

SAWYER BUCKMINSTER FULLER

Curriculum Vitæ

Assistant Professor, Department of Mechanical Engineering

University of Washington

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EDUCATIONAL HISTORY

California Institute of Technology, Pasadena, California

Ph. D., Bioengineering

Minors: Control and Dynamical Systems, Electrical Engineering

June, 2011

Steady as she goes: Visual autocorrelators and antenna-mediated airspeed feedback in the control of flight dynamics in fruit flies and robots

Massachusetts Institute of Technology, Cambridge, Massachusetts

M.S., Mechanical Engineering

June 2004

A fast flexible ink-jet printing method for patterning networks of neurons in culture

Massachusetts Institute of Technology, Cambridge, Massachusetts

B.S., Mechanical Engineering

June 2000

Ink jet deposition of inorganic nanoparticle materials as a route to desktop fabrication of integrated logic and micromachinery

EMPLOYMENT HISTORY

University of Washington

Seattle, WA, USA

Assistant Professor, 2015—present

Harvard University

Cambridge, Massachusetts, USA

Postdoctoral Scholar, 2011—2015

California Institute of Technology

Pasadena, California, USA

Postdoctoral Scholar, 2011

University of Verona

Verona, Italy

Research Assistant, 2003—2004

NASA Jet Propulsion Laboratory
Pasadena, California, USA
Intern, 2000—2001

AWARDS AND HONORS

Bioengineering Graduate Fellowship, 2004, California Institute of Technology
National Science Foundation Fellowship, 2002
Presidential Fellowship, 2001, Massachusetts Institute of Technology
NASA Technical Award, 2001
Silent Hoist & Crane Award for Outstanding Undergraduate Thesis, Massachusetts Institute of Technology, 2000

AFFILIATIONS AND OTHER APPOINTMENTS

PUBLICATIONS

Refereed archival journal publications (citation counts from Google Scholar)

1. **S. B. Fuller**, Z. E. Teoh, P. Chirarattananon, N. O. Pérez-Arancibia, J. Greenberg, and R. J. Wood. “Stabilizing air dampers for hovering aerial robotics: design, insect-scale flight tests, and scaling,” *Autonomous Robots* (January 2017). **(1)**
2. M. A. Graule, P. Chirarattananon, **S. B. Fuller**, N. T. Jafferis, K. Y. Ma, M. Spenko, R. Kornbluh, and R. J. Wood, “Perching and takeoff of a robotic insect on natural and artificial overhangs using switchable electrostatic adhesion,” *Science* (2016), Vol. 352, No. 6288, pp. 978-982. **(12)**
3. **S. B. Fuller**, A. D. Straw, M. Peek, R. M. Murray, and M. H. Dickinson, “Flying *Drosophila* stabilize their vision-based velocity controller by sensing wind with their antennae,” *Proc. Nat. Acad. Sci.* (2014) Vol. 111., No. 13, pp. E1182-1191. **(42, top 10% Altmetric Attention Score for same-age articles in PNAS)**
4. **S. B. Fuller**, M. Karpelson, A. Censi, K. Y. Ma, and R. J. Wood, “Controlling free flight of a robotic fly using an onboard vision sensor inspired by insect ocelli,” *J. Royal Society Interface* (2014) Vol. 11, No. 97. **(47)**
5. K. Y. Ma, P. Chirarattananon, **S. B. Fuller**, and R. J. Wood, “Controlled flight of a biologically-inspired, insect-scale robot,” *Science* (2013) Vol. 340, No. 6132, pp. 603-607. **(295, top 2% Altmetric Attention Score for same-age articles in Science)**
6. N. E. Sanjana and **S. B. Fuller**, “A Fast flexible ink-jet printing method for patterning dissociated neurons in culture,” *J. Neuroscience Methods* (2004) Vol. 136, pp. 151-163. **(203)**
7. **S. B. Fuller**, E. J. Wilhelm, and J. M. Jacobson. “Ink-jet printed nanoparticle micro-electromechanical systems,” *IEEE/ASME J. Micro-electromechanical Systems* (2002) Vol. 11, No. 1, pp. 54–60. **(610)**

Book Chapters

1. E. F. Helbling, **S. B. Fuller**, and R. J. Wood. Altitude Estimation and Control of an Insect-Scale Robot with an Onboard Proximity Sensor. In: A. Bicchi and W. Burgard (Eds.) *Robotics Research*. Springer Proceedings in Advanced Robotics, Springer, Cham (2018) Vol. 2.

