Cyndia Cao

PhD Candidate · Mechanical Engineering · University of California, Berkeley

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I work with NASA on the next generation of planetary rovers. Using wheel-terrain models that I helped refine, I develop and experimentally validate control methods for actuated suspensions to improve mobility performance and ensure robustness.

My goal is to use my research experience to deploy technology from the lab into the field in order to address technical barriers to mitigating climate change. I am a hands-on, experimentally-driven, and theory-motivated builder who adapts to the challenge at hand.

Education

University of California, Berkeley *Berkeley, CA*

PhD - Mechanical Engineering *2018-present*

- NASA Space Technology Research Fellow (2019) | Advisors: Hannah Stuart, Dennis Lieu
- Thesis: *Roving around the moon & Mars: active weight redistribution and strategic slip control for augmenting wheeled mobility*

Massachusetts Institute of Technology *Cambridge, MA*

B.S. - Mechanical Engineering *2013 - 2017*

- Advisors: Alex Slocum, David Trumper
- Thesis: *Exploration of configurations of wave energy converters to mechanically drive a seawater uranium harvester*

Skills

Programming	Python, MATLAB, Arduino (C/C++), Simulink/Simscape
Solid Modeling	NX, Fusion 360, SolidWorks, AutoCAD, ANSYS Structural
Coursework: Mechatronics	Electric Motor Design, Power Electronics, MEMS, Hamiltonian & Lagrangian Dynamics
Coursework: Controls	Model Predictive Control, State Estimation, Reinforcement Learning

Professional Experience

Embodied Dexterity Group, UC Berkeley *Berkeley, CA*

Graduate Student Researcher, NASA Fellow *Aug 2018 - Present*

- Built sub-scale rovers and data collection setups to study the impact of slip controllers for mobility on loose, sandy terrain.
- Performed validation testing with NASA's VIPER (lunar rover) team, and led testing and data analysis for evaluation of VIPER's load-responsive suspension controllers.
- Achieved an 8x efficiency improvement in slope climbing using strategically induced slip in articulated suspensions.
- Refined and applied terrain models to explain and predict unintuitive results.
- Conducted test campaigns at the NASA Jet Propulsion Laboratory, Glenn Research Center, and Ames Research Center.

FIRST Robotics Team 5419 *Berkeley, CA*

Lead Technical Mentor *Sept 2019 - Present*

- Mentored 30-60 high school students as they build a high-speed, 120 pound robot to play a new game each year.
- Fostered students' critical thinking upon facing structural failures, CAD & fabrication inconsistencies, or other challenges.
- Guided the software team to integrate automation in robot control and develop comprehensive competition scouting analysis.

Apple *Cupertino, CA*

Watch Product Design Intern *Jan 2018 - Aug 2018*

- Analyzed users' wrist interactions in various sports to quantify impact loads and environmental factors, then proposed validation tests including machine requirements and SOPs.
- Produced GD&T drawings and tolerance stacks for small, complex assemblies and fasteners.
- Designed interface-representative frames for environmental testing of individual sub-assemblies.

SpaceX *Hawthorne, CA*

Mechanisms Intern *Aug 2017 - Dec 2017*

- Upgraded propulsion structures and their manufacturing tooling, and verified their structural integrity via FEA in ANSYS.
- Tested electrical components under vibration, shock, and separation loads for flight qualification.

Summer Science Program *Boulder, CO & Socorro, NM*

Teaching Assistant *Summer 2017 & 2019*

- Tutored high school seniors in orbital mechanics and Python to track near-Earth asteroids and calculate their orbital elements.
- Assisted students with homework and telescope observation sessions and organized social events.

NASA Jet Propulsion Laboratory *Pasadena, CA*

Mechanisms Intern *May 2016 - Aug 2016*

- Fabricated high fidelity 1/20 scale configuration models of Starshade, an external occulter for finding exoplanets, as prototyping and communication tools for science and engineering parties.

Publications

C. Cao, D. Moon, C. Creager, D. K. Lieu, H. S. Stuart, "Push-pull locomotion: Increasing travel velocity in loose regolith via induced wheel slip." (Under review by *Journal of Terramechanics*.)

T. M. Huh, **C. Cao**, J. Aderibigbe, D. Moon and H. S. Stuart, "Walk-Burrow-Tug: Legged anchoring analysis using RFT-based granular limit surfaces," in *IEEE Robotics and Automation Letters*, Apr. 2023, doi: 10.1109/LRA.2023.3269324.

C. Cao, A. Rogg, A. Tardy, "Actuated Suspension Tuning Characterization of the VIPER Lunar Rover," in *2023 IEEE Aerospace Conference*, Mar. 2023, doi: 10.1109/AERO55745.2023.10115796.

C. Cao, C. Creager, D. K. Lieu, H. S. Stuart, "Mobility experiments assessing performance of front-back differential drive velocity on sandy terrain," in *2021 International Society for Terrain-Vehicle Systems Conference (ISTVS)*, Sep. 2021.

C. Cao, D. K. Lieu, H. S. Stuart, "Dynamic Analysis of Gyroscopic Force Redistribution for a Wheeled Rover," in *Earth and Space 2021*, pp. 318–327, Apr. 2021. doi: 10.1061/9780784483374.032.
Awarded Best Student Paper.

L. K. Treers, **C. Cao**, H. S. Stuart, "Granular Resistive Force Theory Implementation for Three-Dimensional Trajectories." in *IEEE Robotics and Automation Letters*, vol. 6, no. 2, pp. 1887-1894, Apr. 2021, doi: 10.1109/LRA.2021.3057052.