

Ronald S. Fearing
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Research Objectives

Biomimetic microrobotics including flying and crawling microrobots, assembly microrobots, millirobot rapid prototyping, and gecko-inspired surface gripping.

Experience

Professor, Dept. of EE&CS, UC Berkeley, (7/00-present).

Vice Chair for Undergraduate Matters, (7/00-6/06).

Associate Professor, Dept. of EE&CS, UC Berkeley, (7/93-6/00).

Visiting Associate Professor, Nagoya University, Nagoya, Japan, (9/91-11/91).

Assistant Professor, Dept. of EE&CS, UC Berkeley, (1/88 - 6/93).

Research Assistant, Dept. of Electrical Engineering, Stanford University, (9/83-12/87).

Interpretation of contact geometry from tactile strain measurements, object pose determination using weak models, and implementation and analysis of a cylindrical tactile sensing array for a dextrous hand. Also developed NYMPH multiprocessor system which used 7 real time computers for dextrous hand servoing and tactile processing. Implemented part reorientation “twirling” using Stanford/JPL hand.

Co-op student, General Electric Corporate Research and Development, Schenectady NY, (1981-1983). Analyzed grasping and tactile mechanics, worked on tactile sensor development, pneumatic finger, and a distributed sensor and control network for homes.

Education

Ph.D. in Electrical Engineering, Stanford University (9/83 - 12/87).

Thesis title “Tactile Sensing, Perception, and Shape Interpretation”, advisor Prof. Thomas O. Binford.

S.B. and S.M. in EE&CS, M.I.T., (9/79 - 9/83).

Thesis title “Touch Processing for Determining a Stable Grasp”, advisor Prof. John M. Hollerbach.

Honors and Awards

NSF Presidential Young Investigator, 1991.

Third Place, Second International Microrobot Mountain Climbing Contest, Nagoya, Japan, October 9, 1991.

Best paper award:

E.J. Nicolson and R.S. Fearing, “Dynamic Modelling of a Part Mating Problem: Threaded Fastener Insertion”, *IEEE Workshop on Intelligent Robots and Systems*, Osaka, Japan, Nov. 3-5, 1991.

Finalist for best student paper award:

M.D. Berkemeier and R.S. Fearing, “Control of a Two-Link Robot to Achieve Sliding and Hopping Gaits”, *IEEE Int. Conf. on Robotics and Automation*, Nice France, May, 1992.

Finalist for best paper award:

R.S. Fearing, K.H. Chiang, M. Dickinson, D.L. Pick, M. Sitti, and J. Yan, "Wing Transmission for a Micromechanical Flying Insect",
IEEE Int. Conf. on Robotics and Automation, San Francisco, April 24-27, 2000.

Best Conference Video Award:

Joe Yan, et al "The Micromechanical Flying Insect" video presentation:
IEEE Int. Conf. on Robotics and Automation, Washington, DC May 11-15, 2002.

Journal Papers

- J1. S. Baek and R. S. Fearing, "Reducing Contact Resistance Using Compliant Nickel Nanowire Arrays," *IEEE Trans. on Components and Packaging Technology*, vol. 31, no. 4, pp. 859-868, Dec. 2008. 2009.
- J2. J. Lee, R. S. Fearing, K. Komvopolous, "Directional adhesion of gecko-inspired angled microfiber arrays," *Appl. Phys. Lett.* 93, 191910 (2008); DOI:10.1063/1.3006334
- J3. J. Lee and R.S. Fearing, "Contact Self-cleaning Synthetic Gecko Adhesive from Polymer Nanofibers," *Langmuir*, 10 Sep. 2008, doi:10.102/la8021485.
- J4. R.J. Wood, S. Avadhanula, R. Sahai, E. Steltz, R.S. Fearing, "Microrobot design using fiber reinforced composites," *ASME Journal of Mechanical Design*, vol. 130, no. 5, 2008. <http://link.aip.org/link/?JMD/130/052304>
- J5. C. Majidi and R. Fearing, "Adhesion of an elastic plate to a sphere," *Proc. Royal Society, A*, doi:10.1098/rspa.2007.0341, Feb. 2008.
- J6. J. Lee, C. Majidi, B. Schubert, R.S. Fearing Sliding induced adhesion of stiff polymer microfiber arrays: 1. Macroscale behaviour, *Journal Royal Society, Interface*, Jan. 22, 2008. 10.1098/rsif.2007.1308
- J7. B. Schubert, J. Lee, C. Majidi, R.S. Fearing, Sliding induced adhesion of stiff polymer microfiber arrays: 2. Microscale behaviour, *Journal Royal Society, Interface*, Jan. 22, 2008. 10.1098/rsif.2007.1309
- J8. B. Schubert, C. Majidi, R. E. Groff, S. Baek, B. Bush, R. Maboudian, R.S. Fearing, "Towards friction and adhesion from high modulus microfiber arrays," *Journal of Adhesion Science and Technology*, 21(12-13), pp. 1297-1315 (2007).
- J9. R.J. Wood, S. Avadhanula, E. Steltz, M. Seeman, J. Entwistle, A. Bachrach, G. Barrows, S. Sanders, and R.S. Fearing, "An Autonomous Palm-Sized Gliding Micro Air Vehicle: Design, Fabrication, and Results of a Fully Integrated Centimeter-Scale MAV," *IEEE Robotics and Automation Magazine*, vol. 14, no. 2, pp. 82-91, June 2007.
- J10. C. Majidi, R.E. Groff, and R.S. Fearing, "Analysis for Shaft-loaded Membrane Delamination using Stationary Principles" *Mathematics and Mechanics of Solids*, January 2007, 1081286506068823. Vol. 13, No. 1, 3-22 (2008).
- J11. K. Autumn, C. Majidi, R.E. Groff, A. Dittmore, and R. Fearing, "Effective elastic modulus of isolated gecko setal arrays," *Journal of Experimental Biology*, vol. 209, pp. 3558-3568, 2006.
- J12. C. Majidi, R.E. Groff, K. Autumn, S. Baek, B. Bush, N. Gravish, R. Maboudian, Y. Maeno, B. Schubert, M. Wilkinson, and R.S. Fearing, "High friction from a stiff polymer using micro-fiber arrays," *Physical Review Letters*, vol. 97, no. 076103, 18 August 2006.
- J13. C. S. Majidi, R.E. Groff, and R.S. Fearing, "Attachment of Fiber Array Adhesive through Side Contact," *Journal of Applied Physics*, vol. 98, 103521 (2005).
- J14. R.J. Wood, E. Steltz, and R.S. Fearing "Optimal Energy Density Piezoelectric Bending Actuators,"

Sensors and Actuators, Vol. 119/2 pp. 476-488, 2005.