Refereed conference proceedings and other non-journal articles

1. J. James, V. Ayer, Y. Chukewad, S. Gollakota, and **S. B. Fuller**, “The first untethered flights of an insect-scale 200 mg robot,” *IEEE Int. Conf. Robotics and Automation (ICRA)* (Brisbane, Australia, 2018) (under review)
2. S. Balasubramanian, Y. Chukewad, J. James, G. Barrows, and **S. B. Fuller**, “Motion control on an insect-scale robot using an onboard camera,” *IEEE Int. Conf. Robotics and Automation (ICRA)* (Brisbane, Australia, 2018) (under review)
3. Y. Chukewad, A. Singh, and **S. B. Fuller**, “A robot fly composed of actuator units folded from a single laminate sheet, capable of ground locomotion, takeoff and landing,” *IEEE Int. Conf. Robotics and Automation (ICRA)* (Brisbane, Australia, 2018) (under review).
4. T. S. Clawson, **S. B. Fuller**, S. Ferrari, “Robust Hovering Control for Flapping Insect-scale Robots,” *IEEE Int. Symp. Series Computational Intelligence (SSCI)* (Honolulu, HI, November 2017).
5. Y. Chen, **S. F. Fuller**, and K. Dantu, “Quadrobee: Simulating flapping wing aerial vehicle dynamics on a Quadrotor”, *Int. Conf. Intelligent Robots and Systems (IROS)* (2017, Vancouver Canada)
6. T. S. Clawson, **S. B. Fuller**, S. Ferrari, and R. J. Wood, “A blade element approach to modeling aerodynamic flight of an insect-scale robot,” *American Control Conference (ACC)* (Seattle, WA, May 2017).
7. T. S. Clawson, S. Ferrari, **S. B. Fuller**, and R. J. Wood, “Spiking neural network (SNN) control control of a flapping insect-scale robot,” *Int. Conf. on Decision and Control (CDC)* (Las Vegas, NV, December 2016).
8. **S. B. Fuller**, J. P. Whitney, and R. J. Wood, “Rotating the heading angle of flapping-wing flyers by wriggle-steering,” *IEEE/RSJ Int. Conf. Intelligent Robots and Systems (IROS)* (Hamburg, Germany, September 2015).
9. E. F. Helbling, **S. B. Fuller**, and R. J. Wood, “Altitude Estimation and Control of an Insect-Scale Robot with an Onboard Proximity Sensor,” *Int. Symp. on Robotics Res. (ISRR)* (Sestri Levante, Italy, September 2015)
10. D. Miller, I. Fitzner, **S. B. Fuller**, and S. Revzen, “Focused Modularity: Rapid Iteration of Design and Fabrication of a Meter-Scale Hexapedal Robot,” *Int. Conf. Climbing and Walking Robots (CLAWAR)* (Hangzhou, China, September 2015).
11. **S. B. Fuller** & E. F. Helbling, P. Chirarattananon, and R. J. Wood, “Using gyroscope feedback to stabilize the attitude of a fly-sized hovering robot,” *Int. Conf. Micro Air Vehicles (IMAV)* (Delft, the Netherlands, August 2014). **(11)**
12. E. F. Helbling, **S. B. Fuller**, and R. J. Wood, “Pitch and yaw control of a robotic insect using an onboard magnetometer,” *IEEE Int. Conf. on Robotics and Automation (ICRA)* (Hong Kong, May 2014). **(8)**
13. **S. B. Fuller**, A. Sands, A. Haggerty, M. Karpelson, R. J. Wood, “Estimating attitude and wind velocity using biomimetic sensors on a microrobotic bee,” *IEEE Int. Conf. Robotics and Automation (ICRA)* (Karlsruhe, Germany, May 2013). **(6)**
14. Z. E. Teoh, **S. B. Fuller**, P. Chirarattananon, N. O. Perez-Arancibia, J. Greenberg, and R. J. Wood, “A Hovering flapping-wing microrobot with altitude control and passive upright stability,” *IEEE/RSJ Int. Conf. Intelligent Robots and Systems (IROS)* (Algarve, Portugal, October 2012). **(26)**

