Dr. Elliot Wright Hawkes

Assistant Professor
University of California, Santa Barbara
ewhawkes@engineering.ucsb.edu

Education

Stanford University, Stanford, CA

Ph.D. in Mechanical Engineering with Prof. Mark Cutkosky (2015)
Thesis: "Applying Gecko Adhesives to the Real World."
M.S. in Mechanical Engineering, GPA: 4.07 (2011)

Harvard University, Cambridge, MA

A.B. in Mechanical Engineering, Highest Honors, GPA: 3.83, Concentration GPA: 3.88/4
Secondary in Organismic and Evolutionary Biology, Biomechanics (2009)
Thesis: "Paradigm for Building Multi-functional Composite Structures with Embedded Actuation."

Positions Held

Design, Robotics, Mechanics, and Materials Lab 07/16-present
University of California, Santa Barbara
Assistant Professor

Collaborative Haptics And Robotics in Medicine Laboratory, 07/15-7/16
Stanford University, with Prof. Allison Okamura
Postdoctoral Scholar
-Studying soft robotic technologies to understand factors governing performance.
-Applied understanding to create a pneumatic artificial muscle capable of 400% strain.
-Studying robotic devices capable of growth.

Biomimetic and Dextrous Manipulation Laboratory, 12/09-06/15
Stanford University, with Prof. Mark Cutkosky
PhD Candidate
-Investigated the factors that determine the performance of gecko-inspired adhesives.
-Studied gecko adhesive morphology with custom sensor.
-Proposed two fundamental factors for performance: 1) Full Contact and 2) Even Loading.
-Demonstrated importance of factors by creating successful designs:
a) ankle mechanism for loading adhesives that increases capabilities seven-fold.
b) surface grasping mechanism that allows autonomous quadrotor perching.
c) adhesive device that shows little drop-off in performance even at human scale.
d) curved surface gripper for *grasping without squeezing.*

e) world's smallest climbing robot.

f) climbing robot capable of hoisting 100x body weight.

-Led team on multi-year project culminating in demonstration of first human to climb glass using hand-sized area of gecko adhesives.

Romotive, Inc. 1/12-3/13

Design Consultant

-Designed robust mechanism for holding and tilting iPhone for mobile robot.

-Mechanism requirements: DFM injection molding and line assembly, 10,000 cycles minimum life, robust to 2m drop test, positive user experience.

Square One Robotics 7/12

Design Consultant

-Consulted on the design of robotic gripper for grasping rock with microspines.

Harvard Microrobotics Laboratory, 8/07-8/09

Harvard University, with Prof. Robert Wood

Undergraduate Research Assistant

-Investigated the factors determining movement performance of a smart composite material with embedded actuation

-Demonstrated understanding with:

a) device capable of folding into 3D shapes

b) millimeter-scale multi-segmented robotic swimmer

-Optimized Shape Memory Alloy springs for use as artificial muscles.

Multi-scale Robotics Laboratory, 6/08-8/08

Swiss Federal Institute of Technology, with Prof. Bradley Nelson

Herschel Smith Fellow

-Designed and fabricated actuated module for capsule-sized endoscopic microrobots as part of the Assembling Reconfigurable Endoluminal Surgical (ARES) system

-Established Smart Composite Microstructure manufacturing at Institute of Robotics and Intelligent Systems.

Quad Bikes, Non-Profit Community Bicycle Shop, Cambridge, MA 9/06-8/09

Mechanic

-Repaired, refurbished, and built bikes at a local shop, 10-12 hr/wk.

National High Magnetic Field Laboratory, 6/07-8/07

Florida State University, with Prof. Irinel Chiorescu

National Science Foundation Research Experience for Undergraduates

-Designed, drafted (with CAD), and had machined an interlocking sample holder for quantum chip experiments at 4mK and 10 Tesla.

Harvard Skeletal Biology Laboratory, 1/06-5/06

Harvard University, with Prof. Daniel Lieberman

Undergraduate Research Assistant

-Studied the function and activation of the gluteus maximus in trunk stabilization during running and jumping, running test with EKG, force sensors and rate gyros.