J15. M. Sitti and R.S. Fearing, "Synthetic Gecko Foot-Hair Micro/Nano-Structures as Dry Adhesives," *Journal of Adhesion Science and Technology*, vol. 17, no.8, pp. 1055-1074, 2003.

J16. D. Campolo, M. Sitti, and R.S. Fearing, "Efficient Charge Recovery Method for Driving Piezoelectric Actuators in Low Power Applications," *IEEE Trans. on Ultrasonics, Ferroelectrics and Frequency Control*, vol. 50, no.3, pp. 237-244, Mar. 2003.

J17. K. Autumn, M. Sitti, Y.A. Liang, A.M. Peattie, W.R. Hansen, S. Sponberg, T. Kenny, R. Fearing, J.N. Israelachvili, and R.J. Full, "Evidence for van der Waals adhesion in gecko setae," *Proceedings National Academy of Sciences*, vol. 99, no. 19, pp. 12252-12256, September 17, 2002.

J18. J. Yan, S.A. Avadhanula, J. Birch, M.H. Dickinson, M. Sitti, T. Su, and R.S. Fearing, "Wing transmission for a micromechanical flying insect," *Journal of Micromechatronics*, vol. 1, no. 3, pp. 221-238, 2002.

J19. M. Moll, K. Goldberg, M.A. Erdmann, and R. Fearing, "Aligning parts for microassembly," *Assembly Automation*, vol. 22, no. 1, pp. 46-54, 2002.

J20. K. Autumn, Y. Liang, T. Hsieh, W. Zesch, W.-P. Chan, T. Kenny, R. Fearing, and R.J. Full, "Adhesive force of a single gecko foot-hair", *Nature*, vol. 405, pp. 681-685, June 8, 2000.

J21. G. Moy, U. Singh, E. Tan and R.S. Fearing, "Human Psychophysics for Teletaction System Design", *Haptics-e, The Electronic Journal of Haptics Research*, vol. 1, No. 3, February 18, 2000.

J22. M.D. Berkemeier and R.S. Fearing, "Tracking Fast Inverted Trajectories of the Underactuated Acrobot", *IEEE Trans. on Robotics and Automation*, vol. 15, no.4, pp. 740-750, August 1999.

J23. M.D. Berkemeier and R.S. Fearing, "Sliding and Hopping Gaits for the Underactuated Acrobot", *IEEE Trans. on Robotics and Automation*, vol. 14, no.4, pp. 629-634, August 1998.

J24. F. Tendick, S.S. Sastry, R.S. Fearing, and M. Cohn, "Applications of Micromechatronics in Minimally Invasive Surgery", *IEEE/ASME Trans. on Mechatronics*, vol. 3, no.1, pp. 34-42, March 1998.

J25. M.D. Berkemeier and R.S. Fearing, "Determining the Axis of a Surface of Revolution Using Tactile Sensing", *IEEE Trans. on Pattern Analysis and Machine Intelligence*, vol. 15, no. 10, pp. 1079-1087, Oct. 1993.

J26. K.S.J. Pister, M.W. Judy, S.R. Burgett, and R.S. Fearing, "Microfabricated Hinges", *Sensors and Actuators A*, vol. 33, pp. 249-256, 1992.

J27. R.S. Fearing and T.O. Binford, "Using a Cylindrical Tactile Sensor for Determining Curvature," *IEEE Trans. on Robotics and Automation*, Dec. 1991.

J28. R.S. Fearing, "Tactile Sensing Mechanisms", *Int. Journal of Robotics Research*, vol. 9, no. 3, June 1990.

J29. R.S. Fearing, "Simplified Grasping and Manipulation with Dextrous Robot Hands", *IEEE Journal of Robotics and Automation* Vol RA-2, No.4, December 1986.

J30. R.S. Fearing and J.M. Hollerbach, "Basic Solid Mechanics for Tactile Sensing," *Int. Journal of Robotics Research*, vol. 4, no. 3, Fall 1985.

Invited Papers

II. R.S. Fearing, "Challenges for Effective Millirobots," *IEEE Int. Symp. on. Micro-NanoMechatronics and Human Science*, Nagoya Japan Nov. 5-8, 2006.

- I2. R.S. Fearing, R. Sahai, and A. Hoover, "Rapidly Prototyping Millirobots using Toolkits and Microassembly," The IARP - IEEE/RAS - EURON Joint Workshop on Micro and Nano Robotics, Paris, France, 23 - 24 October 2006.
- I3. J. Yan, S. Avadhanula, M. Sitti, R.J. Wood, and R.S. Fearing, "Thorax Design and Wing Control for a Micromechanical Flying Insect," *Proc. of 39th Annual Allerton Conf on Communication, Control and Computing*, Monticello, IL, Oct 3-5, 2001.
- I4. R. Fearing, "Towards Micromechanical Flyers" *The Bridge*, (quarterly for NAE members), vol. 31, no. 4, Winter 2001.
- I5. R.S. Fearing, "A Planar Milli-Robot System on an Air Bearing", in *Robotics Research the 7th International Symposium*, edited by G. Giralt and G. Hirzinger, pp. 570-581, London: Springer-Verlag 1996.
- I6. R.S. Fearing, "A Miniature Mobile Platform on an Air Bearing", *Third Intern. Symp. on Micro Machine and Human Science*, Oct 14-16, 1992, Nagoya, Japan.

