

NATHANIEL J. HANSON, Ph.D.

(+1) (210) 705-1371 ◊ hanson.n@northeastern.edu

2305 Willowgrove Avenue ◊ Dayton, OH 45409

www.github.com/nhanson2 ◊ www.linkedin.com/in/nathaniel-j-hanson ◊ www.nhanson.io

EDUCATION

Northeastern University

August 2020 - December 2023

Ph.D. Computer Engineering

Research Advisors: Dr. Taşkın Padır; Dr. Kris Dorsey

Research Interests: Multi-sensor fusion, in-hand sensing, mapping, integration of multi and hyperspectral imaging into robot vision, terrain aware trajectory planning

Dissertation: Material Informed Robotics – Spectral Perception for Object Identification and Parameter Inference

Boston University

June 2019 - August 2020

M.S. Computer Science

Focus: Big data analysis and machine learning methods with applications focused on emergent humanitarian crises to assist with COVID-19 relief work undertaken at MIT.

University of Notre Dame

August 2015 - May 2019

B.S. Computer Engineering, Minor Theology

Capstone Project: Software and hardware architecture for control of Unmanned Aerial Systems via brokered Message Queuing Telemetry Transport (MQTT) protocol over LTE cellular network. Project enabled beyond visual line of sight control for fleet of unmanned drones via fault-tolerant network

Shandong University

May 2017 - August 2017

Certificate Mandarin Chinese

Selected as foreign language training candidate for cultural and language immersion among competitive nationwide Air Force cadet corps.

WORK EXPERIENCE

MIT Lincoln Laboratory

June 2019 - Present

Associate Technical Staff

- Work with team of research engineers to develop technologies pertinent to US government humanitarian and disaster remediation goals
- Developed end-to-end tropical storm simulation software used by emergency managers to train and execute realistic preparedness exercises
- Built application to leverage cell phone Bluetooth capabilities to register with beacons placed around campus for fast quantification of signal propagation characteristics and anonymous identification of group gatherings during COVID 19 pandemic
- Innovated faster solutions to COVID 19 contact tracing at the height of the pandemic
- Assisted in setup and execution of airborne LIDAR acquisition flights to develop automated solutions to detect natural disaster damage

Northeastern University

August 2020 - Present

Postdoctoral Research Associate & Graduate Research Assistant

- Member of the Robotics and Intelligent Vehicles (RIVeR) Lab and Programmable and Reconfigurable Soft Engineered Systems (PARSES) Lab.
- Current Research*
- Development of novel gripper designs embedding visible to near infrared (VNIR) spectroscopic probes to acquire in-hand material readings

- Extending standard RGB machine vision into higher dimensional space via inclusion of visible and short wave infrared imaging systems
- Fusion of LIDAR with hyperspectral datacubes to create spatial-material representations of the world
Past Research
- Applying robotic control of 6 DoF arm to create precise 3D shapes with high volume cold spray additive manufacturing and measure depositions with laser profilometer
- Developing procedures and computational models to decompose CAD drawings into finite elements with safe tool routes for continuously applied cold spray

Cubert Hyperspectral Gmbh
Consulting Software Developer

January 2023 - Present

- Collaborate with international team of software developers to develop performant hyperspectral classification code.
- Maintain open-source classification toolkit library with robust examples of algorithm selection for hyperspectral data analysis.
- Develop instructional notebooks for community introduction to snapshot hyperspectral imaging.

DeLive Aerial Systems
Chief Technical Officer & Technical Advisor

January 2018 - March 2020

- Co-founded a drone technologies company to provide aerial delivery of emergency medicine in conjunction with the city of South Bend
- Custom designed drone to fit mission requirements including communications module and release mechanisms
- Created web application to enable emergency management call centers to dispatch UAV to incident scene with GIS enabled platform
- Successfully exited and assigned IP to the University of Notre Dame for further development and commercialization.

Software Engineering and Requirements Center
Undergraduate Research Assistant

August 2018 - May 2019

- Assisted in robotics lab developing software control systems for coordinated search and rescue UAV platform (Dronology)
- Transitioned code base to run as decentralized nodes over LTE communication protocol developed for undergraduate capstone

IronNet CyberSecurity
Cyber Operations Center/Data Science Intern

June 2018 - May 2019

- Built out a comprehensive network devices classifier to ingest data from PCAP data and generate asset classification labels (e.g. server, proxy, endpoint) with confidence metrics for integration into larger threat analysis framework
- Contributed to new data visualization system utilizing Golang and Kubernetes to provide real-time analysis of product efficacy

PUBLICATIONS & PRESENTATIONS

Journal Publications

J1. **Hanson, Nathaniel**; Stubbins, Aron; Imbiriba, Tales. Future Directions for Hyperspectral Detection of Micro and Macro Plastics in the Riverine. In preparation, 2024.