Awards and Honors

-Best Student Paper Award, IEEE ICRA 2015

-ASME Best Journal Paper Award in Bioinspired Systems and Materials 2015

-JRSI article Ranked by Altmetrics #1 of 952 articles from JRSI, top 5% of all time

-Co-author, Best Paper Award IEEE, IROS 2015

-Invited to exhibit work at TED2015

-Featured in Cosmos Magazine, Career Profile 2015

-Co-author Best Student Paper Award Finalist, IEEE ICRA 2014

-National Science Foundation Graduate Research Fellowship Program, 2012-2014

-National Defense Science and Engineering Graduate fellowship, 2009-2012

-Graduated with Highest Honors, Harvard School of Engineering and Applied Sciences, 2009

-Phi Beta Kappa, 2009

-Rhodes Scholarship Finalist, 2008

-Research Experience for Undergraduates recipient, Summer 2007- $3800
National Science Foundation

-Herschel Smith Undergraduate Research Program Award, Summer 2008- $6000
Herschel Smith Foundation, Harvard University

-First Place and new Harvard school record, Model Bridge Contest (5400lbs.), 2007
School of Engineering and Applied Sciences, Harvard University

-Harvard College Research Program Award, Summer 2007, Fall 2007, Fall 2008- $4800
Faculty of Arts and Sciences, Harvard University

Publications

Articles in Archival Journals (in Preparation)

1. **Hawkes, E.W.**, Christensen, D.L., Han, A.K., Jiang, H., and Cutkosky, M.R. “Grasping with Shear Adhesion.” In preparation (paper invited to IEEE Trans. Robotics).

2. **Hawkes, E.W.**, Christensen, D.L., Okamura, A.M. “400% Strain, Internally Powered Soft Artificial Muscle.” In preparation.

3. **Hawkes, E.W.**, Christensen, D.L., Suresh, A., and Cutkosky, M.R. “Spatially Variant Microstructures for Highly Anisotropic Adhesion.” In preparation.

4. **Hawkes, E.W.**, Okamura, A.M. “Locomotion by Growth.” In preparation (abstract reviewed, full submission requested by *Nature*).

5. Christensen, D.L, **Hawkes, E.W.**, Suresh, A., Lindheim, K. and Cutkosky, M.R. “Micro but Mighty: Microrobots Creating Macro Forces.” In preparation.

6. Pope, M., Kimes, C.W., Jiang, H., **Hawkes, E.W.**, Han, A.K., Christensen, D.L., and Cutkosky, M.R. “Robust Vertical Perching and Climbing Using Microspines.” In preparation.

Articles in Archival Journals (in Review or Published)

7. **Hawkes, E.W.**, Lentink, D. “Robots smaller than bumble bees can hover longer with flapping wings than with spinning wings.” *J. R. Soc. Interface* (2016): In review.

8. **Hawkes, E.W.**, Christensen, D.L., Pope, M., and Cutkosky, M.R. “One Motor, Two Degrees of Freedom through Dynamic Response Switching.” *IEEE Robotics and Automation Letters.* In Review.

9. Thomas, J., Loianno, G., Pope, M., **Hawkes, E.W.**, Estrada, M., Jiang, H., Cutkosky, M.R., and Kumar, V. “Aggressive Flight for Perching on Inclined Surfaces.” *ASME J. Mechanisms and Robotics*. In press.

10. **Hawkes, E.W.,** Jiang, H., and Cutkosky, M.R. “Three Dimensional Dynamic Surface Grasping with Dry Adhesion.” *Int. J. Robotics Research*. (2015): 0278364915584645.

11. Eason, E.V., **Hawkes, E.W.**, Windheim, M., Christensen, D.L., Libby, T. and Cutkosky, M.R., "Stress distribution and contact area measurements of a gecko toe using a high-resolution tactile sensor," *Bioinsipration & Biomimetics.* 10, no. 1 (2015): 016013.

12. Suresh, A., Christensen, D.L., **Hawkes, E.W.**, and Cutksoky, M.R. “Surface and Shape Deposition Manufacturing for the Fabrication of a Curved Surface Gripper.” *ASME J. Mechanisms and Robotics*. 7, no. 2 (2015): 021005.

13. **Hawkes, E.W.,** Eason, E.V., Christensen, D.L., and Cutkosky, M.R. “Human Climbing with Efficiently Scaled Gecko-inspired Dry Adhesives.” *J. R. Soc. Interface* (2014): 201512 20140675. **ASME Best Journal Paper Award in Bioinspired Systems and Materials.**

14. Pope, M., Lussier Desbiens, A., **Hawkes, E.W.**, Christensen, D., and Cutkosky, M.R. “Design Principles for Efficient, Repeated Jumpgliding." *J. Bioinspiration and Biomimetics*, 9, no. 2 (2014): 025009.

15. **Hawkes, E.W.,** Eason, E., Asbeck, A., and Cutkosky, M.R. "The Gecko's Toe: Scaling Dry Adhesives for Climbing Applications." *IEEE Trans. Mechatronics,* 18, no. 2 (2013): 518-526.

