

Jonathan W. Hurst

Contact Information

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Education

Carnegie Mellon University, Pittsburgh, Pennsylvania USA
Ph.D., Robotics, August 12, 2008
Dissertation Topic: "The Role of Compliance in Legged Locomotion."
Advisor: Jessica K. Hodgins
Thesis Committee: Matthew T. Mason
Alfred A. Rizzi
J. Kenneth Salisbury

M.S., Robotics, May 2004
Advisor: Alfred A. Rizzi

B.S., Mechanical Engineering, Minor in Robotics, May 2001

Current Position

Assistant Professor
Oregon State University, Corvallis, Oregon
School of Mechanical, Industrial, and Manufacturing Engineering

Journal Publications

A. Ramezani, J.W. Hurst, J.W. Grizzle, "Performance Analysis and Feedback Control of ATRIAS, A 3D Bipedal Robot," *Journal of Dynamic Systems, Measurement and Control*, accepted pending revision May 2013

Y. Blum, C. Hubicki, H. Vejdani, J.W. Hurst, M. Daley, "Trade-off Between Disturbance Rejection and Injury Avoidance in Running Guinea Fowl," Submitted to *Public Library of Science One*, accepted pending revision May 2013

D. Koepl and J.W. Hurst, "Impulse Control for Planar Spring-Mass Running," submitted to *Journal of Intelligent and Robotic Systems*, accepted pending revision January 2013

K. Kemper, H. R. Vejdani, B. Piercy, J. Hurst, "Optimal Passive Dynamics for Physical Interaction: Catching a Mass," *Actuators* 2013, 2(2), 45-58, May 2013

J.S. Colett and J.W. Hurst, "Artificial Restraint Systems for Walking and Running Robots: An Overview," *International Journal of Humanoid Robotics*, Vol. 09, Issue 01, March 2012.

J.W. Hurst, "The Electric Cable Differential Leg: A Novel Design Approach for Walking and Running," *International Journal of Humanoid Robotics*, Vol. 8, Issue 2, 301-321, June 2011.

H.W. Park, K. Sreenath, J.W. Hurst, J.W. Grizzle, "Identification of a Bipedal Robot with a Compliant Drivetrain: Parameter Estimation for Control Design," *IEEE Control Systems Magazine*, Vol 31, Issue 2, April 2011 (cover story).

J.W. Hurst, J.E. Chestnutt, and A.A. Rizzi, "The Actuator with Mechanically Adjustable Series Compliance," *IEEE Transactions on Robotics*, Vol. 26, No. 4, September 2010.

J.W. Hurst and A.A. Rizzi, "Series Compliance for an Efficient Running Gait: Lessons Learned from the Electric Cable Differential Leg," IEEE Robotics and Automation Magazine, Special Issue: "Adaptable Compliance / Variable stiffness for Robotic Applications," Vol. 15, Issue 3, September 2008, pages 42-51.

Journal Publications Under Review H.R. Vejdani, Y. Blum, M.A. Daley, and J.W. Hurst, "Bio-Inspired Swing Leg Control for Spring-Mass (SLIP) Running Robots," submitted to Journal of Bioinspiration and Biomimetics, March 2013

C. Hubicki and J.W. Hurst, "Adjustable-Compliance Legs. Why Bother?" submitted to Bioinspiration & Biomimetics, December 2012

Journal Papers In Preparation J. Grimes and J.W. Hurst: ATRIAS 1.0 design paper

J. Grimes and J.W. Hurst: ATRIAS 2.0 design paper

H. Vejdani, J.W. Hurst: combined Leg angle and leg length control in simulation

A. Birn-Jefferey, C. Hubicki, Y. Blum, D. Renjewski, J.W. Hurst, M. Daley: ground reaction force, leg damping, Nature or Science

M. Jones, R. Hatton, J.W. Hurst: Optimal Passive Dynamics for Continuous Physical Interaction

Conference Publications J.A. Grimes and J.W. Hurst, "The Design of ATRIAS 1.0: A Unique Monopod, Hopping Robot" (**Awarded Best Technical Paper**), International Conference on Climbing and Walking Robots (CLAWAR), July 2012.

