PAUL NADAN

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EDUCATION

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

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

SKILLS

Programming: C++, Python, Java, MATLAB   **Tools:** ROS/ROS2, Gazebo, Linux, Git, Docker, Microcontrollers
Mechanical Design: SolidWorks, ANSYS, GD&T   **Fabrication:** CNC Mill, Lathe, Waterjet, 3D Printing, Soldering

GRADUATE RESEARCH

Thesis: Robotic Climbing for Extreme Terrain Exploration *Jun 2020 - Present*

Hybrid Motion Planning on Complex 3D Terrain

- Adapting a sample-based motion planning algorithm for legged locomotion on steep and overhanging terrain
- Developing Climb-SDK, a ROS2-integrated open-source codebase for climbing robot control and planning

Design and Control of a Lightweight Rock Climbing Robot

- Designed, built, and programmed LORIS, a novel lightweight quadrupedal climbing robot for planetary exploration
- Prototyped underactuated microspine grippers that conform to uneven terrain using compliant mechanisms
- Formulated an optimization-based force control strategy for generation of preload forces between opposing grippers
- Achieved vertical climbing on irregular rock faces without gravity offload while 3x lighter than any prior robot to do so
- Supported by the NASA Space Technology Graduate Research Opportunities fellowship award

Magnetic Wall-Climbing for Infrastructure Inspection

- Led a team of student researchers to develop a wall-climbing robot for detecting contaminants on steel structures
- Designed a mobility system to traverse obstacles, transition between surfaces, and maneuver in confined spaces
- Created an analytical model for surface-to-surface transitions to constrain robot design parameters
- Collaborated with industry partner to inform task requirements and demonstrate inspection tasks at an industrial site

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 flexure geometry
- Demonstrated equivalent stiffness and superior durability compared to 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 regolith excavation and manipulation tasks
- Conducted a trade study and demonstrated grasping behaviors on a robotic arm to evaluate design concepts

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
- Validated controller in simulation and on hardware, laying the groundwork for a successful field test at Athabasca Glacier

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 and latching mechanisms for a smaller ballistically-launched folding quadcopter

UNDERGRADUATE RESEARCH

Hexapod Robots as Folding Exploratory Rovers
Sep 2018 - Mar 2020
- Developed a 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
Sep 2017 - Mar 2020
- 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

Bird-Inspired Perching Landing Gear
Sep 2017 - May 2019
- Analyzed a bird-inspired perching landing gear system that enables drones to land on branches and rough terrain
- 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

TEACHING

Carnegie Mellon University
Graduate Teaching Assistant　　　　　　　　　　　　　　　　　　　　　　　　　　　*Sep 2021 - May 2022*
- Courses included Computer Vision and Kinematics, Dynamics & Control
- Held office hours, updated and graded assignments, and provided guidance on student projects

Olin College of Engineering
Course Assistant　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　*Jan 2018 - May 2020*
- Courses included Engineering Systems Analysis, Transport Phenomena, Partial Differential Equations, and Quantitative Engineering Analysis I & II
- Assisted with class instruction, held office hours, individually met with students, and graded assignments

VOLUNTEERING

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