

Aaron M. Johnson

Curriculum Vitae

Contact Carnegie Mellon University
Mechanical Engineering
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<http://www.andrew.cmu.edu/~amj1>

Education **Ph.D., Electrical & Systems Engineering**, May 2014
University of Pennsylvania, Philadelphia, PA
Thesis: *Self-Manipulation and Dynamic Transitions for a Legged Robot*
Advisor: Daniel E. Koditschek

B.S., Electrical & Computer Engineering, May 2008
Carnegie Mellon University, Pittsburgh, PA
Minors: *Robotics* and *Philosophy*
Advisors: Howie Choset, Tsuhan Chen

Work Experience

Academia

Aug. 2016– **Assistant Professor**
Mechanical Engineering Department, Carnegie Mellon University, Pittsburgh, PA
Robotics Institute (Courtesy Appointment)
Electrical & Computer Engineering (Courtesy Appointment)

Jan. 2015– **Postdoctoral Fellow, Personal Robotics Lab**
July 2016
Robotics Institute, Carnegie Mellon University, Pittsburgh, PA

May–Dec. 2014 **Postdoctoral Fellow, Kod*Lab**
Electrical & Systems Engineering, University of Pennsylvania, Philadelphia, PA

2008–2014 **Graduate Student Researcher, Kod*Lab**
Electrical & Systems Engineering, University of Pennsylvania, Philadelphia, PA

2005–2008 **Undergraduate Student Researcher, Biorobotics Lab**
Robotics Institute, Carnegie Mellon University, Pittsburgh, PA

Teaching

Fall 2018– **Robot Dynamics & Analysis** (*New Course*)
Mechanical Engineering, Carnegie Mellon University, Pittsburgh, PA

Spring 2018– **Robot Design & Experimentation** (*New Course*)
Mechanical Engineering, Carnegie Mellon University, Pittsburgh, PA

Fall 2015,
Fall 2016 **Engineering Optimization**
Mechanical Engineering, Carnegie Mellon University, Pittsburgh, PA

Fall 2009,
Spring 2012 **Engineering Probability** (*Teaching Assistant*)
Electrical & Systems Engineering, University of Pennsylvania, Philadelphia, PA

2006–2007 **Fun with Robots Class**
Student College, Carnegie Mellon University, Pittsburgh, PA

Industry

- 2010–2012 **Visiting Graduate Student Researcher**
Boston Dynamics, Waltham, MA
- Summer 2007 **Electrical Engineering Intern**
iRobot Corporation, Burlington, MA

Awards/Honors

- Best Student Paper Finalist**, ICRA Conference, May 2013
- Best Student Paper Finalist**, CLAWAR Conference, July 2012
- David Tuma Laboratory Project Award**, Carnegie Mellon University, ECE Dept, May, 2008
- Computing Research Association’s Outstanding Undergraduate**, Honorable Mention, 2008
- Tau Beta Pi** and **Eta Kappa Nu** Honors societies, 2006-2008
- Undergraduate project awards: **IBM Innovation that Matters Award**, **‘Thought’ Prize for Excellence in Research**, and **Lockheed Martin Undergraduate Project Judges Choice Awards**, Carnegie Mellon University, Meeting of the Minds, May 2005–2008

Publications

Some publications available online: <http://www.andrew.cmu.edu/~amj1/publications.html>