15. **S. B. Fuller** and R. M. Murray, "An insect-inspired autocorrelation model for visual flight control in a corridor," *IEEE Int. Conf. on Robotics and Biomimetics (ROBIO)* (Phuket, Thailand, December 2011). **(9)**
16. A. Censi, S. Han, **S. B. Fuller**, and R. Murray, "A bio-plausible method for attitude stabilization," *IEEE Int. Conf. on Decision and Control (CDC)* (Shanghai, China, January 2010). **(16)**
17. M. Epstein, S. Waydo, **S. B. Fuller**, A. D. Straw, W. Dickson, M. H. Dickinson, and R. M. Murray, "Biologically inspired feedback for *Drosophila* flight," *American Control Conf. (ACC)* (New York, NY, June 2007). **(25)**
18. S. Schell, A. Tretten, J. Burdick, **S. B. Fuller**, and P. Fiorini, "Hopper on wheels: evolving the hopping robot concept," *IEEE Int. Conf. on Field and Service Robotics (FSR)* (Helsinki, Finland, June 2001). **(10)**
19. **S. B. Fuller** and J. M. Jacobson, "Ink jet fabricated nanoparticle MEMS," *IEEE Int. Conf. on Microelectromechanical Systems (MEMS)* (Miyazaki, Japan, January 2000). **(16)**

Patents submitted and/or awarded

1. J. M. Jacobson, B. N. Hubert, B. Ridley, B. Nivi, and **S. B. Fuller**, "Nanoparticle-based electrical, chemical, and mechanical structures and methods of making same," U.S. Patent 6,294,401 (Sept. 25, 2001).

Abstracts, letters, non-refereed papers, technical reports

Abstracts

1. A. T. Sing, Y. M. Chukewad, and **S. B. Fuller**, "A robot fly design with a low center of gravity folded from a single laminate sheet," *Workshop on Foldable Robotics, IEEE Int. Conf. Intelligent Robots and Systems (IROS)* (Vancouver, Canada, 2017).
2. M. Anderson, J. Sullivan, **S. B. Fuller**, Jeff Riffell, Kevin Brink, Jennifer Talley, Matt Reynolds, and Tom Daniel "The Smellicopter: Odor Localization on a Micro Air Vehicle using Bioinspired Control and Hybrid Biological/Synthetic Integrated Sensors," in *Workshop on Robotics-inspired Biology, IEEE/RSJ Int. Conf. Intelligent Robots and Systems (IROS)* (Vancouver, Canada, 2017).
3. **S. B. Fuller**, "Visual motion control in flies and fly-sized robots," *Northeast Robotics Colloquium* (Cambridge, MA, 2013).
4. Z. E. Teoh, **S. B. Fuller**, A. Baisch, and R. J. Wood, "Pop-up book MEMS assembly of complex microrobots," *Workshop on Meso-scale manufacturing, IEEE Int. Conf. Robotics and Automation (ICRA)* (Karlsruhe, Germany, 2013).
5. **S. B. Fuller**, A. D. Straw, R. M. Murray, and M. H. Dickinson, "Do flies use correlators to measure forward velocity?" in *Conf.: Visual Processing in Insects: from Anatomy to Behavior II*. (Howard Hughes Medical Institute Janelia Farm Research Campus, Ashburn, VA, May 2009).
6. **S. B. Fuller** and R. M. Murray, "A geometric analysis of Hassenstein-Reichardt correlators," *Workshop on visual guidance systems for small autonomous aerial vehicles, IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)* (Nice, France, 2008).
7. **S. B. Fuller**, A. D. Straw, M. Epstein, S. Waydo, W. B. Dickson, M. H. Dickinson, and R. M. Murray, "Geometric analysis of Hassenstein-Reichardt elementary motion

detectors and application to control in a fruit fly simulator and a robot,” *Int. Symp. Flying Insects and Robotics (FIR)* (Ascona, Switzerland, 2007).

Non-refereed papers

1. **S. B. Fuller**, M. Epstein, S. Waydo, W. B. Dickson, A. D. Straw, M. H. Dickinson, R. M. Murray, “Flight control in a flapping-wing fruit fly simulator,” *The Neuromorphic Engineer* (2007).

