Nikolas R. Sanderson

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Education

May 2027 Expected Graduation | Northeastern University, Boston, MA

Candidate for Honors BS in Computer Engineering (GPA: 3.98)
Research Interests: Autonomous Navigation, State Estimation, Robot Motion Planning, Marine Robotics

Work & Research Experience

May 2024 - Present | Research Assistant, Northeastern University
Institute for Experimental Robotics, Advisors: Prof. Michael Everett, Prof. Hanumant Singh, Prof. David M. Rosen

- Developed a high-speed off-road autonomous robot platform, leading key design decisions across mechanical, electrical, and software systems, including integration of a state-of-the-art LiDAR SLAM system (DLIOM), and demonstrated capabilities for the Army Research Lab.
- Utilized machine learning to learn a robot dynamics model and integrated it with an MPPI-style planner to enable autonomous, contact-free terrain traversal (e.g., jumping) over challenging terrain.
- Applied *sum-of-squares* semi-definite programing relaxations (1st–2nd order) to marine-robotics localization with depth, range, bearing, and attitude sensing, and ran an empirical tightness study to identify when certifiably global solutions are recovered.
- Worked in large team to develop a sensor payload for *NEUROAM* - large scale multi-robot data collect - for SLAM data collection system integrating GPS, IMU, LiDAR, and cameras with ROS2 Humble-based time synchronization, handling end-to-end mechanical, electrical, and software integration including Jetson configuration for deployment across Unitree and Boston Dynamics Spot platforms.
- Development of *certifiably correct* factors on back end optimization algorithms for simultaneous localization and mapping (SLAM) in C++ utilizing GTSAM and Eigen libraries.
- Authored a paper proposing the first framework that enables online certifiable estimation for SLAM problems including PGO, landmark, and range-aided cases via a concurrent smoothing architecture.
- Co-authored a sparsity-preserving variable projection method for large-scale robotic perception optimization that handles gauge symmetries via a one-time preprocessing step to build a matrix-free Schur complement operator, delivering 2×–35× runtime speedups across standard robotic perception benchmarks and releasing an open-source C++ implementation.
- Implemented a distributed inexact Riemannian quasi-Newton optimizer for large-scale robotic perception using correlative-sparsity graph partitioning and a boundary–interior Schur complement solved matrix-free with communication-efficient PCG to retain second-order performance under memory and bandwidth constraints.
- Julia scripting of a Sparse Null-basis pursuit algorithm reducing null matrices up to 10% of the sparsity applying Riemannian variation of proximal gradient descent.
- Literature reviews on topics in current optimization, control, and robotics research.

July 2024 - December 2024 | R&D Engineering Co-op, Robert Bosch LLC

- Extended an automotive component test bench to evaluate automotive hardware (e.g., compressors), integrating pressure and temperature instrumentation and developing data-collection workflows for characterization testing.
- Designed and executed automotive component validation experiments, selecting sensors (pressure, temperature, current, voltage), configuring acquisition/controls, and analyzing logged data to quantify performance across operating ranges.

June 2022 - May 2024 | Research Assistant, Northeastern University
Department of Physics, Spring Lab, Advisor: Prof. Bryan Spring

- Development of laser endoscope and automated closed-loop control robotic LED illumination system for Photodynamic therapy, microsurgery, and microscopy of cancer.

Publications

[3] Zhexin Xu, **Nikolas R. Sanderson**, Hanna Jiamei Zhang, and David M. Rosen. "Simplifying Certifiable Estimation with Factor Graphs" *preprint*.

[2] Alan Papalia, **Nikolas Sanderson**, Haoyu Han, Heng Yang, Hanumant Singh, Michael Everett. "Sparse Variable Projection in Robotic Perception: Exploiting Separable Structure for Efficient Nonlinear Optimization". In *IEEE International Conference of Robotics and Automation (ICRA)*. Vienna, Austria, May 2026. link

[1] Zhexin Xu, **Nikolas R. Sanderson**, and David M. Rosen. "Simplifying Certifiable Estimation: A Factor Graph Optimization Approach". Presented at the *IEEE International Conference of Robotics and Automation (ICRA)* in the workshop "Robots in the Wild". Atlanta, GA, USA, May 2025. Link

Presentations

[8] Scalable and Certifiable Robotic Perception. IER Day PhD Student research presentation, Northeastern University, Boston MA, November 2025.