Journal Papers

- Amir Patel, Stacey Shield, Saif Kazi, Aaron M. Johnson, and Lorenz T. Biegler. “Contact-implicit trajectory optimization using orthogonal collocation,” *arXiv Pre-print*, no. arXiv:1809.06436 [cs.RO], 2018, Under Review
- Siddhartha S. Srinivasa, Aaron M. Johnson, Gilwoo Lee, Michael C. Koval, et al. “A system for multi-step mobile manipulation: Architecture, algorithms, and experiments,” *Springer Proceedings in Advanced Robotics: 2016 International Symposium on Experimental Robotics*, vol. 1, D. Kulić, Y. Nakamura, O. Khatib, and G. Venture, Eds., pp. 254–265, 2017
- Jiaji Zhou, Robert Paolini, Aaron M. Johnson, James Bagnell, and Matthew T. Mason. “A probabilistic planning framework for planar grasping under uncertainty,” *IEEE Robotics and Automation Letters*, vol. 2, no. 4, pp. 2111–2118, 2017
- Thomas Libby, Aaron M. Johnson, Evan Chang-Siu, Robert J. Full, and D. E. Koditschek. “Comparative design, scaling, and control of appendages for inertial reorientation,” *IEEE Transactions on Robotics*, vol. 32, no. 6, pp. 1380–1398, 2016
- Aaron M. Johnson, Samuel E. Burden, and D. E. Koditschek. “A hybrid systems model for simple manipulation and self-manipulation systems,” *International Journal of Robotics Research*, vol. 35, no. 11, pp. 1354–1392, 2016
- Aaron M. Johnson, Jennifer E. King, and Siddhartha Srinivasa. “Convergent planning,” *IEEE Robotics and Automation Letters*, vol. 1, no. 2, pp. 1044–1051, 2016
- Aaron M. Johnson and Sidney Axinn. “The morality of autonomous robots,” *Journal of Military Ethics*, vol. 12, no. 2, pp. 129–141, 2013
- Aaron M. Johnson and D. E. Koditschek. “Legged self-manipulation,” *IEEE Access*, vol. 1, pp. 310–334, 2013

Conference Papers

Yifan Hou, Zhenzhong Jia, Aaron M. Johnson, and Matthew Mason. “Robust planar dynamic pivoting by regulating inertial and gripping forces,” in *Workshop on the Algorithmic Foundations of Robotics*, San Francisco, CA, 2016

Anna L. Brill, Avik De, Aaron M. Johnson, and D. E. Koditschek. “Tail-assisted rigid and compliant legged leaping,” in *Proceedings of the IEEE/RSJ Intl. Conference on Intelligent Robots and Systems*, Hamburg, Germany, 2015, pp. 6304–6311

Garrett J. Wenger, Aaron M. Johnson, Camillo J. Taylor, and Daniel E. Koditschek. “Semi-autonomous exploration of multi-floor buildings with a legged robot,” in *Unmanned Systems Technology XVII*, vol. 9468, Baltimore, MD: SPIE, 2015, 94680B–8

Aaron M. Johnson and Sidney Axinn. “Acting vs. being moral: The limits of technological moral actors,” in *Proceedings of the IEEE Intl. Symposium on Ethics in Engineering, Science, and Technology*, Chicago, IL, 2014

Aaron M. Johnson and D. E. Koditschek. “Toward a vocabulary of legged leaping,” in *Proceedings of the IEEE Intl. Conference on Robotics and Automation*, Karlsruhe, Germany, 2013, pp. 2553–2560

Best Student Paper Finalist

Camilo Ordonez, Jacob Shill, Aaron M. Johnson, Jonathan Clark, and Emmanuel Collins. “Terrain identification for RHex-type robots,” in *Unmanned Systems Technology XV*, vol. 8741, Baltimore, MD: SPIE, 2013, 87410Q

Aaron M. Johnson, G. Clark Haynes, and D. E. Koditschek. “Standing self-manipulation for a legged robot,” in *Proceedings of the IEEE/RSJ Intl. Conference on Intelligent Robots and Systems*, Algarve, Portugal, 2012, pp. 272–279

Aaron M. Johnson, Thomas Libby, Evan Chang-Siu, Masayoshi Tomizuka, Robert J. Full, and D. E. Koditschek. “Tail assisted dynamic self righting,” in *Proceedings of the Intl. Conference on Climbing and Walking Robots*, Baltimore, MD, 2012, pp. 611–620

Best Student Paper Finalist

Camilo Ordonez, N. Gupta, E. G. Collins, J. Clark, and Aaron M. Johnson. “Power modeling of the XRL hexapedal robot and its application to energy efficient motion planning,” in *Proceedings of the Intl. Conference on Climbing and Walking Robots*, Baltimore, MD, 2012, pp. 689–696

G. Clark Haynes, Jason Pusey, Ryan Knopf, Aaron M. Johnson, and D. E. Koditschek. “Laboratory on legs: An architecture for adjustable morphology with legged robots,” in *Unmanned Systems Technology XIV*, vol. 8387, Baltimore, MD: SPIE, 2012, 83870W