16. Stirling, L., Yu, C., **Hawkes, E.W.**, Miller, J., Wood, R.J., Goldfield, E., and Nagpal, R. “Applicability of shape memory alloy wire for an active, soft orthotic.” *J. Mater. Eng. Perform.,* 20.4 (2011) : 658–662.

17. Paik, J. K., **Hawkes, E.W.**, and Wood, R.J. “A novel low-profile shape memory alloy torsional actuator.” *Smart Materials and Structures* 19.12 (2010) : 125014.

18. **Hawkes, E.W.**, An, B., Benbernou, N., Tanaka, H., Kim, S., Demaine, E., Rus, D., and Wood, R. J. “Programmable matter by folding.” *Proc. Nat. Acad. Sci.,* 107.28 (2009): 12441-12445. **Over 200 Citations.**

19. Nagy, Z., Harada, K., Fluckiger, M., Susilo, E., Kaliakatsos, I.K., Menciassi, A., **Hawkes, E.W.**, Abbott, J.J., Dario, P., and Nelson, B.J. "Assembling Reconfigurable Endoluminal Surgical Systems: Opportunities and Challenges," *Int'l J. Biomechatronics and Biomedical Robotics (IJBBR),* 1.1 (2008): 3.

Refereed Conference Articles (in Review or Published)

20. **Hawkes, E.W.**, Christensen, D.L., and Okamura, A.M. "Design and Implementation of a 300% Strain Soft Artificial Muscle." 2016 *IEEE Int'l. Conf. Robotics and Automation.* In review.

21. Estrada, M., Hockman, B., Bylard, A., **Hawkes, E.W.**, Cutkosky, M.R., and Pavone, M. "Free-Flyer Acquisition of Spinning Objects with Gecko-Inspired Adhesives." 2016 *IEEE Int'l Conf. Robotics and Automation.* In review.

22. Wu, X.A., Suresh, A.S., Jiang, H., Ulmen, J., **Hawkes, E.W.**, Christensen, D.L., and Cutkosky, M.R. "Tactile Sensing for Gecko-Inspired Adhesion." *IEEE Int. Conf. Intelligent Robotics and Automation,* (2015). **Best Paper Award.**

23. Jiang, H., Pope, M., Estrada, M., Edwards, B., Cuson, M., **Hawkes, E.W.**, and Cutkosky, M.R. "Perching Failure Detection and Recovery with Onboard Sensing," *Int. Conf. Intelligent Robots and Systems,* (2015).

24. **Hawkes, E.W.**, Christensen, D.L., Han, A.K., Jiang, H., and Cutkosky, M.R. "Grasping without Squeezing: Shear Adhesion Gripper with Fibrillar Thin Film," *IEEE Int'l. Conf. Robotics and Automation*, (2015). **Best Student Paper Award.**

25. **Hawkes, E.W.**, Christensen, D.L., and Cutkosky, M.R. "Vertical Dry Adhesive Climbing with a 100x Bodyweight Payload," *IEEE Int'l. Conf. Robotics and Automation*, (2015).

26. Jiang, H., **Hawkes, E.W.**, et al. "Scaling Controllable Adhesives to Grapple Floating Objects in Space," *IEEE Int'l. Conf. Robot. and Automation*, (2015).

27. Christensen, D.L, **Hawkes, E.W.**, and Cutkosky, M.R. "Tugs: Enabling Microrobots to Deliver Macro Forces with Controllable Adhesives," *IEEE Int'l. Conf. Robotics and Automation*, (2015).

28. Thomas, J., Loianno, G., Pope, M., **Hawkes, E.W.**, Estrada, M., Jiang, H., Cutkosky, M.R., and Kumar, V. "Planning and Control of Aggressive Maneuvers for Perching on Inclined or Vertical Surfaces." *ASME IDETC, (*2015): 025010.

29. Estrada, M., **Hawkes, E.W.**, Christensen, D., and Cutkosky, M.R. "Robust Landing, Perching and Vertical Climbing: Design of a Multimodal Robot," *IEEE Int'l. Conf. Robotics and Automation*, (2014): 4215-4221. **Best Student Paper Finalist.**

30. Winck, R. C., Sketch, S. M., **Hawkes, E. W.**, Christensen, D. L., Jiang, H., Cutkosky, M. R., and Okamura, A. M. "Time-delayed teleoperation for interaction with moving objects in space." *IEEE Int'l. Conf. Robotics and Automation*, (2014): 5952-5958.

