





Immanuel Ampomah Mensah

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Education

Northeastern University

Boston, MA

Ph.D Student in Electrical and Computer Engineering

July 2024 – Present

Research Advisors: Dr. Kris Dorsey; Dr. David Rosen

Research Interests: Soft robotics, autonomy, planning, and control, large-scale eigen-value optimization, certifiably safe-by-construction planners and controllers for autonomous transportation systems, multi-agent systems

M.S. Mechanical Engineering - Mechatronics

January 2022 – May 2024

Relevant Coursework: Mobile Robotics, Mechatronic Systems, Robot Sensing and Navigation, Dynamics and Mechanical Vibration, Formal Methods for Dynamical Systems, Control Systems Engineering, Optimization Modeling for Engineers

B.S. Mechanical Engineering

August 2014 – May 2019

Study Abroad: Dialogue of Civilizations - Istanbul, Turkey and Berlin, Germany

Summer 2015

Courses: Politics of Gender and Immigration, Diaspora and Urban Studies in Europe and the Middle East

Capstone Project: Hyperloop Rolling Road Wind Tunnel

Achievements: Honors Program, University Scholars Program Scholarship, 2017 RISE Research Expo 1st Place, NU Robotics Club Founder and Project Lead (Swarm Robots), NU Club Taekwondo Founder

Research Experience

NEURAL Lab, Northeastern University

Boston, MA

Graduate Researcher

September 2023 – Present

- Applied information theory and eigenvalue-based E-optimality criteria to high dimensional (10,000+) measurement selection problems, addressing limitations in the scalability of traditional greedy optimization algorithms.
- Generalizing the framework to incorporate additive budget constraints (size, weight, power) and integrated heterogeneous sensor capabilities using factor graphs, broadening its applicability to diverse sensing and robotic systems with convex objectives.
- Integrating branch-and-cut techniques to ensure tight approximations and robust performance under complex constraints.

PARSES Lab, Northeastern University

Boston, MA

Graduate Researcher

June 2023 – Present

- Developing origami-inspired soft actuators, grippers, and arms equipped with proprioceptive capacitive sensors for state estimation and closed loop control.
- Developed closed-loop control systems for Kresling-patterned actuators, achieving sub-4 mm errors without external vision systems.
- Engineered an "origami balance board" capable of supporting and dynamically controlling a 60 kg load for adaptive assistive device applications.
- Exploring non-linear tube-based model predictive control (MPC) architecture to ensure safe operation of multi-unit soft robotic assemblies under uncertainty.

Pohang Institute of Science and Technology

Pohang, South Korea

Research Scientist

July 2017 – January 2018

- Developed a wind tunnel system using an array of small PC fans to test drone flight machine learning algorithms in real time.
- Created bespoke motor controllers and printed circuit boards (PCBs) using Arduino and I2C protocols to enable real-time control of a complex 100-motor system, ensuring precise and scalable motor management.

Rehabilitation Games and Virtual Reality Lab, Northeastern University

Boston, MA

Design Engineer

January 2016 – May 2019

- Developed "REACH Bot," a motion capture-based robotic interface leveraging advanced technology to improve engagement and therapeutic outcomes in pediatric rehabilitation.
- Engineered a cost-effective, modular game console and controller specifically designed to accommodate and engage children with disabilities, promoting interactive therapy through gaming.
- Enhanced software integration by updating Python code to interface new REACH Bot hardware with the Leap Motion API, enabling sophisticated motion tracking and interactive functionalities.

Industry Experience

Motional, Inc.

Boston, MA

Autonomous Vehicles Engineer

June 2020 – January 2022

- Defined comprehensive test cases to validate system requirements, including safety, ride quality, and mission completion, ensuring robust autonomous vehicle performance.
- Developed and designed simulations to proactively identify software regressions, reducing in-vehicle testing time from half a day to approximately 1.5 hours, significantly enhancing software reliability upon deployment.
- Conducted in-depth root cause analysis of system failures, providing actionable recommendations to improve system robustness and performance.