Refereed Conference Papers

- C1. M. Teodorescu, C. Majidi, H. Rahnejat, and R.S. Fearing, "Effect of surface roughness on adhesion and friction of microfibers in side contact," *Proc. of the STLE/ASME Int. Joint. Tribology Conf.* Oct. 20-22, 2008 Miami FL.
- C2. A. Hoover, E. Steltz, and R.S. Fearing, "RoACH: An autonomous 2.4g crawling hexapod robot," *IEEE Int. Conf. on Intelligent Robots and Systems*, Nice France Sept. 2008.
- C3. Aaron Hoover and R.S. Fearing, "A Fast Scale Prototyping Process for Folded Millirobots," *IEEE Int. Conf. Robotics and Automation Pasadena*, May 2008.
- C4. M.P. Reyes and R.S. Fearing, "Macromodel for the Mechanics of Gecko Hair Adhesion," *IEEE Int. Conf. Robotics and Automation Pasadena*, May 2008.
- C5. C. Majidi and R.S. Fearing, "Mechanics of a novel shear-activated microfiber array adhesive," *Mater. Res. Soc. Symp. Proc. Vol. 1086-U01-11*, 2008.
- C6. E. Steltz and R.S. Fearing, "Dynamometer Power Output Measurements of Piezoelectric Actuators" *IEEE Int. Conf. on Intelligent Robots and Systems*, San Diego, CA Oct. 2007.
- C7. E. Steltz, S. Avadhanula and R.S. Fearing, "High Lift Force with 275 Hz Wing Beat in MFI" *IEEE Int. Conf. on Intelligent Robots and Systems*, San Diego, CA Oct. 2007.
- C8. A. Hoover and R.S. Fearing, "Rapidly Prototyped Orthotweezers for Automated Microassembly," *IEEE Int. Conf. on Robotics and Automation*, Rome Italy, April 9-13, 2007.
- C9. E. Steltz, M. Seeman, S. Avadhanula, and R.S. Fearing, "Power Electronics Design Choice for Piezoelectric Microrobots", *IEEE Int. Conf. on Intelligent Robots and Systems*, Beijing, China Oct.9-13, 2006.
- C10. A. Hoover and R.S. Fearing, "A Rapidly Prototyped 2-Axis Positioning Stage for Microassembly using Large Displacement Compliant Mechanisms," *IEEE Int. Conf. on Robotics and Automation*, Orlando, FL May 15-19, 2006.
- C11. R. Sahai, R.E. Groff, E. Steltz, M. Seeman, and R.S. Fearing, "Towards a 3g Crawling Robot through the Integration of Microrobot Technologies," *IEEE Int. Conf. on Robotics and Automation*, Orlando, FL May 15-19, 2006.
- C12. R.J. Wood, S. Avadhanula, E. Steltz, M. Seeman, J. Entwistle, A. Bachrach, G. Barrows, S. Sanders, and R.S. Fearing, "Design, Fabrication and Initial Results of a 2g Autonomous Glider," *31st Annual*

- Conference, IEEE Industrial Electronics Society 2005 Meeting, Raleigh North Carolina, Nov. 6-10, 2005.
- C13. R.J. Wood, E. Steltz, and R.S. Fearing, "Nonlinear Performance Limits for High Energy Density Piezoelectric Bending Actuators," IEEE Int. Conf. on Robotics and Automation, Barcelona, April 2005.
- C14. S. Avadhanula and R.S. Fearing, "Flexure Design Rules for Carbon Fiber Microrobotic Mechanisms," IEEE Int. Conf. on Robotics and Automation, Barcelona, April 2005.
- C15. E. Steltz, S. Avadhanula, R.J. Wood, and R.S. Fearing, "Characterization of the Micromechanical Flying Insect by Optical Position Sensing," IEEE Int. Conf. on Robotics and Automation, Barcelona, April 2005.
- C16. R. Sahai, E. Steltz, and R.S. Fearing, "Carbon Fiber Components with Integrated Wiring for Millirobot Prototyping," IEEE Int. Conf. on Robotics and Automation, Barcelona, April 2005.
- C17. K. Autumn, M. Buehler, M. Cutkosky, R. Fearing, R.J. Full, D. Goldman, R. Groff, W. Provancher, A. A. Rizzi, U. Sarani, A. Saunders, and D.E. Koditschek, "Robotics in Scansorial Environments," 2005 SPIE Security and Defense Symposium, Unmanned Ground Vehicle Technology VII Conference, Conference 5804, OR05-OR43-73, March 29-31, 2005.
- C18. C. Majidi, R. Groff, and R. Fearing, "Clumping and Packing of Nanohairs Manufactured by Nanocasting" 2004 ASME Int. Mechanical Engineering Congress and Exposition. IMECE2004-62142, Anaheim, CA Nov. 13-19, 2004.
- C19. S. Avadhanula, R. J. Wood, E. Steltz, J. Yan and R. S. Fearing "Lift Force Improvements for the Micromechanical Flying Insect" IEEE Int. Conf. on Intelligent Robots and Systems, Oct 28-30, 2003, Las Vegas NV.
- C20. J. Yan and R.S. Fearing, "Wing Force Map Characterization and Simulation for the Micromechanical Flying Insect" IEEE Int. Conf. on Intelligent Robots and Systems, Oct 28-30, 2003, Las Vegas NV.
- C21. R. Sahai, J. Lee, and R.S. Fearing, "Semi-Automated Micro Assembly for Rapid Prototyping of a One DOF Surgical Wrist," IEEE Int. Conf. on Intelligent Robots and Systems, Oct 28-30, 2003, Las Vegas NV.
- C22. M. Sitti and R.S. Fearing, "Synthetic Gecko Foot-Hair Micro/Nano Structures for Future Wall-Climbing Robots," Int. Conf. Robotics and Automation 2003, pp. 1164-1170, Taipei, Taiwan, Sept. 2003.
- C23. R.J. Wood, S. Avadhanula, M. Menon, and R.S. Fearing, "Microrobotics using Composite Materials: the Micromechanical Flying Insect Thorax," IEEE Int. Conf. Robotics and Automation, pp. 1842-1849, Sept. 2003, Taipei, Taiwan.
- C24. W.C. Wu, L. Schenato, R.J. Wood and R.S. Fearing, "Biomimetic Sensor Suite for Flight Control of a Micromechanical Flight Insect: Design and Experimental Results" IEEE Int. Conf. Robotics and Automation, pp. 1146-1151, Sept. 2003, Taipei, Taiwan.
- C25. D. Campolo, R. Sahai, R. S. Fearing, "Development of Piezoelectric Bending Actuators with Embedded Piezoelectric Sensors for Micromechanical Flapping Mechanisms," IEEE Int. Conf. Robotics and Automation, Sept. 2003, pp. 3339-3346, Taipei, Taiwan.
- C26. Domenico Campolo, Steven D. Jones and Ronald S. Fearing, "Fabrication of Gecko foot-hair like nano structures and adhesion to random rough surfaces," IEEE Nano 2003 Aug 12-14, San Francisco.
- C27. R. Sahai, J. Lee, and R.S. Fearing, "Towards Automatic Assembly of Sub-Centimeter Millirobot Structures," *Third Int. Workshop on Microfactories*, Minneapolis, MN, Sept. 16-18, 2002.
- C28. M. Sitti and R.S. Fearing, "Nanomolding Based Fabrication of Synthetic Gecko Foot-Hairs," *IEEE Nano*, August 2002, Washington, DC.

