

PAUL NADAN

Robotics Ph.D. Student

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SUMMARY

A versatile robotics researcher experienced in the design, analysis, and control of novel robotic systems for locomotion and manipulation.

SKILLS

Programming: C++, Python, Java, MATLAB, ROS/ROS2, Arduino
CAD & FEA: SolidWorks, Fusion 360, OnShape, ANSYS
Fabrication: CNC Mill, Lathe, Waterjet, 3D Printing, Soldering

EDUCATION

Carnegie Mellon University

Ph.D. in Robotics

Selected Coursework: Optimal Control & RL, Nonlinear Control, Deep Learning for Robotics, Computer Vision, Space Robotics

Expected Dec 2024

Olin College of Engineering

B.S. in Mechanical Engineering

May 2020

DOCTORAL RESEARCH

Robotic Climbing for Planetary Exploration

- Designing, building, and programming a lightweight quadrupedal climbing robot to ascend vertical rock faces
- Prototyping underactuated microspine grippers that can support off-axis loads and conform to uneven terrain
- Implementing an optimization-based force control strategy for generating inward forces between opposing grippers
- Developing a centralized footstep planning algorithm that operates on 3D point clouds from the onboard depth camera
- Demonstrating climbing capabilities on a variety of surfaces including cinderblock, vesicular basalt, slag, and tufa stone
- Supported by the NASA Space Technology Graduate Research Opportunities fellowship

Magnetic Wall-Climbing for Tanker Inspection

- Leading a team of student researchers to develop a wall-climbing robot for detecting contaminants on steel structures
- Designing a mobility system to traverse obstacles, transition between surfaces, and maneuver in confined spaces
- Creating an analytical model for interior corner transitions to constrain robot design parameters
- Working with an industry partner to inform design requirements and field test the robot in realistic settings

Microspine Design for Additive Manufacturing

- Designed a novel 3D-printed microspine suspension to enable rapid prototyping of new grippers
- Developed a microspine stiffness model based on material tensile modulus and geometric design parameters
- Demonstrated through tensile testing that 3D-printed microspines outperform conventional multi-material microspines

INDUSTRY EXPERIENCE

NASA Jet Propulsion Laboratory

Visiting Technologist

Summer 2024

- Supported the development of a robotic system for construction of lunar habitats using in-situ building materials
- Designed, built, and tested a dual-purpose robotic end-effector for excavation and manipulation tasks

NASA Jet Propulsion Laboratory

Visiting Technologist

Summer 2023

- Worked with the Exobiology Extant Life Surveyor (EELS) team to enable vertical ice climbing with a snake robot
- Directly contributed to the EELS codebase, including ROS nodes, kinematics library functions, and unit tests
- Created a unified control framework to maintain contact with the shaft walls and regulate contact forces while climbing
- Tested the controller in simulation and on hardware, laying the groundwork for a successful field test at Athabasca Glacier

NASA Jet Propulsion Laboratory

Undergraduate Intern

Summer 2018 & 2019

- Led mechanical design and fabrication of a folding hexacopter capable of ballistic deployment from a launch tube
- Overcame challenges including extreme launch loads, tight space constraints, and vibration mitigation
- Machined components, selected flight hardware, and wired up electronics to build a fully functional prototype
- Diagnosed problems and identified potential design improvements through rapid prototyping and field testing
- Developed quick-release mechanisms for a smaller ballistically-launched quadcopter during the preceding summer

UNDERGRADUATE RESEARCH

Bird-Inspired Perching Landing Gear

- Analyzed a bird-inspired perching landing gear system that allows drones to land on branches and rough terrain features
- Developed a hybrid empirical-numerical computational model of grasping forces and kinematics
- Conducted MATLAB simulations to optimize design parameters for future iterations of the landing gear mechanism

Hexapod Robots as Folding Exploratory Rovers

- Developed a six-legged robotic hexapod as an all-terrain exploratory rover for space missions
- Implemented algorithms to traverse rough terrain, ascend steep slopes, and autonomously navigate around obstacles
- Designed and fabricated sensor mounts and custom feet with integrated contact sensing

Control of a Multirotor Swarm Through Guided Autonomy

- Launched a new student team at Olin College to enter the International Aerial Robotics Competition (IARC)
- Competed to solve research problems including indoor navigation, swarm coordination, and human-robot interaction
- Developed algorithms for localization, machine vision, voice control, and coordinated obstacle avoidance
- Demonstrated our system at the 2019 IARC Competition, where we received the award for Best Presentation

TEACHING

Carnegie Mellon University

Sep 2021 - May 2022

Graduate Teaching Assistant

- Courses included Computer Vision and Kinematics, Dynamics & Control
- Held office hours, revised and graded homework assignments, and provided guidance on student projects

Olin College of Engineering

Jan 2018 - May 2020

Course Assistant

- Courses included Engineering Systems Analysis, Transport Phenomena, Partial Differential Equations, and Quantitative Engineering Analysis I & II
- Held office hours, assisted with class instruction, checked in with students individually, and graded assignments

VOLUNTEERING

Organizer , ICRA Workshop on Unconventional Robots	2024
Session Leader , CMU National Biomechanics Day	2023-2024
Mentor , CMU Undergraduate AI Mentoring Program	2021-2024
Reviewer , IEEE RA-L, TRO, and IROS	2022-2023
Mentor , CMU SCS Graduate Application Support Program (GASP)	2020-2023
Mentor , Gwen's Girls Computer-Aided Design & 3D Printing Program	2021-2022
Session Chair , IROS Session on Climbing and Wheeled Robots	2022

PUBLICATIONS

P. Nadan, Jai Kumar, Nate Klein, *et al.*, "A Magnetic-Wheeled Inspection Robot for Interior Corner Traversal," *IEEE Robotics and Automation Letters (RA-L)*, in review

P. Nadan, S. Backus, and A. M. Johnson, "LORIS: A Lightweight Free-Climbing Robot for Extreme Terrain Exploration," *IEEE/RAS International Conference on Robotics and Automation (ICRA)*, 2024

P. Nadan, D. K. Patel, C. Pavlov, *et al.*, "Microspine Design for Additive Manufacturing," *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2022

A. Bouman, **P. Nadan**, M. Anderson, *et al.*, "Design and Autonomous Stabilization of a Ballistically-Launched Multirotor," *IEEE/RAS International Conference on Robotics and Automation (ICRA)*, 2020 (Best Paper on Unmanned Aerial Vehicles)

D. Pastor, J. Izraelevitz, **P. Nadan**, *et al.*, "Design of a Ballistically-Launched Foldable Multirotor," *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2019

P. Nadan, T. M. Anthony, D. M. Michael, *et al.*, "A Bird-Inspired Perching Landing Gear System," *ASME Journal of Mechanisms and Robotics (JMR)*, 2019

P. Nadan and C. L. Lee, "Computational Design of a Bird-Inspired Perching Landing Gear Mechanism," *ASME International Mechanical Engineering Congress and Exposition (IMECE)*, 2018