

# Andrew P. Sabelhaus

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## EDUCATION

### PH.D. MECHANICAL ENGINEERING

Dissertation title: *Tensegrity Spines for Quadruped Robots*

Dissertation Committee: Alice M. Agogino (Chair), Andrew Packard, Claire Tomlin, Murat Arcak

University of California, Berkeley

August 2019

### M.S. MECHANICAL ENGINEERING

Thesis: *Mechanism and Sensor Design for SUPERball, a Cable-Driven Tensegrity Robot*

Thesis Committee: Alice M. Agogino, Dennis Lieu

University of California, Berkeley

Dec. 2014

### B.S. MECHANICAL ENGINEERING

Minor in Computer Science

University of Maryland, College Park

May 2012

## APPOINTMENTS

### Boston University

Dept. of Mechanical Engineering

Assistant Professor

2022 - Present

### Carnegie Mellon University

Dept. of Mechanical Engineering

Postdoctoral Research Fellow

2019 - 2021

### NASA Ames Research Center

Intelligent Systems Division

Visiting Technologist

2015 - 2019

### University of California, Berkeley

Dept. of Mechanical Engineering

Graduate Research Fellow

2012-2019

## FUNDING + AWARDS

5. **Intelligence Community Postdoctoral Research Fellowship.** Office of the Director of National Intelligence. Title: *Rapid Deployment of Hard-to-Control Robots with Optimality Tradeoffs*. Full funding, 2020-2022.
4. **NASA Space Technology Research Fellowship.** National Aeronautics and Space Administration. Title: *Trajectory Tracking in Nonlinear, High-Order, Underactuated Robotic Systems*. Full funding, 2015-2019.
3. **CITRIS Tech for Social Good Development Grant.** University of California Center for Information Technology Research in the Interest of Society (CITRIS). Title: *Laika, The Robot Transport for Disaster Relief*. Block grant, 2018.
2. **Markowski-Leach Foundation Award.** Awarded to LGBTQ individuals at San Francisco Bay Area institutions who "are likely to make a substantial contribution to society." 2013-2014, re-awarded 2016-2018. Currently the only repeated awardee on record.
1. **NSF Graduate Research Fellowship.** National Science Foundation. Full funding, 2012-2015.

## RESEARCH OUTPUT SNAPSHOT

Peer-Reviewed Publication Count:			Total Citations:	h-index:
	1st-Author or PI:	All:		
Conference:	7	12	742* (310 <sup>†</sup> )	12* (6 <sup>†</sup> )
Journal:	4	8		
Total:	11	20		

\*Via Google Scholar, <https://scholar.google.com/citations?user=ze69yEMAAAAJ&hl=en>.

†Via Web of Science, <https://publons.com/researcher/1275784/andrew-p-sabelhaus/>.