- C29. W.C. Wu, R.J. Wood, R.S. Fearing, "Halteres for the Micromechanical Flying Insect," *IEEE Int. Conf. on Robotics and Automation*, Washington, DC May 11-15, 2002.
- C30. S. Avadhanula, R. J. Wood, D. Campolo, R. S. Fearing, "Dynamically tuned design of the MFI thorax" *IEEE Int. Conf. on Robotics and Automation*, Washington, DC May 11-15, 2002.
- C31. M. Moll, K. Goldberg, M.A. Erdmann, and R. Fearing, "Orienting Micro-Scale Parts with Squeeze and roll Primitives," *IEEE Int. Conf. on Robotics and Automation*, Washington, DC May 11-15, 2002.
- C32. J.A. Thompson and R.S. Fearing, "Automating Microassembly with Ortho-tweezers and Force Sensing," *IROS 2001*, Maui, HI, Oct. 29-Nov. 3, 2001.
- C33. R.J. Wood and R.S. Fearing,, "Flight Force Measurements for a Micromechanical Flying Insect," *IROS 2001*, Maui, HI, Oct. 29-Nov. 3, 2001.
- C34. J. Yan, R.J. Wood, S. Avadhanula, D. Campolo, M. Sitti and R.S. Fearing "Towards Flapping Wing Control for a Micromechanical Flying Insect", *IEEE Int. Conf. Robotics and Automation*, Seoul Korea, May 2001.
- C35. M. Sitti, T. Su, R.S. Fearing, D. Campolo, J. Yan, D. Taylor, T. Sands, "Development of PZT/PZN-PT Unimorph Actuators for Micromechanical Flapping Mechanisms," *IEEE Int. Conf. Robotics and Automation*, Seoul Korea, May 2001.
- C36. E. Shimada, J.A. Thompson, J. Yan, R.J. Wood and R.S. Fearing, "Prototyping Millirobots using Dextrous Microassembly and Folding" Symposium on Microrobotics, *2000 ASME International Mechanical Engineering Congress and Exposition*, DSC-Vol. 69-2, pp. 933-940 Nov. 5-10, 2000, Orlando, FL.
- C37. K. H. Chiang and R.S. Fearing, "A Hybrid Pneumatic/Electrostatic Milli-Actuator," *2000 ASME International Mechanical Engineering Congress and Exposition*, vol. MEMS, Nov. 5-10, 2000, Orlando, FL.
- C38. Y. Liang, K. Autumn, S.T. Hsia, W. Zesch, W.P. Chan, R.S. Fearing, R.J. Full, and T.W. Kenny, "Adhesion Force Measurements on Single Gecko Setae", *Technical Digest to the Solid-State Sensors and Actuators Workshop*, pp. 33-38, June 2000, Hilton Head SC.
- C39. R.S. Fearing, K.H. Chiang, M. Dickinson, D.L. Pick, M. Sitti, and J. Yan, "Wing Transmission for a Micromechanical Flying Insect", *IEEE Int. Conf. on Robotics and Automation*, San Francisco, April 24-27, 2000.
- C40. G. Moy, U. Singh, U., E. Tan, R.S. Fearing, " Human tactile spatial sensitivity for tactile feedback," *IEEE Int. Conf. on Robotics and Automation*, pp. 776-782, San Francisco, April 24-27, 2000.
- C41. G. Moy, C. Wagner, and R.S. Fearing, "A Compliant Tactile Display for Teletaction", *IEEE Int. Conf. on Robotics and Automation*, San Francisco, April 24-27, 2000.
- C42. J. Yan, P.K. Scott, and R.S. Fearing, "Inclusion Probing: Signal Detection and Haptic Playback of 2D FEM and Experimental Data", *Proc. ASME IMECE DSC-5 '99*, Nashville, TN Nov. 14-19, 1999.
- C43. W. Zesch and R.S. Fearing, "Alignment of Microparts Using Force Controlled Pushing," *SPIE Conf. on Microrobotics and Micromanipulation*, Nov. 2-5 1998, Boston, MA, USA.
- C44. G. Moy and R. Fearing, "Effects of Shear Stress in Teletaction and Human Perception", *Seventh Annual Symp. on Haptic Interfaces for Virtual Environment and Teleoperator Systems, ASME IMECE*, Anaheim, CA Nov. 1998.
- C45. U. Singh and R. Fearing, "Tactile After-Images from Static Contact", *Seventh Annual Symp. on Haptic Interfaces for Virtual Environment and Teleoperator Systems, ASME IMECE*, Anaheim, CA Nov. 1998.