31. Eason, E. V., **Hawkes, E. W.**, Windheim, M., Christensen, D. L., Libby, T., and Cutkosky, M. R. "Adhesive Stress Distribution Measurement on a Gecko." *In Biomimetic and Biohybrid Systems, Living Machines Conf.* (2014): 386-388.

32. Jiang, H., Pope, M., **Hawkes, E.W.**, Christensen, D., Estrada, M., and Cutkosky, M.R. "Modeling the Dynamics of Perching with Opposed-Grip Mechanisms," *IEEE Int'l. Conf. Robotics and Automation*, (2014): 3102-3108.

33. Seitz, B., Goldberg, B.,Doshi, N., Ozcan, O., Christensen, D., **Hawkes, E.W.**, Cutkosky, M., and Wood, R.J. "Bio-inspired mechanisms for inclined locomotion in a legged insect-scale robot," *ROBIO,* (2014): 791-796.

34. Hawkes, E.W., et al. "Dynamic surface grasping with directional adhesion," *Int. Conf. Intelligent Robots and Systems,* (2015): 5487-5493.

35. Christensen, D.L, Hawkes, E.W., Wong-Foy, A., Pelrine, R.E., and Cutkosky, M.R., "Incremental Inspection for Microrobotic Quality Assurance," Proc. ASME 2013 IDETC/CIE, (2013): V001T09A030.

36. Hawkes, E.W., Ulmen, J., Esparza, N., and Cutkosky, M.R. "Scaling Walls: Applying Dry Adhesives to the Real World." *Proc. of the IEEE Int. Conf. on Intelligent Robots and Systems*, (2011): 5100-5106.

37. Kim, S., Hawkes, E.W., Cho, K., Joldaz, M., Foley, J., and Wood, R.J. "Micro artificial muscle fiber using niti spring for soft robotics," *Proc. of the IEEE Int. Conf. on Intelligent Robots and Systems*, (2009): 2228-34.

38. Cho, K., Hawkes, E.W., Quinn, C., and Wood, R.J. "Design, fabrication and analysis of a body-caudal fin propulsion system for a microrobotic fish," *IEEE Int'l. Conf. Robotics and Automation*, (2008): 706-11.

Theses

-Stanford University, Department of Mechanical Engineering: PhD Thesis: "Applying Dry Adhesives to the Real World," 2015.

-Harvard University, School of Engineering and Applied Sciences: Mechanical Engineering Highest Honors Undergraduate Thesis: "Paradigm for Building Multi-functional Composite Structures with Embedded Actuation," 2009.

Patents

1. Hawkes, E.W., Okamura, A.M. "300% strain inverse pneumatic artificial muscle (IPAM)," 2016. (Stanford Disclosure S15-364).

2. Hawkes, E.W., Okamura, A.M. "Robotic device capable of growth," 2016. (Prov. Appl. No. 62/304980).

3. Hawkes, E.W., Christensen, D.L, and Cutkosky, M.R. "Controllable Adhesive on Conformable Film for Non-flat surface," 2015. (U.S. Appl. No.: 14/993332).

4. Hawkes, E.W., Eason, E.V., Christensen, D.L, and Cutkosky, M.R. "Climbing Device with Dry Adhesives," 2015. (PCT. Appl. No.: PCT/US2015/027729).

5. Christensen, D.L, Hawkes, E.W., and Cutkosky, M.R. "Enhancing ground reaction forces substantially beyond friction using dry adhesives," 2015 (U.S. Appl. No.: 14/952228).

6. Hawkes, E.W., Christensen, D.L, and Cutkosky, M.R. "One Degree of Freedom Climbing Robot with Anisotropic Directional Dry Adhesion," 2015. (U.S. Appl. No.: 14/926728).

7. Hawkes, E.W., Jiang, H., and Cutksoky, M.R. "Surface grasping mechanism using directional adhesives," 2014. (PCT. Appl. No.: PCT/US2015/031748).

8. Hawkes, E.W., Pope, M., Christensen, D.L., and Cutkosky, M.R. "Velocity-dependent magnetic averaging for one-way clutch," 2014. (U.S. Appl. No. 61/924,140).

9. Hawkes, E.W., Choi, K.J., Wood, R.J. "Multi-segmented spine with integrated actuation," 2009. U.S. Patent No. 12/784,899, US20100295417A1.

