PAUL NADAN

Robotics Ph.D. Student

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SUMMARY

A versatile robotics researcher experienced in the design, analysis, and control of mobile robots for locomotion in challenging environments.

SKILLS

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

EDUCATION

Carnegie Mellon University **Expected May 2025**
Ph.D. in Robotics
Selected Coursework: Space Robotics, Optimal Control & RL, Nonlinear Control, Deep Learning for Robotics

Olin College of Engineering **May 2020**
B.S. in Mechanical Engineering

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 **Summer 2023**
Visiting Technologist

- 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 **Summer 2018 & 2019**
Intern

- 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

Eastman Chemical Company **Summer 2016 & 2017**
Engineering Intern

- Assisted effort to scale up new functional film manufacturing technologies for mass production
- Designed test equipment, operated prototype machines, and analyzed results to improve the manufacturing process
- Prepared chemical solutions and performed experiments to optimize film optical properties

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, 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 (Accepted)

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