- C46. R.S. Fearing, G. Moy, and E. Tan, "Some Basic Issues in Teletaction", *IEEE Int. Conf. Robotics and Automation*, Albuquerque, NM April 1997.
- C47. H. Furuichi and R.S. Fearing, "A Planar Capacitive Micro Positioning Sensor", *7th Int. Symp. on Micro Machine and Human Science*, pp. 85-90, Nagoya, Japan, Oct. 2-4, 1996.
- C48. B. Gray and R.S. Fearing, "A Surface Micromachined Microtactile Sensor Array", *IEEE Int. Conf. Robotics and Automation*, Minneapolis, MN April 1996.
- C49. R.S. Fearing, "Survey of Sticking Effects for Micro-Parts", *IEEE Int. Conf. Robotics and Intelligent Systems IROS '95*, Pittsburgh, PA August 7-9, 1995.
- C50. E.J. Nicolson and R.S. Fearing, "The Reliability of Curvature Estimates from Linear Elastic Tactile Sensors", *IEEE Int. Conf. on Robotics and Automation*, Nagoya, Japan, May 1995.
- C51. M.D. Berkemeier and R.S. Fearing "Control Experiments on an Underactuated Robot with Application to Legged Locomotion", *IEEE Int. Conf. Robotics and Automation*, San Diego, CA May 10-12, 1994, pp. 149-154.
- C52. E.J. Nicolson and R.S. Fearing, "Sensing Capabilities of Linear Elastic Cylindrical Fingers", *IEEE/RSJ Int. Conf. on Intelligent Robots and Systems*, Yokohama, Japan, July 1993.
- C53. E.J. Nicolson and R.S. Fearing, "Compliant Control of Threaded Fastener Insertion", *IEEE Int. Conf. Robotics and Automation*, Atlanta, GA May 3-5, 1993.
- C54. M.B. Cohn, M. Lam, and R.S. Fearing, "Tactile Feedback for Teleoperation", *SPIE Conf. 1833, Telemanipulator Technology*, Boston, MA, Nov. 15-16, 1992.
- C55. S.R. Burgett, K.S.J. Pister, and R.S. Fearing, "Three Dimensional Structures Made with Microfabricated Hinges", *DSC-Vol. 40 Micromechanical Systems, ASME Winter Annual Meeting*, Anaheim, CA Nov. 8-13, 1992.
- C56. M.D. Berkemeier and R.S. Fearing, "Control of a Two-Link Robot to Achieve Sliding and Hopping Gaits", *IEEE Int. Conf. on Robotics and Automation*, Nice France, May, 1992.
- C57. E.J. Nicolson and R.S. Fearing, "Dynamic Modelling of a Part Mating Problem: Threaded Fastener Insertion", *IEEE Workshop on Intelligent Robots and Systems*, Osaka, Japan, Nov. 3-5, 1991.
- C58. R.S. Fearing, "Control of a Micro-Organism as a Prototype Micro-Robot", *2nd Int. Symp. on Micromachines and Human Sciences*, Nagoya, Japan, Oct. 8-9, 1991.
- C59. K.S.J. Pister, M.W. Judy, S.R. Burgett, and R.S. Fearing, "Microfabricated Hinges: 1 mm Vertical Features with Surface Micromachining", *IEEE Transducers '91*, San Francisco, CA June 1991.
- C60. M.D. Berkemeier and R.S. Fearing, "Determining the Axis of a Surface of Revolution Using Tactile Sensing", *IEEE Int. Conf. on Robotics and Automation*, Cincinnati, OH May 1990.
- C61. E.M. Sladek and R.S. Fearing, "The Dynamic Response of a Tactile Sensor", *IEEE Int. Conf. on Robotics and Automation*, Cincinnati, OH May 1990.
- C62. K.S.J. Pister, R.S. Fearing, and R.T. Howe, "A Planar Air Levitated Electrostatic Actuator System", *IEEE Workshop on Micro Electro Mechanical Systems*, Napa Valley, CA Feb. 12-14 1990.
- C63. S. Gopalswamy and R.S. Fearing, "Grasping of Polyhedral Objects with Slip", *IEEE Int. Conf. on Robotics and Automation*, Scottsdale AZ, May 1989.
- C64. R.S. Fearing and T.O. Binford, "Using a Cylindrical Tactile Sensor for Determining Curvature," *IEEE Int. Conf. on Robotics and Automation*, Philadelphia, PA, April 1988.
- C65. R.S. Fearing, "Some Experiments with Tactile Sensing during Grasping," *IEEE Int. Conf. on Ro-*

botics and Automation, Raleigh, NC, April 1987.

C66. J.B. Chen, B.S. Armstrong, R.S. Fearing, J.W. Burdick, "Satyr and the Nymph: Software Archetype for Real Time Robotics", *IEEE-ACM Joint Computer Conference*, Dallas, TX November 1986.

C67. R.S. Fearing, A. Rise, and T.O. Binford, "A Tactile Sensing Finger Tip for a Dextrous Hand," *SPIE Conference on Intelligent Robotics and Computer Vision*, Cambridge, MA October 1986.

C68. J.B. Chen, R.S. Fearing, B.S. Armstrong, and J.W. Burdick, "NYMPH: A Multiprocessor for Manipulation Applications", *IEEE Int. Conf. on Robotics and Automation*, San Francisco, CA April, 1986.

C69. R.S. Fearing "Implementing a Force Strategy for Object Re-orientation," *IEEE Int. Conf. on Robotics and Automation*, San Francisco, CA April, 1986.

C70. R.S. Fearing, "Simplified Grasping and Manipulation with Dextrous Robot Hands", *Proceedings of the American Control Conference*, San Diego, CA, June 1984.

C71. R.S. Fearing and J.M. Hollerbach, "Basic Solid Mechanics for Tactile Sensing," *IEEE Int. Conf. on Robotics and Automation*, Atlanta GA, March 1984.

Chapters in Books

[1] R.S. Fearing and R.J. Wood, "Challenges for 100 Milligram Flapping Flight," to appear *Flying Insect Robots*, edited by D. Floreano, M. Srinivasan, C. Ellington, and J-C. Zufferey, Springer-Verlag 2008.

[2] R. Fearing, S. Avadhanula, D. Campolo, M. Sitti, J. Yan, and R. Wood, "A Micromechanical Flying Insect Thorax", *Neurotechnology for Biomimetic Robots*, edited by J. Ayers, J.L. Davis and A. Rudolph, pp. 469-480, MIT Press, August 2002.

[3] K. Boehringer, R.Fearing, and K. Goldberg, "Microassembly", in *Handbook of Industrial Robotics*, edited by S. Y. Nof, Purdue University, p. 1045-1066, 2nd Ed., John Wiley & Sons, 1999.