C.M. Hubicki and J.W. Hurst, "Running on Soft Ground: Simple, Energy-Optimal Disturbance Rejection," International Conference on Climbing and Walking Robots (CLAWAR), July 2012.

H.R. Vejdani and J.W. Hurst, "Swing Leg Control for Actuated Spring-Mass Robots," International Conference on Climbing and Walking Robots (CLAWAR), July 2012.

M.S. Jones and J.W. Hurst, "Effects of Leg Configuration on Running and Walking Robots," International Conference on Climbing and Walking Robots (CLAWAR), July 2012.

D. Koepl, J.W. Hurst, "Force Control for Planar Spring-Mass Running," IEEE International Conference on Intelligent Robots and Systems, September 2011.

D. Koepl, K. Kemper, and J.W. Hurst, "Force Control For Spring-Mass Running and Walking," IEEE Conference on Advanced Intelligent Mechatronics, July, 2010.

Kevin Kemper, Devin Koepl, and J.W. Hurst, "Optimal Passive Dynamics for Torque/Force Control," IEEE Conference on Robotics and Automation, May 2010.

J.W. Grizzle, J. Hurst, B. Morris, H.W. Park, K. Sreenath, "MABEL, A New Robotic Bipedal Walker and Runner," IEEE American Control Conference, June, 2009.

J.W. Hurst, B. Morris, J. Chestnutt, and A. Rizzi, "A Policy for Open-Loop Attenuation of Disturbance Effects Caused by Uncertain Ground Properties in Running," IEEE Conference on Robotics and Automation, April, 2007.

J.W. Hurst, J. Chestnutt, and A. Rizzi, "Design and Philosophy of the BiMASC, a Highly Dynamic

Biped,” IEEE Conference on Robotics and Automation, April, 2007.

J.W. Hurst, Daan Hobbelen, and A. Rizzi, “Series Elastic Actuation: Potential and Pitfalls,” IEEE Workshop on Morphology, Control, and Passive Dynamics, International Conference on Intelligent Robots and Systems, 2005.

J.W. Hurst and A. Rizzi, “Physically Variable Compliance in Running,” International Conference on Climbing and Walking Robots, Springer-Verlag, www.springeronline.com, September, 2004.

J.W. Hurst, J. Chestnutt, and A. Rizzi, “An Actuator with Physically Variable Stiffness for Highly Dynamic Legged Locomotion,” IEEE Conference on Robotics and Automation, May, 2004. Detailed version available as technical report CMU-RI-TR-04-24.

Technical Reports J.W. Hurst, J. Chestnutt, and A. Rizzi, “An Actuator with Mechanically Adjustable Series Compliance,” tech. report CMU-RI-TR-04-24, Robotics Institute, Carnegie Mellon University, April, 2004.

J.W. Hurst, J.W. Grizzle, H. Geyer, DARPA M3 program quarterly and annual reports, Q1-Q10, beginning April 2012 and ongoing

Patents Pending U.S. Patent Application No. 13/542,204, “Apparatus and Method for Legged Locomotion Integrating Passive Dynamics With Active Force Control,” Filed July 5, 2012

Invited Presentations **Georgia Institute of Technology, Robotics and Intelligent Machines Seminar**, April 2013, <http://robotics.gatech.edu/news/seminars>

Live Demonstrations of ATRIAS monopod and biped:

Dynamic Walking Conference, Pensacola, Florida, May 2012

CLAWAR conference, Baltimore, MD, July 2012

Popular Mechanics Breakthrough Award, New York, NY, October, 2012.

IEEE Conference on Robotics and Automation:

Workshop on “Variable Stiffness Actuators moving the Robots of Tomorrow,” May 2012

Workshop on “Achieving Robust, Compliant, Interactive Humanoid Robots via Active Force Control,” May 2010

Workshop on “New Variable Impedance Actuators for the Next Generation of Robots,” May 2010

DARPA PI meetings, M3 Program:

February 2011 Kickoff Meeting, October 2011, January 2012, August 2012

Dynamic Walking Meetings:

