

Matthew Travers

5000 Forbes Ave. Newell-Simon Hall 3217
Pittsburgh, PA 15213

Phone: (303) 709-4489
Email: mtravers@andrew.cmu.edu

RESEARCH INTERESTS

Robotics and biologically-inspired control. Subfields include fundamental mechanics, motion planning, biological locomotion, snake-like robots, walking robots, and nonlinear control.

POSITIONS HELD

Project Scientist, Carnegie Mellon University
Postdoctoral Fellow, Carnegie Mellon University

2013 - Present
2011 - 2013

EDUCATION

Northwestern University, Evanston, Illinois USA

- Ph.D., Mechanical Engineering, August 2011
Thesis Topic: Impulse Smoothing for Data Association
Advisors: Todd Murphey and Lucy Pao
Research Areas: Data association, nonlinear optimization, non-smooth optimization, optimal control, nonlinear estimation, object tracking

University of Colorado, Boulder, Colorado USA

- M.S., Electrical and Computer Engineering, May 2008
Areas of Study: Robotics, dynamics, control, mechatronics
- B.S., Engineering Physics, December 2004
Areas of Study: Analytical mechanics, electromagnetism, optics, quantum mechanics

TEACHING EXPERIENCE

Carnegie Mellon University, Pittsburgh, Pennsylvania USA

- Introduction to Geometric Mechanics and Differential Geometry **Fall 2015**
Prepared course material for lectures
Partial lecturing responsibility
Helped create projects

Northwestern University, Evanston, Illinois USA

- Introduction to Optimal Control **Spring 2010**
Graduate teaching assistant
Developed and graded assignments
Graded projects

University of Colorado, Boulder, Colorado USA

- Control System Analysis
Graduate teaching assistant
Developed and graded labs
Taught recitation sections

Fall 2006

EXTERNAL COLLABORATIONS

Georgia Institute of Technology, Atlanta, Georgia USA

- RoboPhysics of serpentine locomotion
With Professor Dan Goldman
Robotic devices used to study biological locomotion

Fall 2013 - Present

University of North Carolina, Charlotte, North Carolina USA

- Mechanics of dissipative systems
With Professor Scott Kelly
Application of geometric mechanics to motion planning for dissipative systems

Fall 2012 - Present

PUBLICATIONS

JOURNAL PUBLICATIONS

- [1] J. Aguilar, T. Zhang, F. Qian, M. Kingsbury, B. McInroe, N. Mazouchova, C. Li, R. Maladen, C. Gong, M. Travers, R.L. Hatton, H. Choset, P.B. Umbanhowar, and D.I. Goldman. A Review on Locomotion Robophysics: The Study of Movement at the Intersection of Robotics, Soft Matter and Dynamical Systems. To appear in *Reports on Progress in Physics*.
- [2] H. Astley, C. Gong, J. Dai, M. Travers, M. Serrano, P. Vela, H. Choset, J.R. Mendelson, D.L. Hu, and D.I. Goldman. Modulation of Orthogonal Body Waves Enables High Maneuverability in Sidewinding Locomotion. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, 112:19, 6200-6205, 2015.
- [3] C. Gong, M. Travers, H. Astley, L. Li, J.R. Mendelson, D.I. Goldman, and H. Choset. Kinematic Gait Synthesis for Snake Robots. *The International Journal of Robotics Research (IJRR)*, August 2015.
- [4] H. Marvi, C. Gong, N. Gravish, H. Astley, M. Travers, R.L. Hatton, J.R. Mendelson, H. Choset, D.L. Hu, and D.I. Goldman. Sidewinding with Minimal Slip: Snake and Robot Ascent of Sandy Slopes. *Science*, 346:6206, 224-229, 2014.

CONFERENCE PUBLICATIONS

- [1] M. Travers and H. Choset. Shape-Constrained Whole-Body Adaptivity. *International Symposium on Safety, Security, and Rescue Robotics (SSRR)*, 2015. *Nominated for best paper award.*
- [2] T. Dear, S.D. Kelly, M. Travers, and H. Choset. Motion Planning and Differential Flatness of Mechanical Systems on Principal Bundles. *ASME Dynamic Systems and Controls Conference (DSCC)*, 2015.
- [3] M. Travers and H. Choset. Use of the Nonlinear Observability Rank Condition for Improved Parametric Estimation. *International Conference on Robotics and Automation (ICRA)*, 2015.
- [4] X. Xiao, E. Cappelletti, W. Zhen, J. Dai, K. Su, C. Gong, M. Travers, and H. Choset. Locomotive Reduction for Snake Robots. *International Conference on Robotics and Automation (ICRA)*, 2015.