[7] A Platform for High-Speed Off-Road Autonomy. IER Day PhD Student research presentation, Northeastern University, Boston MA, November 2025.

[6] *Presenting Calypso: A Production Ready ROV.* Marine Advanced Technology Education (MATE) Center, Alpena MI, June 2025.

[5] *Simplifying Certifiable Estimation: A Factor Graph Optimization Approach.* Presented at the International Conference of Robotics and Automation (ICRA) in the workshop "Robots in the Wild". Atlanta, GA, USA, May 2025

[4] *Presenting Mariana: NUWaves New ROV.* Marine Advanced Technology Education (MATE) Center, Kingsport TN, June 2024.

[3] *Building a Buoyancy-Controlled Float to Increase Accessibility to Marine Research*. RISE Conference, Northeastern University, Boston, April 2024. link

[2] *Automated Open-Source Led Robotic System Using Nelder-Mead Numerical Optimization Method.* RISE Conference, Northeastern University, Boston, April 2024. link

[1] *Multiwell plate photodynamic therapy experiments using a robotic LED illumination system.* Biophysics Seminar, Northeastern Department of Physics, Boston MA, March 2024.

Awards and Fellowships

Spring 2026 | Bruce Pelzer Merit Scholarship

- $5,000 scholarship for Students of outstanding academic merit in the College of Engineering.

Summer 2025 | Guts & Glory - Marine Advanced Technology Education

- Given to the team that overcame hardships with determination and resolve.

Spring 2025 | MIT Stream Grant - MIT Sea Grant

- Grant of $10,000 to develop a deployment system of an ROV and vertical profiling float.

Fall 2024 | Honors Propel Grant - Northeastern University Honors College

- $2,000 toward SEASTAR, an education program for marine robotics.

Spring 2024 | Promoting Electric Propulsion - Naval Society of Engineers

- Grant of $7,000 to build an unmanned surface vehicle (USV).

Spring 2024 | Eta Kappa Nu Honors Society - Northeastern University Department of Electrical and Computer Engineering

- Top 25% of Electrical and Computer Engineering class.

Spring 2024 | Physics Internship Award - Northeastern University Department of Physics

- Academic Fellowship of $3,000 to develop an optimal position planning algorithm.

Fall 2023 | Tau Beta Phi Engineering Honors Society - Northeastern College of Engineering

- Top 12.5% of College of Engineering Juniors and Seniors.

Fall 2023 | Honors College - Northeastern University Honors College

Summer 2023 | PEAK Base Camp Award - Northeastern University Undergraduate Research Fellowship

- Academic Fellowship of $750 to pursue a research project.

Spring 2023 | PEAK Ascent Award - Northeastern University Undergraduate Research Fellowship

- Academic Fellowship of $1,500 to research and develop a buoyancy controlled float.

Competitions

ROV World Championship — Hosted by Marine Advanced Technology Education (MATE) Center

- June 2025 | Alpena, MI — Placed 13th out of 30 teams
  - Float lead and Co-Electrical Lead
- June 2024 | Kingsport, TN — Placed 13th out of 30 teams
  - Co-Electrical Lead
- June 2023 | Denver, CO — Placed 8th out of 30 teams
  - Electrical Team Member

Skills

Programing: Python (Numpy, Pytorch, Manim, Scipy, Pandas), C++, C, C#, Julia (Clarabel, COSMO, Mosek), Rust, MATLAB, Java, ROS, SLAM, Docker, Git, Gazebo

Software: KiCAD, SolidWorks, Blender, LTSpice, PSpice, LabVIEW, Linux, Intel Quartus Prime

Technical: Oscilloscope, Multimeter, Arduino, Raspberry Pi, STM32, Function Generator, FPGA, Soldering, 3D printing, 3D modeling, Analog & digital circuit design, PCB design, Digital acquisition boards, AD/DA converters, Fiber splicing, Laser alignment.