## JOURNAL PUBLICATIONS

8. A.P. Sabelhaus, R.K. Mehta, A. Wertz, C. Majidi, "In-Situ Sensing and Dynamics Predictions for Electrothermally-Actuated Soft Robot Limbs," *Frontiers in Robotics and AI*, Accepted for Publication.
7. M. Zadan, D.K. Patel, A.P. Sabelhaus, J.Liao, A. Wertz, L. Yao, C. Majidi, "Liquid Crystal Elastomer with Integrated Soft Thermoelectrics for Shape Memory Actuation and Energy Harvesting," *Advanced Materials*, April 2022. doi:10.1002/adma.202200857
6. Z.J. Patterson, A.P. Sabelhaus, C. Majidi, "Robust Control of a Multi-Axis Shape Memory Alloy-Driven Soft Manipulator," *IEEE Robotics and Automatics Letters*, April 2022. doi:10.1109/LRA.2022.3143256
5. A.P. Sabelhaus, K. Zampaglione, E. Tang, L.H. Chen, A.K. Agogino, A.M. Agogino, "Double-Helix Linear Actuators," *Journal of Mechanical Design (ASME)*, Vol. 143, Issue 10, Oct. 2021. doi:10.1115/1.4050739
4. Z. Ren, X. Huang, M. Zarepoor, A.P. Sabelhaus, C. Majidi, "Shape Memory Alloy (SMA) Actuator with Embedded Liquid Metal Curvature Sensor for Closed-Loop Control." *Frontiers in Robotics and AI*, Vol. 8, Mar. 2021. doi:10.3389/frobt.2021.599650
3. A.P. Sabelhaus, H. Zhao, E. Zhu, A.K. Agogino, A.M. Agogino, "Model-Predictive Control with Inverse Statics Optimization for Tensegrity Spine Robots." *IEEE Transactions on Control System Technology*, Vol. 29, Issue 1, Jan. 2021. doi:10.1109/TCST.2020.2975138
2. A.P. Sabelhaus, A.H. Li, K.A. Sover, J. Madden, A. Barkan, A.K. Agogino, A.M. Agogino, "Inverse Statics Optimization for Compound Tensegrity Robots." *IEEE Robotics and Automation Letters*, July 2020. doi:10.1109/LRA.2020.2983699
1. K. Caluwaerts, J. Despraz, A. Iscen, A.P. Sabelhaus, J. Bruce, B. Schrauwen, V. SunSpiral, "Design and Control of Compliant Tensegrity Robots through Simulation and Hardware Validation." *Journal of the Royal Society Interface*, Sept. 2014. doi:10.1098/rsif.2014.0520

## CONFERENCE PUBLICATIONS

12. A. Wertz\*, A.P. Sabelhaus\*, C. Majidi, "Trajectory Optimization for Thermally-Actuated Soft Planar Robot Limbs," *IEEE International Conference on Soft Robotics (RoboSoft)*, April 2022. \*Equal Contribution.
11. A.P. Sabelhaus, C.Majidi, "Gaussian Process Dynamics Models for Soft Robots with Shape Memory Actuators." *IEEE International Conference on Soft Robotics (RoboSoft)*, April 2021.
10. Z. Patterson, A.P. Sabelhaus, K. Chin, T. Hellebrekers, C. Majidi, "An Untethered Brittle Star Robot for Closed-Loop Underwater Locomotion." *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Oct. 2020.
9. L.H. Chen, M.C. Daly, A.P. Sabelhaus, L.A. Janse van Vuuren, H.J. Garnier, M.I. Verdugo, E. Tang, C.U. Spangenberg, F. Ghahani, A.K. Agogino, A.M. Agogino, "Modular Elastic Lattice Platform for Rapid Prototyping of Tensegrity Robots." *ASME International Design Engineering Technical Conferences (IDETC) / 41st Mechanisms and Robotics Conference*, Aug 2017. doi:10.1115/DETC2017-68264
8. A.P. Sabelhaus, A.K. Akella, Z.A. Ahmad, V. SunSpiral, "Model-Predictive Control of a Flexible Spine Robot." *American Control Conference (ACC)*, IEEE, May 2017. doi:10.23919/ACC.2017.7963738
7. K. Zampaglione, A.P. Sabelhaus, L.H. Chen, A.M. Agogino, A.K. Agogino, "DNA-Structured Linear Actuators." *ASME International Design Engineering Technical Conferences (IDETC) / 40th Mechanisms and Robotics Conference*, Aug 2016. doi:10.1115/DETC2016-60291
6. A.P. Sabelhaus, H. Ji, P. Hylton, Y. Madaan, C. Yang, J. Friesen, V. SunSpiral, A.M. Agogino, "Mechanism Design and Simulation of the ULTRA Spine, a Tensegrity Robot." *ASME International Design Engineering Technical Conferences (IDETC) / 39th Mechanisms and Robotics Conference*, Aug 2015. doi:10.1115/DETC2015-47583
5. A.P. Sabelhaus, J. Bruce, K. Caluwaerts, P. Manovi, R.F. Firoozi, S. Dobi, A.M. Agogino, V. SunSpiral, "System Design and Locomotion of SUPERball, an Untethered Tensegrity Robot." *IEEE International Conference on Robotics and Automation (ICRA)*, May 2015. doi:10.1109/ICRA.2015.7139590
4. A.P. Sabelhaus, J. Bruce, K. Caluwaerts, Y. Chen, D. Lu, Y. Liu, A.K. Agogino, V. SunSpiral, A.M. Agogino, "Hardware Design and Testing of SUPERball, a Modular Tensegrity Robot." *The 6th World Conference on Structural Control and Monitoring (6WCSCM)*, July 2014.

