# Isaac R. Harris

Robotics Software Engineer | Pratt Miller Engineering

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## Summary

Robotics and controls software engineer with over 5 years of experience developing software for defense, aerospace, and wearable robotics applications. Expertise in motion control, state estimation, and dynamics simulation, combined with broad experience in general robotic software infrastructure, including containerization, build systems, Linux, and ROS2. Notable work includes implementing an Unscented Kalman Filter for 3D vehicle localization, designing a nonlinear trajectory-tracking controller for satellite attitude control, and developing an impedance controller for an open-source robotic leg.

## Education

**University of Michigan, Ann Arbor** *Sept 2020 - June 2021*
*Master of Science in Mechanical Engineering*

- Concentration: Control Systems and Robotics
- Coursework: Programming for Robotics in C, Digital Control System Design, Robot Kinematics and Dynamics, Linear Systems Theory

**University of Michigan, Ann Arbor** *Sept 2017 - Dec 2020*
*Bachelor of Science in Mechanical Engineering*

- Senior Capstone: Led the electrical and software development of a 3 DoF gimbal instrumented with angle encoders. Responsibilities included sensor, battery, and microcontroller selection, integration of the final electronics board, and firmware creation using C++
- Coursework: Automatic Control Systems, Design/Control of Wearable Robotics, Modeling and Control of Dynamic Systems, Instrumentation and Experimental Techniques (using electronics), Probability and Random Processes

## Experience

**Pratt Miller Engineering** *Dec 2023 – Present*
*Robotics Software Engineer*

Applied expertise in advanced motion control and state estimation to deliver high performing autonomous systems across a variety of vehicle platforms. Highlights include:

- Development of a modular Kalman Filter library in C++ for 3D vehicle localization. This included a quaternion-based multiplicative UKF (Unscented Kalman Filter). Eigen was the only dependency aside from the standard C++ lib. ROS2 nodes were also written to wrap the Kalman Filter core and interface with different vehicles
- Position controller which achieved 0.1 degree accuracy for 10-ton end effector. Gains were synthesized using model-based design in both Python and Simulink and the controller was implemented in C on the target
- Prototyped SLAM algorithms including both Kalman Filter and graph-based approaches. Achieved 2cm position accuracy for fiducial markers in 3D space with iSAM2 graph algorithm (Incremental Smoothing and Mapping v2)

**Metrea Vantage Labs** *May 2021 – Dec 2023*
*Software Simulation and Controls Engineer*

- Responsible for analysis, design, and simulation of satellite control and estimation algorithms in Python. Algorithm experience includes nonlinear trajectory tracking controllers, Extended Kalman Filters (EKF), and Robust Servomechanism Linear Quadratic Regulators (RSLQR)
- Translated mission CONOPs into control and estimation requirements and subsequently selected actuators and sensors based on derived requirements
- Used C/C++ and FreeRTOS to write embedded flight software including sensor drivers and interfaces to communication peripherals (e.g. CAN)
- Participated in regular code reviews and scrums as part of Agile development framework

## Experience

**University of Michigan, Locomotor Control Systems Lab | Neurobionics Lab** *Sept 2020 - May 2021*
*Graduate Research Assistant*

- Used Python in a Linux development environment to model and simulate a disturbance observer (DOB) control algorithm for a series elastic actuator (SEA) on a robotic knee prosthesis
- Designed an embedded state-space controller in Python to validate SEA simulation results on hardware which included two BLDC motors, a torsional spring, and a high-power LiPo battery
- Co-presented control seminar to Google X wearable robotics team
- Research culminated in a first-author RAL journal publication

**University of Michigan, Neurobionics Lab | *Sienko Research Lab** *May 2018 - Aug 2020*
*Undergraduate Research Assistant*

- Integrated firmware for high torque BLDC motor into a MATLAB GUI allowing for benchtop testing of various control schemes including position control and impedance control
- Aided in debugging hardware and software issues during human subject testing of a mechatronic ankle prosthesis
- Created a state machine to control the robotic ankle's motor and display various sensor output using Python and Bash on a Raspberry Pi computer
- Contributed to *Sensors journal publication by developing pipelines and biomechanical models in Vicon Nexus and Visual 3D software to process and analyze optical motion capture data

## Skills

**Languages:** C/C++, Python, MATLAB, Bash

**Algorithms:** EKF, UKF, (RS)LQR, DOB, SLAM

**Infrastructure:** Docker, VirtualBox, FreeRTOS, Simulink, Git, Linux, ROS2, Agile

## Publications

1. **Harris I**, Rouse E, Gregg RD, Thomas GC. A Control Framework for Accurate Mechanical Impedance Rendering with Series-Elastic Joints in Prosthetic Actuation Applications. IEEE Robotics and Automation Letters. 2024 Jun 19.
2. Ma CZ, Bao T, DiCesare CA, **Harris I**, Chambers A, Shull PB, Zheng YP, Cham R, Sienko KH. Reducing slip risk: a feasibility study of Gait training with Semi-real-time Feedback of Foot–Floor Contact Angle. Sensors. 2022 May 10.