Aaron M. Johnson, Matthew T. Hale, G. C. Haynes, and D. E. Koditschek. “Autonomous legged hill and stairwell ascent,” in *Proceedings of the IEEE Intl. Workshop on Safety, Security, & Rescue Robotics*, Kyoto, Japan, 2011, pp. 134–142

Avik De, Goran Lynch, Aaron M. Johnson, and D. E. Koditschek. “Motor sizing for legged robots using dynamic task specification,” in *Proceedings of the IEEE Intl. Conference on Technologies for Practical Robot Applications*, Boston, MA, 2011, pp. 64–69

Aaron M. Johnson, G. Clark Haynes, and D. E. Koditschek. “Disturbance detection, identification, and recovery by gait transition in legged robots,” in *Proceedings of the IEEE/RSJ Intl. Conference on Intelligent Robots and Systems*, Taipei, Taiwan, 2010, pp. 5347–5353

Cornell G. Wright, Aaron M. Johnson, Aaron Peck, Zachary McCord, et al. “Design of a modular snake robot,” in *Proceedings of the IEEE/RSJ Intl. Conference on Intelligent Robots and Systems*, San Diego, CA, 2007, pp. 2609–2614

Chris Atwood, Felix Duvall, Aaron M. Johnson, Richard Juchniewicz, et al. "Relative localization in colony robots," in *Proceedings of the Natl. Conference on Undergraduate Research*, Lexington, VA, 2005

Thesis and Technical Reports

Gilwoo Lee, Zita Marinho, Aaron M. Johnson, Geoffrey J. Gordon, Siddhartha S. Srinivasa, and Matthew T. Mason. "Unsupervised learning for nonlinear piecewise smooth hybrid systems," arXiv, Tech. Rep. arXiv:1710.00440 [cs.RO], 2017

Marshal Childers, Craig Lennon, Barry Bodt, Jason Pusey, et al. "US Army Research Laboratory (ARL) robotics collaborative technology alliance 2014 capstone experiment," US Army Research Laboratory, Tech. Rep. ARL-TR-7729, 2016

Sonia Roberts, Jeff Duperret, Aaron M. Johnson, Scott van Pelt, et al. "Desert RHex technical report: Jornada and White Sands trip," University of Pennsylvania, Philadelphia, PA, Tech. Rep., 2014

Aaron M. Johnson. "Self-manipulation and dynamic transitions for a legged robot," PhD thesis, Electrical & Systems Engineering, University of Pennsylvania, Philadelphia, PA, 2014

Aaron M. Johnson and D. E. Koditschek. "Parametric jumping dataset on the RHex robot," University of Pennsylvania, Philadelphia, PA, Tech. Rep., 2012

Aaron M. Johnson, Cornell Wright III, Matthew Tesch, Kevin Lipkin, and Howie Choset. "A novel architecture for modular snake robots," Robotics Institute, Pittsburgh, PA, Tech. Rep. CMU-RI-TR-11-29, 2011

Kevin C. Galloway, G. C. Haynes, B. Deniz Ilhan, Aaron M. Johnson, et al. "X-RHex: A highly mobile hexapedal robot for sensorimotor tasks," University of Pennsylvania, Philadelphia, PA, Tech. Rep., 2010

Posters and Abstracts

Cameron Selby, Amir Patel, Peter Li, and Aaron M. Johnson. "Bio-inspired high aerodynamic tail for robot reorientation and stabilization," in *ASME International Mechanical Engineering Congress and Exposition*, Pittsburgh, PA, 2018, IMECE2018-89 710

Wooshik Kim and Aaron M. Johnson. "Simple model for tool interaction on a continuously deformable environment," in *ASME International Mechanical Engineering Congress and Exposition*, Pittsburgh, PA, 2018, IMECE2018-89 452

Catherine Pavlov and Aaron M. Johnson. "Wheel-based trenching: Terramechanics of nonprehensile manipulation for planetary rovers," in *Robotics: Science and Systems Workshop on "Autonomous Space Robotics"*, Pittsburgh, PA, 2018

Joseph Norby and Aaron M. Johnson. "Towards energy optimal design and control of tailed legged robot locomotion," in *Robotics: Science and Systems Workshop on "Unusual Appendages"*, Pittsburgh, PA, 2018