- J2. **Hanson, Nathaniel**; Allison, Austin; Daly, Natalie; DiMarzio, Charles; Padır, Taşkın; Dorsey, Kristen. Multi-Functional Soft Gripper System for Simultaneous Curvature and Near Infrared Sensing. In preparation, 2024.
- J3. **Hanson, Nathaniel**; Pyatski, Benjamin; Hibbard, Samuel; Lvov, Gary; DiMarzio, Charles; Dorsey, Kristen; Padır, Taşkın. Adaptive Calibration of Hyperspectral Imaging Systems for Mobile Robots under Dynamic Lighting. In preparation, 2024.
- J4. **Hanson, Nathaniel***; Roberts, Sonia*; Mensah, Immanuel*; Wu, Celine; Healey, Jessica; Furline, Donelle; Dorsey, Kristen. Controlling the Fold: Proprioceptive Feedback in a Soft Origami Robot. Under peer review, 2023.
- J5. Julien, Scott; **Hanson, Nathaniel**; Lynch, Joseph; Roberts, Kirstyn; Padır, Taşkın; Ozdemi, Ozan; Muftu, Sinan. Skewed Track Shape in Cold Spray Deposits Due to Applicator Fouling. Under peer review, 2023.
- J6. Julien, Scott; **Hanson, Nathaniel**; Lynch, Joseph; Nourian-Avaal, Ahmad; Roberts, Kirstyn; Padır, Taşkın; Ozdemi, Ozan; Muftu, Sinan. In Situ Monitoring of Deposit Shape Buildup during Cold Spraying. Under peer review, 2023.
- J7. **Hanson, Nathaniel**; Lvov, Gary; Padır, Taşkın. Occluded Object Detection and Exposure in Cluttered Environments with Automated Hyperspectral Anomaly Detection. *Frontiers in Robotics and AI*. Frontiers Media SA, 2022.

Conference Publications

- C1. Prajapati, Sarvesh; Trivedi, Ananya; **Hanson, Nathaniel Hanson**; Zolotas, Mark; Pathak, Rupesh Pathak; Kumar, Abhinav; Maxwell, Bruce; Padır, Taşkın. EF-Net: End-to-End Friction Estimation Using Intrinsic Imaging and Deep Networks. In preparation, 2024.
- C2. **Hanson, Nathaniel**; Hibbard, Samuel; Rautela, Vedant; Holand, Ethan; Allison, Austin; Abbas, Adeb; Padır, Taşkın. PROSPECT: Precision Robot Spectroscopy Exploration and Characterization Tool. In preparation, 2024.
- C3. Allison, Austin*; **Hanson, Nathaniel***; Wicke, Sebastian; Padır, Taşkın. HASHI: Highly Adaptable Seafood Handling Instrument for Manipulation in Industrial Settings. *IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2024, To appear.
- C4. Holand, Ethan; Homer, Jarrod; Khandeker, Musheera Khandeker; Muhlon, Ethan; Patel, Maulik; Storrer, Alex; Vainqueur, Ben-oni; **Hanson, Nathaniel**; Padır, Taşkın. Battery-Swapping Multi-Agent System for Sustained Operation of Large Planetary Fleets. *2024 IEEE Aerospace Conference*, IEEE, 2024.
- C5. **Hanson, Nathaniel**; Pyatski, Benjamin; Hibbard, Samuel; DiMarzio, Charles; Padır, Taşkın. Hyper-Drive: Visible-Short Wave Infrared Hyperspectral Imaging Data Sets for Robots in Unstructured Environments. *2023 13th Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS)*. IEEE, 2023.
- C6. **Hanson, Nathaniel***; Demirkaya, Ahmet*; Erdoğan, Deniz, Deniz; Padır, Taşkın; Imbiriba, Tales. A Vision for Cleaner Rivers: Harnessing Snapshot Hyperspectral Imaging to Detect Macro-Plastic Litter. *2023 13th Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS)*. IEEE, 2023.
- C7. Lvov, Gary; Zolotas, Mark; **Hanson, Nathaniel**; Allison, Austin; Hubbard, Xavier; Carvajal, Michael; Padır, Taşkın. Mobile MoCap: Retroreflector Localization On-The-Go. *IEEE International*

Conference on Automation Science and Engineering (CASE). IEEE, 2023.