Technical Reports

1. A. Censi, E. Frazzoli, and **S. B. Fuller**, “On the optimal codesign of vehicle sensing and actuation,” *Technical Report* (2014).

Other significant research dissemination (web sites, software, Wikis, etc.)

OTHER SCHOLARLY ACTIVITY

Invited lectures and seminars.

1. Workshop on Planning Legged and Aerial Locomotion with Dynamic Motion Primitives, *IEEE Int. Conf. Intelligent Robots and Systems* (September 2017)
2. Workshop on Robotics Inspired Biology, *IEEE Int. Conf. Intelligent Robots and Systems* (September 2017)
3. University of Washington Mechanical Engineering Colloquium May 2017
Selected by popular vote by UW Mech. Eng. Faculty.
4. University of Washington Biology Colloquium: *Aerial Autonomy at Insect scale: What can biology teach us about robotics and vice versa?* October 2016
5. University of Washington Electrical Engineering Colloquium: *Aerial Autonomy at Insect scale: What can biology teach us about robotics and vice versa?* April 2016
6. University of Washington Computer Science Robotics Colloquium Seminar: *Aerial Autonomy at Insect scale: What can biology teach us about robotics and vice versa?* October 2015
7. Stanford University Aeronautics and Astronautics Seminar, *Aerial Autonomy at Insect scale: What can biology teach us about robotics and vice versa?* April 2015
8. Columbia University Mechanical Engineering Seminar, *Aerial Autonomy at Insect scale: What can biology teach us about robotics and vice versa?* March 2015
9. MIT Enterprise Forum, *Outperforming the fly: bio-inspired solutions to small-scale flight*, May 2014
10. “Outperforming the fly: bio-inspired solutions to small-scale flight” *International Micro Aerial Vehicle Conference*, Technical University of Delft, Delft, The Netherlands, August 2014.
Opening Plenary Speaker
11. US Army Research Laboratory, *Feedback control strategies inspired by the fly*, March 2011

Presentations given at conferences.

Professional society memberships.

Member, IEEE

Other

Reviewer, *Bioinspiration and Biomimetics* (2 articles, last on 2/16)

Reviewer, *IEEE Conferences*, (6 articles, last on 3/17)

Reviewer, *Proceedings of the IEEE* (1 article, 1/14)

Reviewer, *J Royal Society Interface* (3 articles, last on 7/16)

Reviewer, *Scientific Advances* (1 article, 9/16)

Reviewer, *Sensors & Actuators A* (1 article, 1/17)

Reviewer, *Robots and Autonomous Systems* (1 article, 5/17)

GRADUATE STUDENTS

Current Doctoral Students

- Johannes James (chair), June 2016 - present
- Yogesh Chukewad (chair), August 2016 - present
- Melanie Anderson (co-chair, with Tom Daniel, Dept. of Biology), September 2016 – present
- Riccy Kurniawan (chair) March 2017--present

Other significant student supervision

Committee member

- Dr. Mark A. Jankauski (Chair: Steve Shen, Defended March 2017)
- Dr. Kevin Kadooka (Chair: Minoru Taya, Defended March 2017)

Graduate School Representative

- Dr. Sweta Agarawal (Chair: Michael Dickinson, Defended November 2015)
- Dr. Joshua Ensworth (Chair: Matt Reynolds, Defended January 2017)
- Xingyi Shi (Chair: Josh Smith)

Independent Study

List of other teaching contributions

Guest lecture, ME598 – Biomechanics Seminar, *Wind sensing and flight stability: new insights from tracking freely-flying flies in gusts of wind*, April 2016

Guest lecture, ME599 Advanced Robotics – *Biology-inspired approaches to robotics*, December 2016

Other supporting documents

Teaching Awards, Nominations for Teaching Awards

SERVICE

Departmental service

Ph.D. Qualifications examiner, Systems & Dynamics area, May 2016

College service

University service

Faculty advisor, Husky Robotics club (~70 student members)

Professional society and other service

Faculty mentor for two undergraduate students under STARS (Washington State Academic RedShirt) program aimed at giving academically talented but underprepared students, particularly from underrepresented minority groups, academic support.

Community service

Speaker – ENGR 598: Preparing for Academic Careers in Engineering. Nov 10, 2015 (UW Seattle)

International, national or governmental service

Reviewer – Israel Science Foundation (most recent 4/2017)

All other service