- [5] C. Gong, M. Travers, H. Astley, D.I. Goldman, and H. Choset. Limbless Locomotors that Turn in Place. *International Conference on Robotics and Automation (ICRA)*, 2015.
- [6] J. Dai, M. Travers, T. Dear, C. Gong, H. Astley, D.I. Goldman, and H. Choset. Robot-Inspired Biology: The Compound-Wave Control Template. *International Conference on Robotics and Automation (ICRA)*, 2015.
- [7] T. Dear, S.D. Kelly, M. Travers, and H. Choset. Snakeboard Motion Planning with Viscous Friction and Skidding. *International Conference on Robotics and Automation (ICRA)*, 2015.
- [8] C. Gong, M. Travers, H. Kao, and H. Choset. Conditioned Basis Array Factorization: An Approach to Gait Pattern Extraction. *Robotics: Science and Systems (RSS)*, 2014.
- [9] T. Dear, S.D. Kelly, M. Travers, and H. Choset. Dissipation-Induced Self-Recovery in Systems on Principal Bundles. *ASME Dynamic Systems and Controls Conference (DSCC)*, 2014.
- [10] H. Ponte, M. Travers, and H. Choset. Guided Locomotion in 3D for Snake Robots Based on Contact Force Optimization. *International Conference on Intelligent Robots and Systems (IROS)*, 2014.
- [11] M. Travers and H. Choset. Recursive Dynamics and Feedback Linearizing Control of Serial-Chain Manipulators. *International Conference on Intelligent Robots and Systems (IROS)*, 2014.
- [12] C. Gong, M. Travers, H. Kao, and H. Choset. Parameterized Controller Generation for Multiple Mode Behavior. *International Conference on Intelligent Robots and Systems (IROS)*, 2014.
- [13] A. Rangaprasad, M. Travers, and H. Choset. Using Lie Algebra to Estimate the Shape of Medical Snake Robots. *International Conference on Intelligent Robots and Systems (IROS)*, 2014.
- [14] H. Ponte, M. Queenan, C. Mertz, M. Travers, F. Enner, M. Hebert, and H. Choset. Visual Sensing for Developing Autonomous Behavior in Snake Robots. *International Conference on Robotics and Automation (ICRA)*, 2014.
- [15] E.A. Cappel, M. Travers, and H. Choset. Head-Orientation for a Sidewinding Snake Robot using Modal Decomposition. *SPIE Defense and Security*, 2014.
- [16] M. Travers and H. Choset. Optimal Gait Design for Systems with Drift on $SO(3)$. *ASME Dynamic Systems and Control Conference (DSCC)*, 2013.
- [17] T. Dear, S.D. Kelly, M. Travers, and H. Choset. Mechanics and Control of a Terrestrial Vehicle Exploiting a Nonholonomic Constraint for Fishlike Locomotion. *ASME Dynamic Systems and Control Conference (DSCC)*, 2013.
- [18] T. Dear, R.L. Hatton, M. Travers, and H. Choset. Snakeboard Motion Planning with Local Trajectory Information. *ASME Dynamic Systems and Control Conference (DSCC)*, 2013.
- [19] M. Travers, R.L. Hatton, and H. Choset. Minimum Perturbation Coordinates on $SO(3)$. *American Control Conference (ACC)*, 2013.
- [20] C. Gong, M. Travers, X. Fu, and H. Choset. Extended Gait Equation for Sidewinding. *International Conference on Robotics and Automation (ICRA)*, 2013.
- [21] T. Kamegawa, R. Kuroki, M. Travers, and H. Choset. Proposal of EARLI for a Snake Robot Obstacle-Aided Locomotion. *International Symposium on Safety, Security, and Rescue Robotics (SSRR)*, 2012.
- [22] M. Travers, T. Murphey, and L. Pao. Linear Time-Varying Impulse Optimization for Data Association. *American Control Conference (ACC)*, 2012.
- [23] M. Travers, T. Murphey, and L. Pao. Impulsive Data Association with an Unknown Number of Targets. *Hybrid Systems: Computation and Control (HSCC)*, 2011.