Amir Patel, Philipp Suhrcke, Adam Zeloof, Peter Li, Cameron Selby, and Aaron Johnson. "Tail aerodynamics in cheetahs and robots," in *Robotics: Science and Systems Workshop on "Unusual Appendages"*, Pittsburgh, PA, 2018

Monica Barragan, Nikolai Flowers, and Aaron M. Johnson. "MiniRHex: A small, open-source, fully programmable walking hexapod," in *Robotics: Science and Systems Workshop on "Design and Control of Small Legged Robots"*, Pittsburgh, PA, 2018

Catherine Pavlov and Aaron M. Johnson. "Wheel-based trenching: Terramechanics of nonprehensile manipulation on planetary rovers," in *Robotics: Science and Systems Workshop on "Women In Robotics"*, Pittsburgh, PA, 2018

Aaron M. Johnson, Natha Singhasaneh, and Praxis Bays. "Bioinspired hoof design," in *Dynamic Walking*, Pensacola, FL, 2018

Joseph Norby and Aaron M. Johnson. “Towards energy optimal design and control for inertial reorientation device,” in *Dynamic Walking*, Pensacola, FL, 2018

Amir Patel and Aaron M. Johnson. “Wheels versus ankles: Rapid acceleration of a hybrid wheeled-biped robot,” in *Dynamic Walking*, Pensacola, FL, 2018

Nikolai Flowers, Monica Barragan, and Aaron M. Johnson. “MiniRHex: An open-source walking hexapod,” in *Dynamic Walking*, Pensacola, FL, 2018

Aaron M. Johnson. “Three uses for springs in extension in legged locomotion,” in *Dynamic Walking*, Mariehamn, Finland, 2017

Aaron M. Johnson and Thomas Libby. “Morphological reduction on the slip template,” in *Dynamic Walking*, Holly, MI, 2016

Thomas Libby, Aaron M. Johnson, Robert J. Full, and D. E. Koditschek. “Design and comparative morphology for inertial reorientation,” in *Robotics: Science and Systems Workshop on “Robotic Uses for Tails”*, Rome, Italy, 2015

Thomas Libby, Aaron M. Johnson, Robert J. Full, and D. E. Koditschek. “Comparative morphology of inertial reorientation,” in *IEEE International Conference on Robotics and Automation Workshop on “Robotics-Inspired Biology”*, Seattle, WA, 2015

Thomas Libby, Aaron M. Johnson, and Robert J. Full. “Scaling of effectiveness for inertial reorientation,” in *Society for Integrative and Comparative Biology Annual Meeting*, West Palm Beach, FL, 2015

Aaron M. Johnson and D. E. Koditschek. “Cellular decomposition and classification of a hybrid system,” in *Northeast Robotics Colloquium*, Providence, RI, 2014

Aaron M. Johnson. “Gait design using self-manipulation,” in *Robotics: Science and Systems Workshop on “Dynamic Locomotion”*, Berkeley, CA, 2014

Avik De, Aaron M. Johnson, and D. E. Koditschek. “Planar hopping with a leg and a tail,” in *Dynamic Walking*, Zurich, Switzerland, 2014

Aaron M. Johnson and D. E. Koditschek. “Robot parkour: The ground reaction complex & dynamic transitions,” in *Dynamic Walking*, Pittsburgh, PA, 2013

Aaron M. Johnson and Sidney Axinn. “The morality of autonomous robots,” in *Florida Philosophy Association Annual Meeting*, Ft. Lauderdale, FL, 2011

Kevin Woo, Eugene Marinelli, James Kong, Aaron M. Johnson, et al. “Investigating power management in a robot colony,” in *Meeting of the Minds*, Carnegie Mellon University, Pittsburgh, PA, 2008
IBM Innovation that Matters Awards and ‘Thought’ Prize for Excellence in Research

Aaron M. Johnson and Tsuhan Chen. “Vision-based relative slam,” in *Meeting of the Minds*, Carnegie Mellon University, Pittsburgh, PA, 2008

Felix Duvall, Kevin Woo, James Kong, Aaron M. Johnson, et al. “Control of a robot colony,” in *Meeting of the Minds*, Carnegie Mellon University, Pittsburgh, PA, 2007
Lockheed Martin Undergraduate Project Judges Choice Award

Aaron M. Johnson. “A friendly voip box,” in *Meeting of the Minds*, Carnegie Mellon University, Pittsburgh, PA, 2007