[4] R.S. Fearing, "Micro-Actuators for Micro-Robots: Electric and Magnetic", in *Micromechanical Systems: Principles and Technology*, edited by T. Fukuda and W. Menz, Elsevier Science B.V.: Amsterdam 1998.

[5] R.S. Fearing, "Micro Structures and Micro Actuators for Implementing Sub-millimeter Robots", in *Precision Sensors, Actuators and Systems*, edited by H.S. Tzou and T. Fukuda, Kluwer Academic Publishers, Dordrecht The Netherlands, 1992.

[6] R.S. Fearing, "Planar Elasticity for Tactile Sensing", in *Tactile Sensing*, edited by H.R. Nicholls, pp. 75-93, World Scientific Publishing, Singapore, 1992.

[7] R.S. Fearing, "Basic Linear Elasticity", in *Tactile Sensing*, edited by H.R. Nicholls, pp. 277-290, World Scientific Publishing, Singapore, 1992.

[8] R.S. Fearing, "Tactile Sensing for Shape Interpretation", in *Dextrous Robot Hands*, edited by S.T. Venkataraman and T. Iberall, Springer-Verlag, New York: 1990.

Technical Reports

[1] M.D. Berkemeier and R.S. Fearing, "Determining the Axis of a Surface of Revolution Using Tactile Sensing", UCB/ERL Memorandum M89/117, October 1989.

[2] E.M. Sladek and R.S. Fearing, "The Dynamic Response of a Tactile Sensor", UCB/ERL Memorandum M89/138, December 1989.

[3] R.S. Fearing, "Simplified Grasping and Manipulation with Dextrous Robot Hands", MIT AI Memo 809, November 1984.

[4] R.S. Fearing and J.M. Hollerbach, "Basic Solid Mechanics for Tactile Sensing," MIT AI Memo 771, March 1984.

[5] R.S. Fearing, "Exploration of the Dextrous Hand Control Problem", GE CR&D Technical Information Series Report 82CRD337, December 1982.

Other Papers

[1] R.S. Fearing, A.M. Hoover, M. Hudson, "Enabling Low Cost Microassembly," 2008 NSF Design, Service, and Manufacturing Grantees and Research Conference, Jan. 3-6, 2008, Knoxville, TN.

[2] Matthew Spenko, Mark Cutkosky, Carmel Majidi, Ronald Fearing, Richard Groff, Kellar Autumn, "Foot design and integration for bioinspired climbing robots" SPIE 2006 Defense and Security Symposium.

[3] A.M. Hoover, R. Sahai, and R.S. Fearing, "Toward Low-Cost Automated Rapid Prototyping of Millirobots Using Kit Parts," 2006 NSF Design, Service, and Manufacturing Grantees and Research Conference St. Louis, MO, Jul. 25-27 2006.

[4] R. Sahai, J.L. Kao, and R.S. Fearing, "Grasping Improvements in a Semi-Automated Procedure for the Rapid Prototyping of Millirobots," 2005 NSF Design, Service, and Manufacturing Grantees and Research Conference, Jan. 3-6, 2005, Scottsdale, AZ.

[5] R. Sahai and R.S. Fearing, "Carbon Fiber Components with Integrated Wiring for Millirobot Prototyping," 2005 NSF Design, Service, and Manufacturing Grantees and Research Conference, Jan. 3-6, 2005, Scottsdale, AZ.

[6] R. Sahai and R.S. Fearing, "Improvements to a Semi-Automated Procedure for Rapid Prototyping of Millirobots with Applications," 2004 NSF Design, Service, and Manufacturing Grantees and Research Conference, Jan. 4-8, 2004, Dallas, TX.

[7] R. Sahai, J. Lee, and R.S. Fearing, "Towards Automatic Assembly of Sub-Centimeter Millirobot Structures" 2003 NSF Design, Service, and Manufacturing Grantees and Research Conference, Jan. 6-9, 2003, Birmingham, AL.

[8] Joe Yan, et al "The Micromechanical Flying Insect" video presentation: *IEEE Int. Conf. on Robotics and Automation*, Washington, DC May 11-15, 2002.

[9] R.S. Fearing, "Powering 3 Dimensional Microbots: Power Density Limitations", *Workshop WS5 on Micromechatronics and Micro Robotics, IEEE Int. Conf. on Robotics and Automation*, May 16-20, 1998, Leuven Belgium.

Abstracts

B. Geisler, A. Dittmore, B. Gallery, T. Stratton, R. Fearing, and K. Autumn, "Deformation of isolated gecko setal arrays: bending or buckling?" Society for Integrative and Comparative Biology, San Diego, Wed. Jan. 5, 2005.

R. Fearing, "Biological inspiration for micro flight: The micromechanical flying insect" 227th ACS National Meeting, Anaheim, CA, March 28-April 1, 2004. DIVISION: Division of Polymeric Materials: Science and Engineering SESSION: Interface of Polymers and Biomimetics

R.J. Full, R. Fearing, and K. Autumn "Evolutionary Nanotechnology: Gecko Adhesive Mechanisms" 227th ACS National Meeting, Anaheim, CA, March 28-April 1, 2004. DIVISION: Division of Polymeric Materials: Science and Engineering SESSION: Interface of Polymers and Biomimetics

Patents

1. R.J. Full, R.S. Fearing, T.W. Kenny, and K. Autumn, “Adhesive Microstructure and Method of Forming Same” US patent 6,737,160 May 18, 2004.
2. R.S. Fearing and E. Shimada, “ Apparatus and method for manipulation of an object” US Patent 6,798,120 Sept. 28, 2004.
3. R. Fearing and M. Sitti. “An Improved Adhesive Microstructure and Method of Forming Same”, US Patent 6,872,439 March 29, 2005.
4. R.J. Full, R.S. Fearing, T.W. Kenny, and K. Autumn, “Adhesive Microstructure and Method of Forming Same” US Patent 7,011,723 March 14, 2006.
5. S.D. Jones and R.S. Fearing, “Structure having nano-fibers on annular curved surface, method of making same and method of using same to adhere to a surface,” US Patent 7,175,723 Feb. 13, 2007.
6. R.J. Full, R.S. Fearing, T.W. Kenny, and K. Autumn, “Adhesive microstructure and method of forming same,” US Patent 7,229,685 June 12, 2007.
7. R.J. Wood, R.S. Fearing, J. Hickerson, “High performance piezoelectric actuator,” US Patent 7,368,860 May 6, 2008.