- [24] M. Travers, T. Murphey, and L. Pao. Trajectory Optimization Estimator for Impulsive Data Association. *American Control Conference (ACC)*, 2011.
- [25] M. Travers, T. Murphey, and L. Pao. Impulsive Optimization for Data Association. *IEEE Conference on Decision and Control (CDC)*, 2010.
- [26] M. Travers, T. Murphey, and L. Pao. Stochastic Sampling-Based Data Association. *American Control Conference (ACC)*, 2009.
- [27] M. Travers, T. Murphey, and L. Pao. Data Association with Ambiguous Measurements. *American Control Conference (ACC)*, 2008.

PUBLICATIONS IN PREPARATION

- [1] “Biologically-Inspired Compliant Control in Serpentine Locomotion” with H. Choset and D.I. Goldman. In preparation for *Robotics: Science and Systems, 2016*.
- [2] “Parameterized Compliance in Locomotion” with H. Choset and D.I. Goldman. In preparation for *International Journal of Robotics Research*.

CONFERENCE ABSTRACTS

- [1] M. Travers and H. Choset. Compliant Synergies in Locomotion. To appear in *American Physical Society March meeting*, 2016.
- [2] M. Travers, P. Schiebel, D.I. Goldman, and H. Choset. Limbless Locomotion Control in Unstructured Terrains. To appear in *Society for Integrative and Comparative Biology annual meeting*, 2016.
- [3] P. Schiebel, T. Zhang, C. Gong, J. Dai, H. Astley, M. Travers, H. Choset, and D.I. Goldman. Slithering on Sand: Kinematics and Controls for Success on Granular Media. To appear in *Society for Integrative and Comparative Biology annual meeting*, 2016.
- [4] J. Dai, H. Faraji, P. Schiebel, C. Gong, M. Travers, R.L. Hatton, D.I. Goldman, and H. Choset. Geometric Swimmer on Granular Material. To appear in *Society for Integrative and Comparative Biology annual meeting*, 2016.
- [5] C. Gong, H. Astley, J. Dai, B. McInroe, P. Schiebel, M. Travers, D.I. Goldman, and H. Choset. Geometric Mechanics: A Framework for Studying Animal Locomotion. To appear in *Society for Integrative and Comparative Biology annual meeting*, 2016.
- [6] M. Travers, P. Schiebel, C. Gong, H. Astley, D.I. Goldman, and H. Choset. Shape-Constrained Whole-Body Adaptivity. *Symposium on Adaptive Motion of Animals and Machines*, 2015.
- [7] H. Astley, C. Gong, M. Travers, M. Serrano, P. Vela, H. Choset, P. Schiebel, M. Travers, D.I. Goldman, and H. Choset. Modulation of Orthogonal Body Waves Enables Versatile and Rapid Maneuverability in Sidewinding Locomotion. *Society for Integrative and Comparative Biology annual meeting*, 2015.

PROFESSIONAL EXPERIENCE

CONFERENCE COMMITTEES

IEEE International Symposium on Safety, Security, and Rescue Robotics

- Program Committee, Purdue University, West Lafayette, Indiana USA, 2015
- Program Committee, Linkoping, Sweden, 2013

PROFESSIONAL SOCIETY MEMBERSHIPS

- American Society of Mechanical Engineers (ASME)
- Institute of Electrical and Electronics Engineers (IEEE)
- American Physical Society (APS)
- Society for Integrative and Comparative Biology (SICB)

WORK EXPERIENCE

Air Force Research Laboratory

- Space Scholar, Albuquerque, New Mexico USA **June 2009 - Sept 2009**
Tracking objects in orbit
Developed new data-association algorithms

Aerospace Corporation

- Summer Intern, El Segundo, California USA **May 2006 - Aug 2006**
Developed software for satellite-to-satellite communications
Worked with LabVIEW software and National Instruments hardware

TECHNICAL SKILLS

Programming: Matlab, Mathematica, LabVIEW, version control software (SVN), C, C++, Python

Applications: Latex, Bibtex, Microsoft Office

Operating Systems: Apple OS X, Microsoft Windows, Linux