3. J. Bruce, **A.P. Sabelhaus**, Y. Chen, D.Lu, K. Morse, S. Milam, K. Caluwaerts, A.M. Agogino, V. SunSpiral, "SUPERball: Exploring Tensegrities for Planetary Probes." *12th International Symposium on Artificial Intelligence, Robotics, and Automation in Space (i-SAIRAS)*, June 2014.
2. J. Bruce, K. Caluwaerts, A. Iscen, **A.P. Sabelhaus**, V. SunSpiral, "Design and Evolution of a Modular Tensegrity Robot Platform." *IEEE International Conference on Robotics and Automation (ICRA)*, May 2014. doi:10.1109/ICRA.2014.6907361
1. **A.P. Sabelhaus**, D. Mirsky, L.M. Hill, S. Bergbreiter, "TinyTeRP: A Tiny Terrestrial Robotic Platform with Modular Sensing." *IEEE International Conference on Robotics and Automation (ICRA)*, May 2013. doi: 10.1109/ICRA.2013.6630933

## UNDER REVIEW + PRE-PRINTS

2. X. Huang, Z. Patterson, **A.P. Sabelhaus**, W. Huang, K. Chin, Z. Ren, M.K. Jawed, C. Majidi, "Unethered Soft Robots - Design and Closed Loop Motion Planning with Discrete Elastic Rods." *Under Review, Nature Communications*.
1. **A.P. Sabelhaus**, L.A. Janse van Vuuren, A. Joshi, E. Zhu, H.J. Garnier, K.A. Sover, J. Navarro, A.K. Agogino, V. SunSpiral, A.M. Agogino, "Design, Simulation, and Testing of a Flexible Actuated Spine for Quadruped Robots." *Preprint Only*. Available, arXiv:1804.06527

## IN-PREPARATION

3. **A.P. Sabelhaus**, Z. Patterson, A. Wertz, C. Majidi, "Safe Supervisory Control of Soft Robot Actuators."
2. **A.P. Sabelhaus**, L.A. Janse van Vuuren, D. Macri, A. Joshi, K.A. Sover, Z. Rodriguez, J. Navarro, A. Bronars, A.H. Li, A. Barkan, A. Zhang, A.K. Agogino, A.M. Agogino, "Tensegrity Spines for Quadruped Robots."
1. **A.P. Sabelhaus**, "Stability and Control Design for Lagrangian Systems with Statically-Conservative Forces."

## PATENTS

2. A. Agogino, K. Zampaglione, L.-H. Chen, **A.P. Sabelhaus**, "DNA Structured Linear Actuator." *US Patent No. 10,630,208*, issued April 21, 2020.
1. L.-H. Chen, A. Agogino, M. Daly, **A.P. Sabelhaus**, A.K. Agogino, "Elastic Lattices for Design of Tensegrity Structures and Robots." *Under review, US Patent Application No. US20190382995A1*.