C8. **Hanson, Nathaniel***; Lewis, Wesley*; Puthuveetil, Kavya*; Furline, Donelle; Padmanabha, Akhil; Padır, Taşkın; Erickson, Zackory. SLURP! Spectroscopy of Liquids Using Robot Pre-Touch Sensing. IEEE International Conference on Robotics and Automation (ICRA). IEEE, 2023.

C9. **Hanson, Nathaniel**; Shaham, Michael; Erdogmus, Deniz; Padır, Taşkın. Vast: Visual and spectral terrain classification in unstructured multi-class environments. 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2022.

C10. **Hanson, Nathaniel**; Kelestemur, Tarik; Berman, Joseph; Ritzenhoff, Dominik; Padır, Taşkın. Hyperbot – A Benchmarking Testbed for Acquisition of Robot-Centric Hyperspectral Scene and In-Hand Object Data. 2022 12th Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS). IEEE, 2022.

C11. **Hanson, Nathaniel**; Hochsztein, Hillel; Vaidya, Akshay; Willick, Joel; Dorsey, Kristen; Padır, Taşkın. In-Hand Object Recognition with Innervated Fiber Optic Spectroscopy for Soft Grippers. 5th International Conference on Soft Robotics (RoboSoft). IEEE, 2022.

Archive and Preprints

Hanson, Nathaniel; Keleştemur, Tarık; Erdoğan, Deniz; Padır, Taşkın. Pregrasp Object Material Classification by a Novel Gripper Design with Integrated Spectroscopy. *arXiv*, 2021.

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, 2023.

Poster Presentations

Hanson, Nathaniel; De La Garza, Oscar; Padır, Taşkın. See the Difference: Non-Contact Terrain Property Estimation via Hyperspectral Imaging for Off-Road Mobile Robots. Northeast Robotics Colloquium (NERC); November 2023; New Haven, CT

Hanson, Nathaniel; Pyatski, Benjamin; Hibbard, Samuel; DiMarzio, Charles; Padır, Taşkın. HyperDrive: Visible-Short Wave Infrared Hyperspectral Imaging Data Sets for Robots in Unstructured Environments. Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS); November 2023; Athens, GR.

Hanson, Nathaniel*; Demirkaya, Ahmet*; Erdoğan, Deniz, Deniz; Padır, Taşkın; Imbiriba, Tales. A Vision for Cleaner Rivers: Harnessing Snapshot Hyperspectral Imaging to Detect Macro-Plastic Litter. Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS); November 2023; Athens, GR.

Hanson, Nathaniel; Allison, Austin; Dorsey, Kristen; Padır, Taşkın. Spec-Tact-ular Fabric Perception: Multi-Stage, Multi-Modal Sensing. IEEE International Conference on Robotics and Automation (ICRA); May 2023; London, UK

Hanson, Nathaniel; Padır, Taşkın. SLURP! Spectroscopy of Liquids Using Robot Pre-Touch Sensing. Northeastern University PhD Expo; March 2023; Boston, MA

Hibbard, Samuel; **Hanson, Nathaniel**; Padır, Taşkın. Conical Compliant Rolling Contact Mechanism for Precision Robotic Wrists. Northeast Robotics Colloquium (NERC); October 2022; Lowell, MA

Hanson, Nathaniel; Padır, Taşkın. Pregrasp Object Material Classification by a Novel Gripper Designs with Integrated Spectroscopy - A Precursor to Materially Aware Robotics. Northeastern University PhD Expo; March 2022; Boston, MA

Hanson, Nathaniel; Julien, Scott; Ozan, Ozdemir; Muftu, Sinan; Padır, Taşkın. In Situ Characterization of Fundamental Building Blocks for Cold Spray Additive Manufacturing. Cold Spray Action Team; June 2021; Leominster, MA

CONFERENCE AND WORKSHOP PRESENTATIONS

Promises and Futures for Robotics in Disaster Response and Public Safety. Advanced Technology for Public Safety Workshop, 2024.

Vast: Visual and spectral terrain classification in unstructured multi-class environments. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2022.

Hyperbot – A Benchmarking Testbed for Acquisition of Robot-Centric Hyperspectral Scene and In-Hand Object Data. 12th Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS), 2022.

INVITED SEMINARS & COLLOQUIA

SLURP! Spectroscopy of Liquids Using Robot Pre-Touch Sensing. Northeastern University Institute for Experiential Robotics Seminar, 2023.

Material Informed Robotics - How Sensing the Stuff Around Us Makes Robots Smarter. University of Notre Dame Computer Science and Engineering Faculty Seminar, 2023.