Pending Patents

- R.J. Full, R.S. Fearing, T.W. Kenny, and K. Autumn, “Adhesive Microstructure and Method of Forming Same” 20050072509, application published April 7, 2005.
- L. Sverduk, R. Sahai, and R.S. Fearing, “Surgical instrument for adhering to tissues” 20050119640, application published June 2, 2005.
- R.S. Fearing and M. Sitti, “Adhesive Microstructure and Method of Forming Same” 20050181170, application published Aug. 18, 2005
- R. Fearing and K. Autumn, “Controlling peel strength of micron-scale structures,” 20060078725, application published April 13, 2006.
- C. Majidi, R. Groff, R.S. Fearing, “Nanostructured friction enhancement using fabricated microstructure,” 2006202355, published Sept. 14, 2006.
- R. Fearing, A. Bachrach, and C. Mahjidi, “Actively switchable nano-structured adhesive,” 20080014465, published Jan. 17, 2008.
- C. Majidi, R. Groff, and R.S. Fearing, “Symmetric, spatular attachments for enhanced adhesion of micro- and nano-fibers,” 20080070002, published March 20, 2008.

Papers Accepted or in Press

- E. Steltz and R.S. Fearing, “Dynamometer Power Output Measurements of Miniature Piezoelectric Actuators,” to appear IEEE/ASME Trans. on Mechatronics, 2009.

Papers Submitted

Invited Talks

- “Design, micro assembly, rapid prototyping of flying and crawling micro-robots” Makani Power, Alame-

da, CA Nov. 20, 2008

- [1] "Gecko Technology Briefing," Nike Corp. Portland, Oct. 30, 2008.
- [2] "Gecko Inspired Synthetic Adhesives," AS&T Colloquium, UC Berkeley, 29 Oct. 2008.
- [3] "Biomimetic Principles for Insect-Scale Flapping Flight and Ambulation," Int. Workshop on Biomimetic Complex System Design, KAIST, Daejeon, Korea June 3-4, 2008.
- [4] "Biomimetic Millirobots," Michigan State University, March 27, 2008.
- [5] "Challenges for 100 milligram flapping flight," IROS Workshop on Micro Aerial Vehicles Design, Control, and Navigation, 2 Nov. 2007, San Diego.
- [6] "Biomimetic Millirobots" RPI CS Day, Oct. 26, 2007
- [7] "Challenges for 100 Milligram Flapping Flight" plenary talk, Flying Insect Robots, Acon, Switzerland, Aug. 13-17, 2007.
- [8] "Challenges for Effective Millirobots," plenary talk, IEEE MicroMachine and Human Sciences Symp. Nagoya, Japan Nov. 5, 6, 7. 2006.
- [9] "Challenges for Effective Millirobots" Stanford Broad Area Colloquium for Artificial Intelligence, Geometry, Graphics, Robotics and Computer Vision, Oct. 9, 2006.
- [10] "Fingers for Interactions in Micro and Nano World" ICRA Workshop on Role of Robotics Research in Micro and Nanotechnologies, Orlando, FL May 15, 2006.
- [11] "Challenges for Effective Millirobots" plenary talk, IEEE Int. Conf. on Robotics and Automation May 18, 2006, Orlando, FL
- [12] "Microrobots Using Composite Materials" 1st Workshop on Very Small Robots MITRE Corp., McLean, VA, 23-24 February 2005.
- [13] "Mechanisms for 1 gram and 0.1 gram Autonomous Flyers" presentation to Board on Army Science and Technology, Washington, DC December 16-17, 2004.
- [14] "Gecko Inspired Dry Adhesion: Principles of Operation", Gordon Research Conference on Adhesion Science. Tilton, NH, August 8-13, 2004.
- [15] "Micromechanical Flying Insect," ICRA Workshop on Micro Air Vehicles, New Orleans, April 2004.
- [16] "Design and Fabrication of a Micromechanical Flying Insect", IGERT Seminar, Case Western Reserve, 23 March 2004.
- [17] "Synthetic Gecko Foot-Hair Micro/Nano-Structures for Future Wall-Climbing Robots," IROS Workshop on Nanoscience and Technology, Oct. 27, 2003, Las Vegas, NV.
- [18] "Towards Automatic MicroAssembly of MilliRobots", IROS Workshop on Sensing and Manipulation of Micro and Nano Entities: Science, Engineering, and Applications, Oct. 27, 2003, Las Vegas, NV.
- [19] "Design and Fabrication of Micromechanical Flying Insect," Bioengineering Seminar, Caltech, 19 May 2003.
- [20] "Towards Synthetic Biomimetic Adhesion," Defense Sciences Review Council, San Francisco, 21 April 2003.
- [21] "Towards Automatic MicroAssembly of MilliRobots" Zyvex Corp, Plano Texas, 15. Nov. 2002.
- [22] "MilliRobotics for Manipulation, Remote Sensing and Presence," Dept. of Computer Science and

Engineering, Univ. of Minnesota, Minneapolis Nov. 4, 2002.

[23] “Compliant Fingers, Toes and Thoraxes for Versatile MilliRobots” Darpa Biodynamics Workshop, Arlington, VA, Oct. 7, 2002.

[24] “Towards Micromechanical Flyers,” NAE Frontiers in Engineering, Irvine, CA, Mar. 1-3, 2002.

[25] “Design and Fabrication of a Micromechanical Flying Insect” Grasp Lab Seminar, Univ. of Pennsylvania, Philadelphia, April 13, 2001.

[26] “Design and Construction of a Micromechanical Flying Insect” Xerox Summer Robotics Seminar, Xerox PARC, Palo Alto, CA July 25, 2000.

[27] “Micromechanical Flying Insect” Neurotechnology for Biomimetic Robots, Nahant, MA, May 14-16, 2000

[28] “Micromechanical Flying Insect” Workshop on Mobile Microrobotics, IEEE Int. Conf. Robotics and Automation, April 28, 2000

[29] “Alignment of Microparts Using Force Controlled Pushing”, *Tutorial on Modeling and Control of Micro- and Nano-manipulation, IEEE Int. Conf. Robotics and Automation*, Detroit, MI May 11, 1999.