## INVITED TALKS + PRESENTATIONS

17. **A.P. Sabelhaus**, "Close Enough is Good Enough: Approximations in Soft Robot Control." *Embodied Intelligence Conference*, 2022
16. **A.P. Sabelhaus**, "Double-Helix Linear Actuators." *4th ASME Journal of Mechanical Design Webinar*, American Society of Mechanical Engineers, Dec. 2021
15. **A.P. Sabelhaus**, "Soft Robot Locomotion: Not as Hard as You Might Think." *Intelligence Community Academic Research Symposium*, United States Office of the Director of National Intelligence, Sept. 2021.
14. **A.P. Sabelhaus**, "Controlling Soft Robots: Not as Hard as You Might Think." *NGA IC Postdoc Speaker Series*, National Geospatial Intelligence Agency (Online), June 2021.
13. **A.P. Sabelhaus**, "Towards Rich Locomotion Gaits for Soft Robots." *CMU Locomotion Seminar*, Carnegie Mellon University, Nov. 2020.
12. **A.P. Sabelhaus**, C. Majidi, "Gaussian Process Models for Soft Robot Locomotion." *Workshop on Application-Oriented Modeling and Control of Soft Robots, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Oct. 2020.
11. **A.P. Sabelhaus**, "Tensegrity Spines for Quadruped Robots." *Workshop on Tensegrity Robotics, IEEE International Conference on Robotics and Automation (ICRA)*, May 2019.
10. **A.P. Sabelhaus**, "Tensegrity Spines for Quadruped Robots." *CMU Locomotion Seminar*, Carnegie Mellon University, Feb. 2019.
9. **A.P. Sabelhaus**, "Laika and Belka: Walking Robots with Flexible Spines." *Workshop on Autonomy for Future NASA Science Missions*, National Aeronautics and Space Administration, Oct. 2018.

8. **A.P. Sabelhaus**, A.K. Agogino, "Inverse Kinematics for Tensegrity Soft Robot Control: Existence and Optimality." *Soft Robotics Modeling and Control Workshop, IEEE/RSJ International Conference on Intelligent Robots and Systems*, Oct. 2018.
7. **A.P. Sabelhaus**, "Laika, The Four-Legged Robot with a Flexible Spine." *NASA Space Technology Day-On-The-Hill*, United States Congress / House of Representatives, Nov. 2017.
6. **A.P. Sabelhaus**, "Laika, The Quadruped Robot with a Flexible Spine." *Bay Area Robotics Symposium (BARS)*, Oct. 2017.
5. **A.P. Sabelhaus**, "Trajectory Tracking Control of a Flexible Spine Robot." *Workshop on Structurally Adaptive Tensegrity Robotics, 13th NASA/ESA Conference on Adaptive Hardware and Systems*, July 2017.
4. **A.P. Sabelhaus**, "UC Berkeley Robotics for Disaster Relief." *Field Innovation Team Bootcamp 5.0*, Mar. 2017.
3. **A.P. Sabelhaus**, "DNA-Structured Linear Actuators." *SKTA Innopartners IP Redux*, Apr. 2016.
2. **A.P. Sabelhaus**, "The ULTRA Spine Project." *Bay Area Robotics Symposium (BARS)*, Oct. 2015.
1. **A.P. Sabelhaus**, "Robotics, Mechatronics, and Intelligent Systems." *Osher Lifelong Learning Institute*, Feb. 2014.

## PROFESSIONAL ACTIVITIES

- **Editorial Work: Guest Editor**
  - *Frontiers in Robotics and AI: Special Topic on Materials, Design, Modeling and Control of Soft Robotic Artificial Muscles*. 2022
- **Reviewer for Journals and Conferences**
  - **Journals:** *Soft Robotics*, *IEEE Robotics and Automation Letters (RA-L)*, *IEEE Transactions on Control System Technology (T-CST)*, *Journal of Open-Source Software (JOSS)*, *IEEE Robotics and Automation Magazine*, *International Journal of Space Structures (IJSS)*.
  - **Conferences:** *IEEE International Conference on Robotics and Automation (ICRA)*, *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, *American Control Conference (ACC)*, *ASME International Design Engineering Technical Conference (IDETC)*, *IEEE Conference on Control Technology and Applications (CCTA)*.