TEACHING EXPERIENCE

Massachusetts Institute of Technology

January 2020 - Present

Lead Instructor - BeaverWorks Summer Institute

- Teach rising high school seniors from around the world concepts from machine learning, computer vision, and UAV control at an undergraduate level
- Transitioned in-person course curriculum to fully online format with simulation environments and individualized projects in response to the COVID-19 pandemic.

Robotics Engineer NEET Course 16.84

- Mentor senior capstone design course in design, construction, and evaluation of an autonomous sailboat.
- Provide practical engineering leadership lessons in how to appropriately design project scope and properly conduct literature reviews on the current State of the Art (SOTA).

Teaching Staff - Learning Machines Executive Education Course

- Develop curriculum targeted to teach senior military leadership fundamental concepts of artificial intelligence, machine learning, and reinforcement learning.
- Instruct course modules on human-in-the-loop reinforcement learning with small unmanned aerial systems.

AI Expert - Air Force AI Accelerator Know Apply Lead Cohort at Scale

- Coordinated live sessions, answered questions, moderated a forum, and generated discussion questions towards enhancing AI education for online learners in the United States Air Force.

University of Notre Dame

August 2018 - May 2019

- *CSE 30246* Assisted with the teaching and grading of an undergraduate level database and web development course
- *CSE 40773* - Helped debug drone control code and advised students on planning and executing final projects

AWARDS & SCHOLARSHIPS

Runner-Up, 2023 Soft Robotics Toolkit Competition

Outstanding Graduate Student Award - Recognized amongst entire graduate student body at Northeastern for integration of experiential research into doctoral education.

2023 Huntington 100 Member - Selected as 1 of 100 most influential students at Northeastern University for achievements commensurate with the university's mission, ideals, values, and academics.

Northeastern University PhD Network Travel Grant

National Hurricane Conference Outstanding Achievement Award - Selected for developing a state of the art tool to enable emergency managers develop simulated tropical cyclone scenarios to test a range of response and recovery situations

Department of Energy E-Robot Finalist - developed holistic robotic solution to support home crawlspace retrofit. Included in top 10/67 submissions

MIT Team Award (2021) - for rapid curriculum redevelopment efforts in support of the BeaverWorks Summer Institute

MIT Team Award (2020) - for outstanding service to MIT LL COVID-19 relief efforts and the Privacy Award Contact Tracing (PACT) project

ACC Inventure Prize Finalist - Startup DeLive recognized as one of the top three startups among schools in the Atlantic Coast Conference through televised competition

McCloskey Prize Finalist - Selected from +130 startup companies in the South Bend/Notre Dame community as a top 7 team for our combination of technical development, business plan, and overall ideation

Project Global Officer Awardee - Selected to receive intensive foreign language training at internationally regarded universities in the United States and abroad

University of Notre Dame Engineering Scholars Program - 1/19 students selected for advanced interdisciplinary studies in College of Engineering's class of 2019

University of Notre Dame Provost's Scholarship (2015-2019; 8 semester)

University of Notre Dame University Scholarship (2015-2019; 8 semesters)

PATENTS

Soft Robot Sensor for Simultaneous Curvature and Near Infrared Sensing. U.S. Provisional Patent, 63/613,570, filed Dec 1, 2023. Patent pending.

Highly Adaptable Seafood Handling Instrument. U.S. Provisional Patent, 63/595,017, filed Nov 2, 2023. Patent pending.

Soft Spectral Gripper With Innervated Fiber Optics Cables. U.S. Application Patent, 63/267,677, filed Feb 7, 2023. Patent pending.

SERVICE TO THE DISCIPLINE

Ad-hoc reviewer: IEEE RoboSoft Conference; IEEE International Conference on Robotics and Automation (ICRA); IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS); IEEE Conference on Automation Science and Engineering; International Symposium on Experimental Robotics (ISER)

SERVICE TO THE INSTITUTION

Student Panelist: Faculty Search Committee, Northeastern University

Student Panelist: Institute Lab Manager Search Committee, Northeastern University

Alumni Panelist: College of Engineering First-Year Alumni Panel, University of Notre Dame

PROFESSIONAL MEMBERSHIPS

Student Member, IEEE; Society of Catholic Scientists

UNDERGRADUATE & GRADUATE MENTORING

Daly, Natalie; Graduate - Northeastern; Software infrastructure for soft finger actuation and curvature measurement. Fall 2023.

Mensah, Immanuel; Graduate - Northeastern; Design of multi-chamber Kresling structure for underwater locomotion. Summer/Fall 2023.