Aligned Vision

Chelmsford, MA

Electro-Mechanical Engineer

December 2019 – May 2020

- Redesigned electro-mechanical assemblies, reducing manufacturing costs by 7% and assembly time by 20%, while streamlining processes for improved efficiency.
- Engineered automated camera and laser calibration fixtures, training over 40 technicians in their operation and maintenance.

iRobot Corporation

Bedford, MA

Systems Test Intern

July 2018 – November 2018

- Developed and implemented test procedures for replicating product failures during user testing.
- Enhanced automated test fixture operations by designing and manufacturing custom parts, improving testing efficiency by 30% and accuracy by 20%.

Mechanical Engineering Intern

July 2016 – December 2016

- Performed fine debris testing and prototyped a debris dispenser system for automated testing, enabling continuous 8-hour test runs without manual intervention.
- Constructed high-precision test fixtures for evaluating robot dock quality, reducing variance in measurements by 0.2 mm and improving alignment accuracy.

Selected Class Projects

Optimization Modeling for Multi-Agent Pickup and Delivery

ME 5374 – Optimization Modeling for Engineers

Designed and implemented MILP formulations for a multi-agent pickup and delivery system, optimizing task allocation and paths to minimize cumulative travel distances in grid-based environments for batch and dynamic task allocation. Integrated energy, capacity, and time-window constraints for heterogeneous agents, such as drones, trucks, and cars.

Embedded Data Logging System for Wearable Applications

ME 5978 – Independent Study in Embedded Programming

Engineered a low power ESP32-based system for wearable applications, featuring OTA updates, LittleFS file management, and wireless data retrieval for monitoring fluid retention in healthcare conditions like lymphedema.

A Review of Autonomous Racing Strategies

EECE 5550 – Mobile Robotics

Reviewed an autonomous racing strategy using control barrier functions for safe overtaking. Simulated and extended the approach with dynamic behaviors and additional vehicles to assess scalability, exploring trajectory generation and control methods like MPC to balance safety, and performance.

Multi-Agent Pickup and Drop-Off Simulator with (SC)LTL Specifications

EECE 5698 – Formal Methods for Dynamical Systems

Developed a modular simulator for multi-agent systems handling pickup and drop-off tasks, ensuring compliance with syntactically co-safe Linear Temporal Logic (SC-LTL) specifications. Applied formal methods such as Büchi automata and product automaton construction to verify task completion and safety. The implementation accounted for collision-free path planning, addressing constraints like energy, capacity, and agent-specific behaviors. Simulated dynamic environments with heterogeneous agents (drones, cars, trucks).

Teaching Experience

MIT Beaverworks Summer Institute: Autonomous Air Vehicle Racing

Cambridge, MA

Lead Instructor

August 2024 - Present

- Redesigned and taught a 5-week advanced robotics curriculum to 33 high school students, covering ROS2, robot perception, sensor fusion, signal conditioning, and autonomous UAV control and navigation using undergraduate and graduate-level materials.
- Designed and built a custom research drone platform equipped with GPS, optical flow sensors, range finder, Raspberry Pi companion computer, stereo and mono cameras, and a PX4 6c mini flight controller to overcome unforeseen technical challenges that rendered existing pre-COVID drones unusable and ensuring the continuity of research projects.
- Designed hands-on projects where students implemented SLAM and trajectory planning for drone systems.
- Mentored teams through project development and provided feedback to improve technical and collaborative skills.

Lowell Boys and Girls Club

Lowell, MA

Robotics Program Lead

January 2020 – March 2020

- Led a LEGO Robotics program, introducing middle and high school students to engineering concepts and programming.
- Mentored students in preparation for FIRST LEGO League (FLL) competitions, focusing on teamwork and problem-solving skills.
- Designed engaging robotics challenges to inspire creativity and encourage STEM education among youth.

Northeastern University NUTrons

Boston, MA

FIRST Robotics Mentor

September 2014 – May 2015

- Mentored a local FIRST Robotics Competition (FRC) team, guiding students in mechanical design, programming, and competition strategy.
- Provided technical guidance on robot construction and control systems, fostering collaboration and innovation within the team.
- Supported students in developing critical thinking and engineering skills through hands-on mentorship.