Felix Duvall, Aaron M. Johnson, Ryan Kellogg, James Kong, et al. “A robotic platform for exploring emergent behavior,” in *Meeting of the Minds*, Carnegie Mellon University, Pittsburgh, PA, 2006

Allison Naaktgeboren, Jessica Kang, Steven Shamlan, Aaron M. Johnson, et al. “Relative localization in colony robots,” in *Meeting of the Minds*, Carnegie Mellon University, Pittsburgh, PA, 2005
Lockheed Martin Undergraduate Project Judges Choice Award

Invited Talks

- 9/29/2017 **Frontiers in Contact-rich Robotic Interaction**, IROS Workshop, Vancouver, Canada
- 9/24/2017 **Planning Legged and Aerial Locomotion**, IROS Workshop, Vancouver, Canada
- 11/3/2016 **ARL Robotics Collaborative Technology Alliance**, RMB Meeting Poster, Aberdeen, MD
- 3/10/2016 **Massachusetts Institute of Technology**, Mechanical Engineering Department, Cambridge, MA
- 2/29/2016 **Brown University**, Computer Science Department, Providence, RI
- 2/24/2016 **University of North Carolina**, Computer Science Department, Chapel Hill, NC
- 2/9/2016 **Northwestern University**, Masters in Robotics Seminar, Evanston, IL
- 1/26/2016 **Carnegie Mellon University**, Department of Mechanical Engineering Seminar, Pittsburgh, PA
- 12/18/2015 **Carnegie Mellon University**, Bipedal Locomotion Seminar, Pittsburgh, PA
- 12/11/2015 **IBM-CMU Day**, Cognitive Institute Workshop, Pittsburgh, PA
- 4/8/2015 **Toyota Motor Engineering & Manufacturing North America**, San Jose, CA
- 4/2/2015 **Locomotion and Manipulation: Why the great divide?** NSF Workshop, Arlington, VA
- 3/12/2015 **University of Maryland**, Department of Mechanical Engineering Seminar, College Park, NJ
- 2/4/2015 **Princeton University**, Princeton, NJ
- 11/21/2014 **University of Pennsylvania**, Law School, The Ethics of Autonomous Weapons Systems Workshop Panelist, Philadelphia, PA
- 6/26/2014 **Carnegie Mellon University**, Center for Foundations of Robotics Seminar, Pittsburgh, PA
- 5/21/2014 **ARL Robotics Collaborative Technology Alliance**, PI Meeting Poster, Aberdeen, MD
- 4/25/2014 **NSF CABiR Consortium**, Berkeley, CA
- 3/4/2014 **Massachusetts Institute of Technology**, CSAIL Center for Robotics Seminar, Cambridge, MA
- 5/1/2013 **George Washington University**, Department of Computer Science Talk, Washington, DC
- 11/8/2012 **University of California**, Berkeley, CA
- 11/2/2012 **Northwestern University**, Evanston, IL
- 6/4/2012 **Carnegie Mellon University**, Pittsburgh, PA
- 4/27/2012 **Royal Veterinary College**, London, UK
- 2/3/2011 **Boston University**, Neuromorphics Laboratory, Boston, MA

Selected Media Appearances

- 7/1/2017 **ASME Mechanical Engineering**: *A Leg Up on Robomechanics* – Article and interview
- 5/28/2017 **Recode**: *Robots copy their coolest moves from animals* – Article and interview
- 4/14/2017 **Pittsburgh Post-Gazette**: *CMU and Tata Consultancy Services partner for the “4th Industrial Revolution”* – Article
- 4/13/2017 **Carnegie Mellon University**: *Carnegie Mellon and Tata Consultancy Services Break Ground on Global Research Facility in the U.S.* – Press Release
- 10/5/2016 **The Washington Post**: *Robots could eventually replace soldiers in warfare. Is that a good thing?* – Article written with Vivek Wadhwa