## TEACHING + MENTORING

- **Mentorship of PhD students.** Boston University: 2 students. Diversity: 1/2 identify as minority or under-represented, 50%.
- **Mentorship of master's students.** UC Berkeley Master of Engineering (M.Eng): 15 students. Diversity: 8/15 identify as minority or under-represented, 53%.
- **Mentorship of undergraduate students.** UC Berkeley and Carnegie Mellon University, 19 students. Diversity: 13/19 identify as minority or under-represented, 68%.
- **Instructor / Assistant Professor.** Boston University.
  - Spring 2022 | Eng. 103, Computational Linear Algebra
- **Graduate Student Instructor (GSI).** University of California, Berkeley.
  - Spring 2018 | Mech. Eng. 135/235, Design of Microprocessor-Based Mechanical Systems
- **Outstanding Graduate Student Instructor (GSI) Award.** University of California, Berkeley, 2019

## DIVERSITY + OUTREACH\* + SERVICE

- **Faculty/Staff Advisor.** Out in Science, Technology, Engineering, and Mathematics (oSTEM)<sup>†</sup> at Carnegie Mellon University, 2020 - 2022.
- **ASME Diversity and Inclusion Strategic Committee (DISC), Advisor.** American Society of Mechanical Engineers (ASME). Revised ASME policy P-15.11, PS16-02, and Statement on Diversity and Inclusion to include protections for transgender ASME members. June 2016 - 2018.
- **ASEE LGBTQ Virtual Community of Practice, Member.** American Society for Engineering Education. 2018 - 2020.

- **Graduate Student Search Committee, Member.** UC Berkeley Mechanical Engineering Faculty Searches. 2017 - 2018.
- **Graduate Peer Advisor.** UC Berkeley Mechanical Engineering - Equity, Diversity, and Inclusion Initiative. 2014 - 2015.
- **Coordinator, Chapter Leadership Programs.** Out in Science, Technology, Engineering, and Mathematics<sup>†</sup> Incorporated. 2012 - 2013.
- **Single Outreach Events (Selected):**
  - LGBTQ Professionals in STEM Panel, Boston University, 2022: Panelist
  - NASA High School Camp at Carnegie Mellon University, 2021: Guest lecture
  - Carnegie Science Center Day, 2020: Organized table presentation
  - Cal Day, UC Berkeley, 2015-2019: Organized lab tours
  - Robot Block Party, Silicon Valley Robotics, 2015, 2017: Organized table presentation

<sup>†</sup> Out in Science, Technology, Engineering, and Mathematics (oSTEM) is a national organization for LGBTQ science and engineering students, [www.ostem.org](http://www.ostem.org)

## PROFESSIONAL DEVELOPMENT

- **Essentials of Effective Instruction.** American Society for Engineering Education (ASEE). Intensive course on active learning and theory of teaching and learning for new instructors. Sept. 2021.
- **Summer Institute for Preparing Future Faculty.** A professional development program to prepare students for academic careers. University of California, Berkeley. Completed / certified in June 2018.
- **Question, Persuade, Refer: Gatekeeper.** Trained for response to mental health crises in students. University of California Berkeley Health Center, March 2018.
- **Teaching of Mechanical Engineering at the University Level.** UC Berkeley Mechanical Engineering Department. Course on teaching pedagogy in engineering. Spring 2018.
- **Workshops on Teaching and Learning.** UC Berkeley GSI Teaching and Resource Center / Academic Innovation Studio. Attended workshops on teaching pedagogy, including 'How Students Learn' and 'Teaming With Diversity.' Fall 2017 - Spring 2018.
- **Teaching Conference for Graduate Student Instructors.** UC Berkeley GSI Teaching and Resource Center. Introductory pedagogy for first-time Graduate Student Instructors. Attended in Jan. 2018.