Grants (helped write or provided content)

-NASA “Astrobee,” $500,000, under Prof. Cutkosky, 2016

-NSF CHS “Soft User Interfaces,” $1.2 million, PI: Prof. A. Okamura, In Review

-Ford-Stanford Alliance “Gecko Gripper,” $250,000, PI: Prof. M. Cutkosky, 2015

-NSF NRI “Robosimian on Rough Terrain,” $1.5 million, PI: Prof. K. Hauser, 2015

-NASA JPL “CIF FY16 Advanced Concept,” $200,000, PI: Dr. A Parness, 2015

-DARPA “Z-Man,” Phase IIIb, $500,000, PI: Prof. M. Cutkosky, 2013

-NASA DRDF “ON-OFF Gecko Adhesion,” $200,000, PI: Dr. A. Parness, 2012

-DARPA “Programmable Matter,” Phase II, $1 million, PI: Prof. R. Wood, 2009

Teaching

-Guest lecturer for ME 161/261: Control, Vibration, and Design of Dynamic Systems, 2015
-Guest lecturer for ME 310: Design Innovation; Lecture on The Art of Iteration in Design, 2015
-Taught Stanford Cycling Safety and Skills Clinic, 2012-2015
-Mentored Stanford Undergraduate Research Institute Fellows, 2012-2015
-Mentored younger PhD students, resulting in 16 papers as co-author, 2012-2015
-Taught Stanford Cycling 301: Bicycle Fit, Maintenance, and Safety, 2014
-TA for both undergraduate and graduate levels, ME 161/261: Control, Vibration, and Design of Dynamic Systems, 2014
-Recognized as Outstanding TA by members of ME 161/261, 2014

Presentations

-“Soft Robotics,” SCU Physics Colloquim 2016, Santa Clara University
-“Mechanics, Design, and Materials for Soft Robotics,” BiD Seminar 2016, UC Berkeley
-“Gecko Adhesion,” Exhibited work by invitation at TED2015, Vancouver, CA
-“Grasping without Squeezing,” ICRA 2015, Seattle, WA
-“Climbing with 100x Body Weights,” ICRA 2015, Seattle, WA
-“Applying Gecko Adhesives,” PhD Defense 2015, Stanford, CA
-“Human Climbing with Gecko Adhesives,” ThinkTech Hawaii, 2014
-“Rock Climbing with Spines,” ARAVIS AG Venture Capital 2014, Stanford, CA
-“Dynamic Surface Grasping,” IROS 2013, Tokyo, Japan
-“Scaling Walls,” IROS 2011, San Francisco, CA
-“Adaptable,” EXPE 2010, Stanford, CA
-“Telepresentation,” SAP Headquarters 2009, Berlin, Germany
-“Microrobotic Swimmers,” Rhodes Scholar Presentation 2008, Birmingham, AL
-“Sample Holder for Quantum Chip Experiments,” REU Presentations 2007, Tallahassee, FL

Press for Research

Perching MAV

-New York Times: *What You Get When You Blend a Drone and a Gecko*

Microrobots

-NBC News: *Tiny Gecko-Inspired Robots Carry Loads Over 100 Times Their Weight*
-Huffington Post: *Tiny Robots Use Gecko Power To Carry Heavy Weights*
-CNN Money: *These tiny robots have superhuman strength*
-Forbes: *These Micro Robots Can Haul 2,000 Times Their Weight*

Human Climbing Project

-Science Magazine News: *Gecko inspired adhesives allow people to climb walls*
-The Guardian: *Geckos inspire scientists in US military-developed Spider-Man suit project*
-Cell: *Building a Superhero*
-Newsweek: *Gecko gloves let scientist climb sheer glass walls*
-Popular Mechanics: *Scientists have created gecko-inspired spider man gloves*
-Stanford News: *Stanford engineers climb walls using gecko-inspired climbing device*
-Huffington Post: *Scientists Figure Out How To Scale Walls Like Spider-Man*
-Washington Post: *Inspired by geckos (and possibly 'Mission Impossible'), researchers unveil adhesives that allow humans to scale walls*
-BBC News: *Geckos inspire 'Spider-Man' gloves*
-Fox News: *Gecko-inspired adhesive enables people to scale buildings*
-MIT TechReview: *An Artificial Adhesive Outgrips the Gecko*
-Boston Globe: *A new invention that helps you climb like a gecko*
-San Jose Mercury News: (Front page in print) *Stanford 'lizard brains' create gecko-like paws that allow humans to scale glass walls*
-New York Times: *Climbing a Glass Building? Try a Gecko's Sticky Pads*

Personal

-Category 1 sponsored competitive cyclist with multiple podiums at National Championships
-Enjoy guitar, bonsai, yoga, hiking, and building gifts for loved ones