Institute for Human and Machine Cognition, Pensacola, Florida, June 2012

University of Jena, Germany, June 2011

Massachusetts Institute of Technology, Boston, MA, 2010

Simon Fraser University, Vancouver, CA 2009

Mariehamn Island, Finland, June 2007

University of Michigan, June 2006

Carnegie Mellon University, June 2005

University of Michigan, June 2004

Current Research Funding Defense Advanced Research Projects Agency, “High-Efficiency Actuation for Humanoid Robots,” total award: \$4,000,000, OSU share: \$482,400, my share: \$390,000

National Science Foundation, “Unified Model and Robotic Implementation of Bio-Inspired Walking and Running,” total award: \$499,320, my share: \$190,049

PI: Defense Advanced Research Projects Agency, “Efficient, Agile, and Robust 3D Bipedal Walking and Running,” total award: \$4,733,646, my share: \$1,927,303

Human Frontier Science Organization, “Fundamental Principles of Dynamic Running Gaits,” total award: \$750,000, my share: \$375,000

Teaching

New curriculum development: ENGR 421/521, Applied Robotics, 4 units, S10: 5.1/4.5 (new course); S11: 38 students, no data; S12: 54 students, 5.1/4.9

New curriculum development: ME536, Actuator Dynamics, S11 (new course), 4 units, 7 students

ME451, Introduction to Instrumentation and Measurement Systems, 4 units, S09: 4.0/4.0 (updated course), F09: 4.2/4.2, F10: 4.1/4.3, S11: 76 students, 3.3/3.2 (new evaluation system), F12: 56 students, 3.6/3.7

ENGR212, Introduction to Dynamics, W09: 3.2/3.1, 3 units, 58 students

Advising

Graduated

- Kevin Kemper, M.S., employed at Meka Robotics: <http://mekabot.com/>
- Devin Koepl, M.S., employed at Hewlett-Packard

Graduate Students

- Hamid Vedjani, Ph.D. student (expected graduation: December 2015)
- Christian Hubicki, Ph.D. student (expected graduation: September 2014)
- Jesse Grimes, master’s student (expected graduation: July 2013)
- Mikhail Jones, master’s student (expected graduation: July 2014)
- Andrew Peekema, master’s student (expected graduation: July 2014)
- Brent Piercy, master’s student (recruited away to robotic exoskeleton manufacturer Ekso Bionics, 2011, did not graduate)

Postdoctoral Researchers

- Daniel Renjewski
- Siavash Rezazadeh
- Alex Sproewitz

Senior Design Projects

- Brushless Motor Amplifier - EECS, 2012-13, Tyler Slone, Cody Hyman, Daniel Miller
- Spring Characterization Device - MIME, 2011-12, Nicholas Moses, Jonathan Jackson, Eric Hazlett
- Mars Rover chassis design - MIME, 2011-12, Jonathan Ayers, Ian Harsey, Aaron Wilson
- Mars Rover arm design - MIME, 2011-12, Andrew Peekema, Kasey Cousins, Richard Lee
- Design and construction of a robotic arm for Mars Rover - MIME, 2010-11, Jesse Grimes, Jon Doltar, Brandon Conroy
- Design and construction of a robot boom - MIME, 2009-10, Ben Jablonski, Jeff Inman, Andrew Mora
- Design and construction of a robotic arm for Mars Rover - MIME, 2009-10, Joe Hortnagl, Jon Nichols, Andrew Schroth
- Design and construction of a robotic arm for SWAT vehicle - MIME, 2009-10, Megan Colbath, Nick Cornilson, Max Broehl
- Design and construction of cable transmission testing device - MIME, 2009-10, Drew Arnold, Erik Hammagren, Thomas Wright

- Creation of stand-alone software simulation of bipedal running robot - EECS, 2009-10, Gavin Hills, Travis Moore, Jonathan Mark
- Design and construction of prototype robot leg - MIME, 2008-09, Joe Hertel, C.J. Veach, Devin Koepl, Fazil Tazunkan
- Design and construction of teleoperated reconnaissance vehicle for Salem, Oregon SWAT team - MIME, 2008-09, Chris Johnston, Scott Zenier, Rich Walloch

Undergraduate Honor's Theses

- Allison Joyner, spring characterization testing, 2013
- Michael Summers, Cable Transmission Testing, 2010
- Devin Koepl, Force-Controller Actuator, 2009

Served on Ph.D. Committee

- Chris Holmes-Parker, Dynamics and Control, Oregon State University
- Delvin Pederson, Dynamics and Control, Oregon State University

Served on Masters Committee

- Stephen Sills, Mechanical Engineering, Oregon State University
- Ehsan Nasroullahi, Mechanical Engineering, Oregon State University
- Scott Carson, Industrial Engineering, Oregon State University
- Paul Bartlett, Lunar Rover prototype vehicle, Carnegie Mellon University.
- Nathan Abraham, Mini Bone-Attached Robotic System, Carnegie Mellon University.

