

Aaron M. Hoover

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Education and Research Experience

Postdoctoral Researcher

Dept. of Electrical Engineering and Computer Science, University of California, Berkeley **2010**

Developed embedded software for sensing, control, planning, and wireless communication on a 5.5g centimeter scale, power-autonomous legged robot.

University of California, Berkeley

Ph.D. in Mechanical Engineering **2010**

Thesis: Design of Minimally Actuated Legged Milli-Robots Using Compliant Mechanisms and Folding

University of California, Berkeley

M.S. in Mechanical Engineering **2006**

Thesis: Design, Prototyping, and Testing of a Low Cost 2 Axis Micropositioning Stage Using Compliant Mechanisms

Stanford University

B.S. in Mechanical Engineering **1999**

Teaching Experience

Courses taught at Olin College

Dynamics (ENGR2340) - A required course for all mechanical engineering majors at Olin, this course covers topics in kinematics and dynamics of particles and rigid bodies as well as linear dynamical systems. Students learn to formulate and solve equations of motion for particles, rigid bodies, and systems of each. A significant portion of the course is devoted to numerical simulation of equations of motion and visualization applied to problems like determining stable parameters for a model of legged locomotion or chaotic parameters an initial conditions for simple systems like the double pendulum.

User-Oriented Collaborative Design (ENGR2250) - Students develop detailed concepts and models of authentic new products and services. Our focus is on user-oriented, collaborative approaches to design and seeking holistic solutions integrating user and functional perspectives. We emphasize the importance of process and the development of strategies. Students observe and engage people to develop a deep understanding of their values and the patterns of their lives. They work collaboratively in a studio environment to create a shared understanding of the people they design for (and with) and the product ideas they develop. Topics covered include design thinking, ethnographic methods, concept development and interaction design.

Senior Capstone Project in Engineering (ENGR4190) - SCOPE is a year-long senior capstone project in which a team of five to six undergraduate students and a faculty advisor work with an industry sponsor to deliver a solution to a real world engineering problem. Students perform all aspects of the project including budgeting, managing interactions with the sponsor liaison, project planning and schedule development,

technical work, and written and oral communication of results.

Teams Advised:

MIT Lincoln Laboratory (2011 - 2012) - “A Hybrid Aerial Underwater Vehicle”

Ariens (2012 - 2013) - “Traction Control Systems for Commercial Lawn Mowers”

Introduction to Mechanical Prototyping (ENGR2330) - An elective course available and accessible to all Olin, Babson, and Wellesley students. The course is an introduction to the design and physical prototyping of mechanical systems of moderate complexity. Students get experience communicating mechanical designs using 3-dimensional models in computer-aided design (CAD) software as well as traditional 2-dimensional engineering drawings. Throughout the course, students complete a series of hands-on projects designed to provide them with experience prototyping machines and mechanisms in materials ranging from foamcore and plywood to sheet metal and 3-D printed polymers. Sample work can be found online at <http://mechproto.olin.edu>.

Principles of Engineering (ENGR2210) - Sophomore level course required for all Olin students in which they're introduced to mechatronic systems. Topics covered included programming PIC microcontrollers in the C programming language, interfacing with additional hardware such as motors, sensors, and a host computer via the USB protocol. Students complete projects comprising a combination of non-trivial mechanical, electrical, and software systems in groups of two to five. The course is exclusively hands-on and includes no lectures and no required text.

Controls - Theory and Practice (ENGR3370) - Junior/senior level elective course introducing fundamental concepts in modeling and control of single-input, single-output (SISO) linear, time-invariant (LTI) systems. Topics covered include state space modeling of linear dynamical systems, Laplace transforms, root locus, Bode plots, frequency domain analysis, and PID and lead-lag controller design techniques. Students complete a group project that includes the implementation of a control strategy on hardware of their choice at the end of the class.

Teaching experiences prior to joining Olin College

Graduate Student Instructor <i>Introduction to Engineering Graphics</i> University of California, Berkeley	2007
Graduate Student Mentor Summer Undergraduate Program in Engineering Research at Berkeley (SUPERB)	2006, 2007
Graduate Student Mentor University of California's Leadership Excellence through Advanced Degrees (UC LEADS)	2006
Team Coach <i>ME 118/218 - Introduction to Mechatronics</i> Stanford University	1999

Journal Publications

T. Zhang, F. Qian, C. Li, P. Masarati, A. M. Hoover, P. Birkmeyer, A. Pullin, R. S. Fearing, and D. I.

Goldman, “Ground fluidization promotes rapid running of a lightweight robot”, *Int. J. Robotics Research in review*