- 8/23/2016 **Carnegie Mellon University:** *Robomechanics: Aaron Johnson's robotic zoo* – Press release
- 7/18/2014 **IEEE Spectrum – Automation:** *Video Friday: RHex Pronking ...* – Article
- 8/15/2013 **CNN.com What's Next:** *Met RHex – the curvy-legged, leaping robot* – Article
- 8/13/2013 **Wall Street Journal News Hub:** *All-terrain robot, or overexcited puppy?* – Live video interview
- 8/13/2013 **The Associated Press:** *Penn researchers strive for a more athletic robot* – Syndicated article and video including interview
- 7/29/2013 **Computerworld:** *Researchers build jumping, flipping, handstanding robot* – Article and interview
- 7/26/2013 **Fast Company – Co.EXIST Blog:** *This versatile robot can climb just about anywhere* – Article
- 7/25/2013 **Slate:** *“Parkour robot” jumps around, other robots roll eyes* – Article
- 7/24/2013 **The Atlantic:** *Hardcore parkour (with robots)* – Article
- 7/23/2013 **IEEE Spectrum – Automation:** *RHex does parkour all over UPenn* – Article and interview
- 7/23/2013 **University of Pennsylvania:** *A robot that jumps, flips, and does pullups* – Press release
- 5/9/2013 **Gizmodo:** *Does This Acrobatic Robot Have Olympic Aspirations?* – Article
- 5/8/2013 **IEEE Spectrum – Automaton:** *This robot's acrobatic leaps are the coolest thing you'll see today* – Article
- 8/5/2012 **The Naked Scientist:** *[RHex] the robot gets a tail* – Radio interview
- 7/31/2012 **Wired:** *Robot uses its tail to land on its feet, just like a cat* – Article
- 7/30/2012 **Engadget:** *X-RHex Lite robot grows a tail, always lands on its feet* – Article
- 7/30/2012 **IEEE Spectrum – Automaton:** *XRL hexapod robot gets a tail, learns to use it* – Article

Workshop and Seminar Organization

Seminar Series Organizer, “CMU Locomotion Seminar,” 2017–

<http://www.andrew.cmu.edu/user/amj1/locomotion.seminar.html>

Workshop Organizer, “Unusual Appendages: Novel, multi-modal, or multi-functional uses for limbs, tails, and other body parts,” Robotics: Science and Systems Conf., 2018,

<https://www.cmu.edu/me/robomechanicslab/ws/rss2018.html>

Symposium Organizer, “RSS Area Chair Research Symposium”, 2017

Workshop Organizer, “AAAI-RSS Celebrating the 50th Anniversary of Shakey: The Role of AI to Harmonize Robots and Humans,” Robotics: Science and Systems Conf., 2015,

<http://rll.berkeley.edu/RSS2015-BlueSky-Shakey>

Workshop Organizer, “Robotic Uses for Tails,” Robotics: Science and Systems Conf., 2015,

<https://www.cmu.edu/me/robomechanicslab/ws/RSS2015.html>

Special Session Organizer, “Throwing Your Weight Around: Using Appendage Inertia,” CLAWAR Conf., 2012, <https://www.cmu.edu/me/robomechanicslab/ws/CLAWAR2012.html>

Professional and Other

Associate Editor, IEEE International Conference on Robotics and Automation, 2017–

Program Committee, Robotics: Science and Systems, 2016–

International Program Committee, Climbing and Walking Robots Conference (CLAWAR), 2013–2015

NSF Panelist, 2015, 2018

Reviewer for numerous journals and conferences including: ASME Journal of Dynamic Systems, Measurement, and Control, Bioinspiration & Biomimetics, Biology Letters, IEEE/ASME Transactions on Mechatronics, IEEE Transactions on Robotics, International Journal of Robotics Research, Robotics and Autonomous Systems, Science Robotics, and SIAM Journal on Applied Dynamical Systems

Professional memberships: The American Society of Mechanical Engineers (ASME) and The Institute of Electrical and Electronics Engineers (IEEE).

Faculty Advisor, CMU Tartan Ice Drilling Team, student organization participating in the NASA RASC-AL Mars Ice Challenge, 2017–

Judge, Sigma Xi Poster Competition, Carnegie Mellon University Meeting of the Minds, 2015

Community presentations, demos, and tours including invited talks at a local elementary/middle school and senior living center

President of the Carnegie Mellon University Robotics Club, 2007–2008

Robot inspector, website evaluator, and mentor for FIRST Robotics Competition, 2003–2012

Director and instructor for “Career Exploration and Mentoring Program,” an afterschool robotics program for students at nine elementary and middle schools throughout Maryland, 2000–2004