Publications

J1. Hanson, Nathaniel*; **Mensah, Immanuel***; Roberts, Sonia*; Healey, Jessica; Wu, Celina; Dorsey, Kristen. *Controlling the Fold: Proprioceptive Feedback in a Soft Origami Robot*. Frontiers in Robotics and AI. Frontiers Media SA, 2024.

C1. **Mensah, Immanuel***; Leblebicioglu, Damla*; Dorsey, Kristen L*. *Wireless Capacitive Measurement Board for Soft or Wearable Robots*. Submitted to IEEE RoboSoft 2025, under review.

Archive and Preprints

Ampomah Mensah, Immanuel; Healey, Jessica; Wu, Celina; Lacunza, Andrea; Hanson, Nathaniel; Dorsey, Kristen. *Hold 'em and Fold 'em: Towards Human-Scale, Feedback-Controlled Soft Origami Robots*. arXiv, 2023.

Poster, Presentations and Demos

Leblebicioglu, Damla; Gao, Henry; **Ampomah Mensah, Immanuel**; Khan, Muhammad; Dorsey, Kris. *Soft Capacitive Sensor and Wearable Sleeve Towards Measuring Fluid Retention*. IEEE Sensors Conference 2024; Kobe, Japan.

Mensah, Immanuel*; Hanson, Nathaniel*; Roberts, Sonia*; Wu, Celina; Healey, Jessica; Dorsey, Kristen. *Closed-Loop Proprioceptive Control of a 2-DOF Soft Origami Robot*. Accepted for presentation at the New England Robotics Colloquium (NERC 2024), September 2024, University of Massachusetts Amherst, Amherst, MA.

Hanson, Nathaniel*; Roberts, Sonia*; **Mensah, Immanuel** **Ampomah***; Wu, Celina; Healey, Jessica; Dorsey, Kristen. *Controlling the Fold: Proprioceptive Feedback in a Soft Origami Robot*. Late Breaking Results at 7th International Conference on Soft Robotics (RoboSoft); April 2024; San Diego, CA.

Mensah, Immanuel*; Hanson, Nathaniel*; Roberts, Sonia*; Wu, Celina; Healey, Jessica; Dorsey, Kristen. *Proprioceptive Feedback Control of a Soft Origami Robot*. Accepted for presentation at the New England Robotics Colloquium (NERC), October 2023, Yale University, New Haven, CT.

Awards, Scholarships and Fellowships

Runner-Up, 2023 Soft Robotics Toolkit Competition

2023 3M and Black in Robotics Masters Graduate Fellowship - \$25,000

2017 Northeastern University RISE Research Expo 1st Place for Innovation in Health Sciences

Recipient of the full-tuition University Scholars Program Scholarship as part of the 2014 cohort, awarded to high-achieving students for visionary leadership and academic excellence.

Service to The Discipline

Reviewer: IEE Robosoft Conference; 2024 IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR)

Professional Memberships

Member Black in Robotics - Boston Chapter

Mentoring

Faubus, Julia; Undergraduate - Northeastern University; Origami based soft robotic gripper. Fall 2024

Huang, Joshua; Undergraduate - NYU; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2024.

Saidi, Sakina; Undergraduate - Bates College; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2024.

Pallogudis, Jake; Undergraduate - Northeastern University; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2024.

McMahon, Sarah; Undergraduate - Washington University in St. Louis; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2024.

Hosseini, Noreen; Undergraduate - Northeastern University; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2024.

Extracurricular Activities

Founder, Northeastern Robotics Club

Founder, Northeastern Club Taekwondo

Athlete, tBos Taekwondo Competition Group - Olympic Sparring

Athlete, Northeastern Club Taekwondo A-Team

Volunteering and Outreach

Volunteer, iRobot Education

Volunteer, Orchard Garden Boys & Girls Club of Boston

Volunteer Science Fair Mentor, John D. O'Bryant School of Mathematics and Science

Mentor, Belmont High School Engineers for Good

Volunteer, Kitty Connection Inc., Cat Fostering

Technical Skills

Computer Languages: C/C++, Python, MATLAB, Julia

Software & Tools: ROS1 & 2, Gazebo, Jupyter Notebook, SolidWorks, LaTeX, Git, Arduino IDE

Skills: Rapid Prototyping, GD&T, System Design, Sensor Integration, Optimization, Control Systems