J.-M. Mongeau, B. McRae*, A. Jusufi, P. Birkmeyer, A. M. Hoover, R. S. Fearing, and R. J. Full, “Rapid inversion: Running animals and robots swing like a pendulum under ledges”, *PLoS ONE*, June 2012

D. Evangelista, M. J. Fernandez, M. Berns*, A. M. Hoover, and R. Dudley, “Hovering energetics and thermal balance in Anna’s Hummingbirds (*Calypte anna*)”, *Physiol. and Biochem. Zool.*, Vol. 83, No. 3, pp. 406-413, May-June 2010

A. Vijayaraghavan, A. Sodemann, A. M. Hoover, J. R. Mayor, and D. Dornfeld, “Trajectory Generation in High-Speed, High-Precision Micromilling using Subdivision Surfaces” *Int. J. Mach. Tools Manuf.*, Vol 50, No. 4, pp. 394-403, 2010

A. Vijayaraghavan, A. M. Hoover, J. Hartnett, and D. A. Dornfeld, “Improving End-Milling Surface Finish by Workpiece Rotation and Adaptive Toolpath Spacing”, *Int. J. Mach. Tools Manuf.*, Vol. 1, No. 49, January 2009

Peer-Reviewed Conference Proceedings

G. C. Thomas*, C. C. Gimenez*, E. D. Chin*, A. P. Carmedelle*, A. M. Hoover, “Controllable, high force amplification using elastic cable capstans” *Proceedings of the ASME International Design Engineering Technical Conferences*, Chicago, IL, August 2012

F. Qian, T. Zhang, C. Li, A. M. Hoover, P. Masarati, P. Birkmeyer, A. Pullin, R. Fearing, and D. Goldman. Walking and running on yielding and fluidizing ground. In *Proceedings of Robotics: Science and Systems*, Sydney, Australia, July 2012.

Winner - Best Student Paper

F. Qian, T. Zhang, C. Li, P. Masarati, A. M. Hoover, P. Birkmeyer, A. Pullin, R. S. Fearing, D. I. Goldman, “Legged locomotion of a bio-inspired lightweight robot on granular media” *International Congress on Theoretical and Applied Mechanics (ICTAM)*, Beijing, China, August 2012

T. Zhang, F. Qian, C. Li, P. Masarati, A. M. Hoover, P. Birkmeyer, A. Pullin, R. S. Fearing, and D. I. Goldman, “Walking and running on yielding and fluidizing ground” *Robotics Science Systems*, July 2012
(Winner - Best Student Paper)

N. Kohut, A. M. Hoover, X. Y. Fu, K. Ma*, S. Baek, and R. S. Fearing “MEDIC: A 5.5 g Legged Millirobot Utilizing Novel Body-Supported Climbing”, *IEEE International Conference on Robotics and Automation*, Shanghai, China, May 2011

A. M. Hoover, S. Burden, X. Y. Fu*, S. Shankar Sastry, and R. S. Fearing, “Bio-inspired design and dynamic maneuverability of a minimally actuated six-legged robot” *IEEE International Conference on Biomedical Robotics and Biomechatronics*, Tokyo, Japan, Sept. 2010

A. M. Hoover and R. S. Fearing “Analysis of off-axis performance of compliant mechanisms with applications to mobile millirobot design”, *IEEE International Conference on Intelligent Robots and Systems*, St. Louis, MO, Oct. 2009

R. S. Fearing, S. Baek, P. Birkmeyer, K. Peterson, A. M. Hoover, J. Lee, K. Ma*, “Biomimetic Millirobots”, *Biologically Inspired Robotics Workshop*, *IEEE International Conference on Intelligent Robots and Systems*, St. Louis, MO, Oct. 2009

A. M. Hoover, E. Steltz, and R. S. Fearing, “RoACH: An autonomous 2.4g crawling hexapod robot”, IEEE International Conference on Intelligent Robots and Systems, Nice, France, Sept. 2008

A. M. Hoover and R. S. Fearing, “Fast scale prototyping for folded millirobots”, IEEE International Conference on Robotics and Automation, Pasadena, CA, May 2008

A. M. Hoover and R. S. Fearing, “A Fast Scale Prototyping Process for Folded Millirobots”, Video Presentation, IEEE International Conference on Robotics and Automation, Pasadena, CA, May 2008

A. M. Hoover and R. S. Fearing, “Rapidly prototyped orthotweezers for automated microassembly”, IEEE International Conference on Robotics and Automation, Rome, Italy, April 2007

R. S. Fearing, R. Sahai, and A. M. Hoover, “Rapid prototyping millirobots using toolkits and microassembly” International Advanced Robotics Programme, Paris, France, October 2006

