRTOS), nRF Connect (Zephyr-RTOS)
C# and .NET
MATLAB, Python, Julia
JavaScript, React.JS, React Native
AWS, Azure
Bluetooth Mesh
Bluetooth Low Energy (BLE)
Android (Java/Kotlin)

My Favorite Tools
Altium, VScode, WSL, Solidworks
LPKF Protolaser R4, MHP30
Docker, Docker Hub, Github

Research Engineer II, continued:

- **Authored technical reports for, presented to, and performed live demonstrations for project sponsors.**
- **Large mammal behavioral estimation** algorithm development and implementation in animal research facilities
- **Extensive laboratory experience** for electronics, mechanics, biology and chemistry workflows

Power Systems Research Intern, Packetized Energy (Summer 2018)
University of Vermont affiliated smart-grid startup, acquired in 2020

- **Developed visualization tools for exploratory data analysis** of power distribution networks with distributed energy storage mechanisms.
- **Learned full stack modern web development** with D3.js, React.js, and Node.js to build asynchronous and performant large graph visualizations.

Device Design and Process Development Intern, Biogen (Summer 2017)
Pharmaceuticals Focused on Neurodegenerative Diseases

- **Augmented existing autoinjectors for high viscosity drug substances** to enable electronic tracking of patient adherence, dosage control, and occlusion detection.
- **Developed testing fixtures and Instron methods** for implantable spinal stent port resealing in accordance with applicable standards using Stratasys Objet 3D-printers
- **Applied market analysis techniques** to smart auto-injectors market segment for business and engineering team strategy justifications

My Publications (Google Scholar is more up to date)

[1] H.-W. Huang et al., "An automated all-in-one system for carbohydrate tracking, glucose monitoring, and insulin delivery," Journal of Controlled Release, vol. 343, pp. 31–42, Mar. 2022, doi: 10.1016/j.jconrel.2022.01.001.

← Embedded Electrochemistry, control systems, radio communication, and drug delivery

[2] H.-W. Huang et al., "Cost-Effective Solution of Remote Photoplethysmography Capable of Real-Time, Multi-Subject Monitoring with Social Distancing," in 2022 IEEE Sensors, Oct. 2022, pp. 1–4. doi: 10.1109/SENSORS52175.2022.9967120.

← Autonomous systems and contactless vital signs monitoring

[3] H.-W. Huang et al., "Encapsulation of Gas Sensors to Operate in the Gastrointestinal Tract for Continuous Monitoring," in 2022 IEEE Sensors, Oct. 2022, pp. 1–4. doi: 10.1109/SENSORS52175.2022.9967279.

← Ultra-miniature electromechanical system design and fabrication

[4] S. H. Lee et al., "Implantable system for chronotherapy," Science Advances, vol. 7, no. 48, p. eabj4624, Nov. 2021, doi: 10.1126/sciadv.abj4624.

←Signal processing and machine learning for biological signals

[5] H. Huang et al., "In Situ Detection of Gastrointestinal Inflammatory Biomarkers Using Electrochemical Gas Sensors," in 2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), Jul. 2022, pp. 2491–2494. doi: 10.1109/EMBC48229.2022.9871468.

← Disease identification with biomarker electrochemical sensors