

CATHERINE ANN PAVLOV

catherinepavlov.com

EDUCATION

CARNEGIE MELLON UNIVERSITY Pittsburgh, PA
Doctor of Philosophy in Mechanical Engineering January 2023
GPA: 3.9/4.0

CALIFORNIA INSTITUTE OF TECHNOLOGY Pasadena, CA
Bachelor of Science in Mechanical Engineering with Honors June 2016
GPA: 3.5/4.0

SKILLS

DESIGN, PROTOTYPING, FABRICATION AND ELECTRONICS

Mechanical design, 3D printing and 3D printer maintenance, lathe, mill, CNC mill, and other standard machine shop tools, waterjet & laser cutter, microcontrollers, selection and assembly of COTS parts and systems

SOFTWARE & PROGRAMMING LANGUAGES

SolidWorks, MATLAB, Adobe Photoshop, Illustrator & Premiere Pro, Python and C

DOCTORAL RESEARCH

Graduate Research Assistant, CARNEGIE MELLON UNIVERSITY Robomechanics Lab Fall 2016 – Present
NASA Space Technology Research Fellow 2018 – 2022
Jean-Francois and Catherine Heitz Scholar 2020 – 2022
Carnegie Mellon Presidential Fellow 2016 – 2017

Nonprehensile Terrain Manipulation:

- Pioneered work in the use of planetary rover wheels for modification of natural terrain - defined the space of terrain manipulation for wheeled rovers, which adds functionality to space rovers without adding hardware.
- Developed novel model of soil flow around a rover wheel and validated it on trenches dug both in a lab setting and with a NASA mars rover prototype in the Atacama Desert. The model evaluates many times faster than standard approaches, making it viable for real-time use with low computing resources.
- Expanded on existing wheel-terrain interaction models to enable wheel-based manipulation through creation of a 3D terramechanics model. The newly developed model covers a wider range of wheel operational states than previously explored in the literature.
- Constructed a high precision, low-cost testbed for evaluation of wheel-terrain interaction using only COTS parts and at-home manufacturing capabilities. Used testbed to collect a dataset of wheel forces over a wider range of wheel states than existing literature.

Rover Mobility Actuator Failure Analysis & Compensation

- Assessed impact of individual motor failure on a prototype of NASA's VIPER lunar rover. Concluded that loss of a wheel drive motor is catastrophic, while steer and suspension actuators require reducing the maximum allowed terrain slope angle.
- Integrated the 3D terramechanics model with optimization techniques to automatically generate driving strategies that allow rovers to compensate for actuator failure. Demonstrated open-loop compensation for mobility degradation on a rover.

Microspine Robots for High-Angle Mobility:

- Spearheaded novel use of microspine technology that leverages the same mechanical compliance in a robot leg for both running and climbing abilities on a hexapedal robot.
- Invented new fabrication technique for microspine flexures using additive manufacturing, which drastically reduced both design iteration time and required manufacturing resources.
- Derived model of leg stiffness for automatic generation of robot leg geometry.

ADDITIONAL RESEARCH EXPERIENCE

Research Assistant, CARNEGIE MELLON UNIVERSITY Planetary Robotics Lab Summer 2016

- Designed test setup and experimental plan for analyzing a novel locomotion concept for planetary rovers operating in soft soils.

Intern, NASA JET PROPULSION LABORATORY

Doris Everhart Summer Undergraduate Research Fellow Summer 2015
Homer J. Stewart Summer Undergraduate Research Fellow Summer 2014

- Independently performed mechanical and electrical design, testing, and fabrication of a robot for 3D mapping of Hawaiian volcanic vents. Built functional robot from the ground up both summers.
- Performed field work imaging volcanic vents with the robot in March 2015. Work resulted in high fidelity 3D maps of Mauna Ulu fissures and novel insights into volcanic vent formation mechanisms.

ADDITIONAL EXPERIENCE

- Graduate Teaching Assistant, CARNEGIE MELLON UNIVERSITY** Fall 2018
- Taught junior-level Mechanical Design course for 120 students.
 - Led team of seven Teaching Assistants in crafting design challenge assignments, mentoring student teams, holding office hours, fabricating test equipment, creating and maintaining course documents, purchasing course materials, and grading homework, reports, and presentations.
- Graduate Teaching Assistant, CARNEGIE MELLON UNIVERSITY** Fall 2017
- Taught junior-level Dynamics course for 180 students. Responsible for leading recitations, holding office hours, and grading exams.
- Undergraduate Teaching Assistant, CALIFORNIA INSTITUTE OF TECHNOLOGY** Fall 2015
- Taught sophomore-level Solid Mechanics course for 30 students. Responsible for holding office hours as well as grading homework assignments and exams.