A. M. Hoover, R. E. Groff, S. Avadhanula, and R. S. Fearing, “A rapidly prototyped 2-axis positioning stage for microassembly using large displacement compliant mechanisms”, IEEE International Conference on Robotics and Automation, Orlando, FL, May 2006

Conference Proceedings

F. Qian, T. Zhang, C. Li, J. Shen, A. M. Hoover, P. Birkmeyer, A. Pullin, R. S. Fearing, D. I. Goldman “Legged locomotion of a bio-inspired lightweight robot on granular media”, Annual Meeting of the Society for Integrative and Comparative Biology (abstract), Charleston, SC, Jan. 2012

T. Zhang, F. Qian, J. Shen, A. M. Hoover, P. Birkmeyer, R. S. Fearing and D. I. Goldman, “Light-weight robot locomotion on granular media”, 64th Annual Meeting of the American Physical Society Division of Fluid Dynamics, Baltimore, MD, Nov. 2011

R. J. Full, K. Jayaram, J. M. Mongeau, P. Birkmeyer, A. M. Hoover, R. S. Fearing, “Role of robustness in running: bio- and bio-inspired exoskeletons” Annual Meeting of the Society for Integrative and Comparative Biology (abstract), Salt Lake City, Utah, Jan. 3-7, 2011.

C. Li, A. M. Hoover, P. B. Birkmeyer, P. B. Umbanhowar, R. S. Fearing, D. I. Goldman, “Systematic study of the performance of small robots on controlled laboratory substrates”, SPIE Defense, Security, and Sensing, Orlando, FL, April 2010

Conference Posters

G. Thomas*, C. Gimenez* , A. Carmadelle*, E. Chin*, A. M. Hoover, “Using a capstan cable-drive actuator under helical constraint to achieve high amplification ratios”, IEEE International Conference on Technologies for Practical Robot Applications (TePRA), Woburn, MA, Apr. 2012

* Denotes undergraduate author

Invited Talks

“Robust, Bio-Inspired, Mesoscale Mobile Robots”, Mar. 19, 2012, Ortiz Research Group, MIT

“Undersized, Underpowered, and Underactuated - Design, Fabrication, and Control Challenges for Legged Millirobots”, July 22, 2011, GRAB Lab, Yale University

“Undersized, Underpowered, and Underactuated - Mobility Challenges for Legged Millirobots”, Apr. 1, 2011, Research Division, iRobot Corporation

“Capable Legged Robots at the Milli- and Meso Scales”, Mar. 11, 2010, Olin College

“Challenges for Legged Robots at the Milli- and Meso Scales”, Oct. 3, 2008, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

“Two Biologically Inspired Millirobots: Flying and Crawling Mechanisms,” Biomechanics Seminar, UC Berkeley Integrative Biology Dept., April 2008

“Rapid Prototyping Using Molding,” CS 285 - Procedural Solid Modeling, UC Berkeley, April 2005

Professional Activities

Member IEEE Robotics and Automation Society Technical Committee on BioRobotics

Reviewer for *Bioinspiration and Biomimetics*

Reviewer for *IEEE/ASME Transactions on Mechatronics*

Reviewer for *IEEE Transactions on Robotics*

Reviewer for *Institute of Physics Journal of Micromechanics and Microengineering*

Reviewer for *Robotica*

Co-chair Animal and Robot Session, IEEE International Conference on Biomedical Robotics and Biomechanics (BIOROB), 2010, Tokyo, Japan

Co-chair Millirobots Session, IEEE International Conference on Intelligent Robots and Systems, 2009, St. Louis

Co-chair Micro/Nano Robotics Session, IEEE International Conference on Intelligent Robots and Systems, 2008, Nice, France

Member ASME, IEEE

Media Coverage

“At Olin Students Get a Grasp on Engineering”, Needham Times, 12/27/2012 - Article in the Needham Times about Mechanical Prototyping final competition in which students compete to design and demonstrate capable robotic hands.

“Catalyst” (Australian Broadcasting Corporation) television feature on bio-inspired robotics

Ecole Polytechnique Fédérale de Lausanne “Robots” podcast on millimeter scale legged robots

Honors and Awards

ASME Student Robot Design Competition - First Place, "RoACH: An autonomous 2.4g crawling robot", DETC 2009, San Diego

Fellow of the Berkeley Summer Institute for Preparing Future Faculty, 2009

ICROS 2008 Best Application Paper Award Finalist, "RoACH: An autonomous 2.4g crawling robot", IROS 2008, Nice, France