Lewis, Wesley; Undergraduate - University of Virginia; Machine learning for interrogation of liquids in concealed containers with spectroscopy. Summer 2022; Summer 2023.

Holand, Ethan; Undergraduate - Northeastern; Design of sensors for surface analysis using robot manipulators and reflectance spectroscopy. Spring 2023.

Hibbard, Samuel; Undergraduate - Northeastern; Design of optical housings for outdoor hyperspectral sensing. Spring 2023.

Rautela, Vedant; Undergraduate - Northeastern; Semantic segmentation of hyperspectral data captured from a moving vehicle in urban and suburban environments. Spring 2023.

Pyatski, Benjamin; Undergraduate Co-Op - Northeastern; System architectures and drivers for real-time snapshot hyperspectral data analysis from a moving vehicle. Spring 2023.

Schofield, Matthew; Graduate - MIT/MIT LL; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2022.

Abdulhai, Rumaisa; Undergraduate - MIT/MIT LL; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2022.

Furline Jr., Donelle; Undergraduate - Northeastern; Ground truth motion capture system for soft robotic grippers. Summer 2022.

Lvov, Gary; Undergraduate - Northeastern; Automated hyperspectral anomaly detection in cluttered environments; Infrared Marker Tag Detection. Summer 2022; Spring - Summer 2023.

Healey, Jessica; Undergraduate Co-Op - Northeastern; Design and construction of a biodegradable waste collection robot constructed from cork. Spring 2022.

Berman, Joseph; Undergraduate - Northeastern; Hardware interface and control of a linear rail actuator for a robot manipulator. Spring 2022.

Ritzenhoff, Dominik; Undergraduate - Northeastern; Fundamentals of manipulation and point cloud processing. Spring 2022.

North, Christian; Undergraduate - Middlesex CC/MIT LL; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2021.

Joyce, Kiernan; Graduate - WPI/MIT LL; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2021.

Giacalone, Giovanni; Undergraduate - WPI/MIT LL; Teaching assistant for Autonomous Air Vehicle Racing with Beaver Works Summer Institute (BWSI). Summer 2021.

TECHNICAL SKILLS

Computer Languages	C/C++, MATLAB, Python, Java, Scala, JavaScript
Software & Tools	ROS, ArcGIS, ENVI, Gazebo, Jupyter Notebook, LaTeX
Skills	System Design, Sensor Integration, Computer Vision

RELEVANT COURSEWORK

Core Courses	Other Courses
Mobile Robotics	Machine Learning
Field Robotics	Remote Sensing
Hyperspectral Imaging	Reinforcement Learning
Robotic Science & Systems	Analysis of Algorithms
Robotics, Sensing, & Navigation	Artificial Intelligence
Software Development for Unmanned Aerial Systems	Software Engineering

EXTRACURRICULAR ACTIVITIES

Volunteer, St. Mary of the Assumption Catholic Parish, Brookline, Massachusetts
Mentor, ESTEEM Master's degree program, University of Notre Dame
Musician, Band of the Fighting Irish, Marching Band

MEDIA COVERAGE & APPEARANCES

“An invasive plant is strangling Connecticut’s waters, so these students developed a robotic boat to help fix it”, Northeastern Global News, <https://news.northeastern.edu/2023/12/14/hydrilla-plant-invasive-connecticut/>

“NU Team PARIS Wins in Phase 1 of American-Made E-ROBOT Prize”, Northeastern College of Engineering News, <https://coe.northeastern.edu/news/nu-team-paris-wins-in-phase-1-of-american-made-e-robot-prize/>

“Behind the Scenes of Contact Tracing Study”, TEDx MIT, <https://youtu.be/wz6tedCAEkc>

“Defibrillators by Drone”, University of Notre Dame News, <https://engineering.nd.edu/news/defibrillators-by-drone/>

“Prospective Student Startup Aims to Save Lives by Delivering Defibrillators by Drone”, <https://ideacenter.nd.edu/news-events/news/prospective-student-startup-aims-to-save-lives-by-delivering-defibrillators-by-drone/>

REFERENCES

Dr. Kristen Dorsey
Associate Professor
Department of Electrical and Computer Engineering
Northeastern University
k.dorsey@northeastern.edu

Dr. Taşkın Padır
Professor/Director
Institute for Experiential Robotics
Northeastern University
t.padir@northeastern.edu

Adam Norige

Group Leader

Humanitarian Assistance and Disaster Relief Systems

MIT Lincoln Laboratory

anorige@ll.mit.edu

(781) 981-7211