PUBLICATIONS

- Catherine Pavlov** and Aaron M. Johnson. *A Terramechanics Model for High Slip Angle and Skid with Prediction of Wheel-Soil Interaction Geometry*. Journal of Terramechanics. In review, 2023.
- Qishun Yu, **Catherine Pavlov**, Wooshik Kim, and Aaron M. Johnson. *Locomotion in Granular Media using 3D-RFT and Sand Deformation Model*. Journal of Terramechanics. In prep, 2023.
- Paul Nadan, Dinesh K. Patel, **Catherine Pavlov**, Spencer Backus, and Aaron M. Johnson. *Microspine Design for Additive Manufacturing*. IEEE/RSJ International Conference on Intelligent Robots and Systems 2022.
- Catherine Pavlov** and Aaron M. Johnson. *Field Experiments in Nonprehensile Terrain Manipulation with Planetary Exploration Rovers*. International Symposium on Artificial Intelligence, Robotics and Automation in Space (i-SAIRAS), October 2020.
- Renee Jessica Wallace, **Catherine Pavlov**, and Aaron Johnson. *Design of Microspine-Enhanced Spring Legs for Robotic Running and Climbing*. Dynamic Walking, May 2020.
- Matt Martone, **Catherine Pavlov**, Adam Zeloof, Vivaan Bahl, and Aaron M Johnson. *Enhancing the Vertical Mobility of a Robot Hexapod Using Microspines*. Technical Report arXiv:1906.04811 [cs.RO], arXiv, 2019.
- Catherine Pavlov**; and Aaron M. Johnson. *Soil Displacement Terramechanics for Wheel-Based Trenching with a Planetary Rover*. IEEE Intl. Conference on Robotics and Automation, pages 4760–4766, Montreal, Canada, May 2019.
- Catherine Pavlov**; and Aaron M. Johnson. *Wheel-Based Trenching: Terramechanics of Nonprehensile Manipulation for Planetary Rovers*. Robotics: Science and Systems Workshop on “Autonomous Space Robotics”, Pittsburgh, PA, June 2018.
- Carolyn E. Parcheta, **Catherine A. Pavlov**, Nicholas Wiltsie, Kalind C. Carpenter, Jeremy Nash, Aaron Parness, Karl L. Mitchell. *A robotic approach to mapping post-eruptive volcanic fissure conduits*. Journal of Volcanology and Geothermal Research, Volume 320, 2016, Pages 19-28.
- Carolyn E. Parcheta, Jeremy Nash, Aaron Parness, Karl L. Mitchell, **Catherine A Pavlov**. *Narrow Vertical Caves: Mapping Volcanic Fissure Geometries*. 2nd International Planetary Caves Conference, held 20-23 October, 2015 in Flagstaff, Arizona. LPI Contribution No. 1883, p.9010.

VOLUNTEER WORK

- Visiting Instructor, GWEN’S GIRLS** 2021 – Present
- Designed and taught curriculum in Computer Aided Design and 3D printing for middle and high school students, along with other members of the Robomechanics Lab.
 - Consulted on acquisition of 3D printers for Gwen’s Girls and performed setup.
- Mentor, WOMEN IN MECHANICAL ENGINEERING, MECHANICAL ENGINEERING GRADUATE STUDENTS** 2018 – 2021
- Mentored undergraduate and graduate students at Carnegie Mellon University.
- Adviser, TARTAN ICE DRILLING SYSTEMS** 2017 – 2019
- Advised a team of Carnegie Mellon undergraduate students participating in NASA’s annual Mars Ice Challenge.

LEADERSHIP

- Rock Climbing Chair, Explorers Club – CARNEGIE MELLON UNIVERSITY** 2017 – Present
- Instructor, Rock Climbing & Mountaineering Schools – EXPLORERS CLUB OF PITTSBURGH** 2018 – Present
- President, Explorers Club – CARNEGIE MELLON UNIVERSITY** 2020 – 2021
- President, Blacker House – CALIFORNIA INSTITUTE OF TECHNOLOGY** 2015 – 2016
- Red Cross First Responder/Health Advocate, Blacker House – CALIFORNIA INSTITUTE OF TECHNOLOGY** 2014 – 2016