[30] “Powering 3 Dimensional Microbots: Power Density Limitations”, *Workshop WS5 on Micromechanics and Micro Robotics, IEEE Int. Conf. on Robotics and Automation*, May 16-20, 1998, Leuven Belgium.

[31] “MEMS for Tactile Sensing and Display”, Workshop on Human and Machine Haptics, Asilomar, CA Dec. 8-9, 1997.

[32] “Micro-Actuators for Micro-Robots: Electric and Magnetic”, *Tutorial Su 1: Micro Mechatronics, IEEE 1997 Int. Conf. on Robotics and Automation*, Albuquerque, NM April 20, 1997.

[33] “Tele-taction”, East Bay chapter, IEEE EMBS Nov. 15, 1995

[34] “Micro-Actuators for Micro-Robots” and “Micro-Sensors for Micro-Robots”, *Tutorial on Micro-Robotic Principles and Applications, IEEE Int. Conf. Robotics and Automation*, Nagoya, Japan, May 1995.

[35] “Tele-taction: remotely transmitting the sense of touch” Univ. of Wisconsin, Feb 22, 1995.

[36] “Grasping of Microparts in Air”, *Tutorial on Micro Dexterous Motion Control, IEEE Int. Conf. Robotics and Automation*, San Diego, CA, May 8, 1994.

[37] “Tele-taction”, Robotics Colloquium, Univ. of Washington, Feb. 14, 1994.

[38] “Actuation for Micro-Robots”, *Tutorial on Miniature and Micro Robotic Machines: Technology, Designs and Applications, IEEE Robotics and Automation*, Atlanta, GA, May 6, 1993.

[39] “Micro Structures and Micro Actuators for Implementing Sub-Millimeter Robots”, *Workshop on Microtechnologies and Applications to Space Systems*, May 27-28, 1992, Jet Propulsion Laboratory, Pasadena, CA.

[40] “Micro Structures and Micro Actuators for Implementing Sub-Millimeter Robots”, *Tutorial on High Precision Sensors/Actuators and Systems, IEEE Robotics and Automation*, Nice, France, May 11, 1992.

[41] “Intelligent Micro Sensors and Actuators”, *Tutorial, IECON 1991*, Kobe, Japan, Oct. 28, 1991.

[42] “Control of Natural and Un-Natural Micro-Robots”, Beckman Institute, U. Ill., May 2, 1991.

[43] “A Planar Air Levitated Electrostatic Manipulator System”, *Workshop on Micro Electro Mechanical*

Systems, IEEE Int. Conf. on Robotics and Automation, Cincinnati, OH, May 13, 1990.

[44] “Robotic Tactile Shape Interpretation”, and “Grasping of Polyhedral Objects Using Slip”, ONR Workshop on Dextrous Manipulation and Tele-Operation, Oxford, UK August 7-9, 1989.

[45] “Robotic Tactile Shape Interpretation”, Autonomous Systems and Robotics Conference, Pasadena, CA, April 25-16, 1989.

Service to Community

June 25, 2008 PBS Dragon Fly TV episode, UC Berkeley (filming with Minnesota Public TV, and Prof. Bob Full)

Professional Service

co-editor with Prof. Kellar Autumn of special issue of *Jnl. Adhesion Science and Technology*, “Gecko Inspired Adhesion: Theoretical and Applied Aspects,” vol. 12-13, pp. 1119-1341, 2007.

MTO Workshop May 24-25, 2004.

Defense Sciences Review Committee Workshop, 4/21/03 San Francisco.

NSF ERC review, Caltech Center for Neuromorphic Systems Engineering, Oct. 23-26, 2000, Pasadena, CA

Panel Member NSF Sensitive Skin Workshop, Oct. 14-15, 1999, Washington DC

Served on 5 NSF review panels, Washington, DC.

North American Editor-in-Chief, *Journal of Micromechatronics*, (VSP) 1998-2006.

Program committee member, IEEE Int. Conf. Robotics and Automation, 1995, 1998, 2000, 2001-2006.

Program committee member, IEEE Int. Conf. Intelligent Robotics and Systems, 2001-2006.

Program committee member, American Association for Artificial Intelligence AAAI-90, March 1990.

Associate Editor for *Mechatronics*, (Pergamon Press) 1990-2005.

Editorial Board Member, *Haptics-e*.

Secretary East Bay Chapter IEEE EMBS 9/95-6/96, vice-president 6/96-6/97.

Reviewer for: NSF proposals, children’s book for Scholastic, *IFAC 08 Journal Royal Society, Interface, PNAS, Langmuir, IEEE Trans. on Robotics and Automation, IEEE Int. Conf. on Robotics and Automation, IEEE/RSJ Int. Conf. on Intelligent Robots and Systems, Int. Journal of Robotics Research, 5th Int. Conf. on Advanced Robotics, Journal of Robotic Systems, Int. Jnl. Intelligent Machines, Sensors and Actuators, IEEE Journal of Microelectromechanical Systems, ASME Annual Symposium on Haptic Interfaces for Virtual Environment, IEEE/ASME Trans. on Mechatronics, IEEE Trans. on Semiconductor Manufacturing, ASME Jnl. of Biomechanical Engineering, IEEE Journal of Solid-State Circuits.*

Panel Member

presentation to NAE Board on Army Science and Technology, Washington, Dec. 16-17, 2004.

DARPA/ISAT Study Group: Cost Effective Configurable Robots, Arlington, VA April 5, 1996, Berkeley June 18, 1996, Pittsburgh, PA, July 23, 1996, Woods Hole, MA, Aug. 19-23, 1996.

Panel member: “DARPA MEMS Infrastructure Workshop”, Millbrae, CA, Sept. 22-23, 1992.

Panel member: "Workshop on Expanding Access to Japanese Robotics R&D", National Academy of Sciences, Washington, DC May 1, 1992.

Panel member: "NSF Workshop on Educational Use of Field Programmable Gate Arrays", Washington, DC Jan. 7-8, 1990.