University Service Co-advisor to the Oregon State University Robotics Club, Sept. 2008-present; Club membership growth from 3-5 members up to over 100, with approximately \$20,000 per year spent on student robotics projects, and many students joining us for graduate school or going on to work for companies such as SpaceX or NASA.

Undergraduate Program Committee, 2011-present

Robotics and Control faculty search committee, 2012 ++ (extensive involvement in selection, recruitment, and hiring of five robotics faculty members)

Organizing MIME seminars, 2010-2011

Outreach

Brought FIRST Tech Challenge to Oregon State as Tournament Director, Oregon State University Regional FIRST Tech Challenge, March 2010; competition has been run by the Robotics Club each year since.

Advised and encouraged the Robotics Club, via funding carrots, to demonstrate robots and generate a presence at regional competitions and schools, to recruit top engineering students to OSU.

Honors, Awards, and Publicity

Popular Mechanics "Breakthrough" Award, 2012:
<http://www.popularmechanics.com/breakthrough-award-winners>

Best Technical Paper, J.A. Grimes and J.W. Hurst, "The Design of ATRIAS 1.0: A Unique Monopod, Hopping Robot," International Conference on Climbing and Walking Robots (CLAWAR), July 2012.

Best Poster Presentation, "Optimization-Inspired Control Policies for Analytically and Computationally Intractable Systems," C. Hubicki and J.W. Hurst, Dynamic Walking, Principles and Concepts of Legged Locomotion, July 2011.

Control Systems Magazine cover story of MABEL, April 2011

Machine Design Magazine cover story on BiMASC, July 26, 2007

Engineering TV interviews on AMASC and BiMASC robots, episodes 37 and 38, <http://engineeringtv.com>

Integrative Graduate Education and Research Traineeship (IGERT) recipient, September 2005—September 2006.

Attended International School of Robot Science, September 2005, Tokyo, Japan. Awarded IEEE Fellowship for tuition.

National Science Foundation Graduate Fellowship recipient, August 2001—May 2003.

SAE International Walking Machine Decathlon 1st place, April 2000
Special Awards: Excellence in Autonomy, Best Technical Presentation.

Professional Activities

Co-Organizer for Dynamic Walking meeting at the Florida Institute for Human and Machine Cognition, May 2012

Reviewer:

- IEEE Transactions on Robotics
- IEEE Journal of Robotics Research
- IEEE/ASME Transactions on Mechatronics
- IEEE Transactions on Systems, Man, and Cybernetics
- IEEE Transactions on Biomedical Engineering
- The International Journal of Robotics Research
- Journal of Field Robotics
- Journal of Bioinspiration and Biomimetics
- International Journal of Humanoid Robotics
- ASME Journal of Dynamic Systems, Measurement and Control
- ASME Journal of Mechanical Design
- ASME Transactions on Mechatronics
- ASME International Design Engineering Technical Conferences and Computers and Information in Engineering Conference
- Public Library of Science (PLoS) ONE
- Robotics and Autonomous Systems Journal: Special Issue on Morphology, Control and Passive Dynamics, December 2005
- Robot Science and Systems (RSS)
- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- ASME Dynamic Systems and Control Conference (DSCC)

Member, Institute of Electrical and Electronics Engineers (IEEE) Robotics and Automation Society

Member, American Academy of Mechanical Engineers (ASME)

Assisted in organization of CMU Dynamic Walking meeting, 2005

- Chaired session on actuation for passive dynamics
- Co-organized program with Dr. Martijn Wisse for approximately 50 faculty and students from Cornell, Ohio State, Carnegie Mellon, MIT, Delft, and University of Michigan