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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.

S. Baek and R.S. Fearing, Flight forces and altitude regulation of 12 gram i-Bird *IEEE BioRob*, Tokyo Sept. 2010.

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. K Peterson, P Birkmeyer, R Dudley, and R S Fearing, "A Wing-Assisted Running Robot and Implications for Avian Flight Evolution," *Bioinspiration and Biomimetics*, in press Sept. 2011.

J2. Dae Ho Lee, Yongkwan Kim, Ronald S. Fearing, and Roya Maboudian, "Effect of Fiber Geometry on Macroscale Friction of Ordered Low-Density Polyethylene Nanofiber Arrays," *Langmuir*, July 20, 2011. DOI: 10.1021/la201498u

J3. Andrew G. Gillies and Ronald S. Fearing, "Shear Adhesion Strength of Thermoplastic Gecko-Inspired Synthetic Adhesive Exceeds Material Limits," *Langmuir*, August 17, 2011, DOI: 10.1021/la202085j.

J4. X. Zhang, C.L. Pint, M.H. Lee, B.E. Schubert, A. Jamshidi, K. Takei, H. Ko, A. Gillies, R. Bardhan, J.J. Urban, M. Wu, R. Fearing, and A. Javey, "Optically- and Thermally-Responsive Programmable Materials Based on Carbon Nanotube-Hydrogel Polymer Composites" *Nano Letters*, Article ASAP, July 2011. DOI: 10.1021/nl201503e

J5. K. Takei, T. Takahashi, J.C. Ho, H. Ko, A.G. Gillies, P.W. Leu, R.S. Fearing, and A. Javey, "Nanowire active-matrix circuitry for low-voltage macroscale artificial skin," *Nature Materials*, 12 Sept. 2010, doi:10.1038/NMAT2835

J6. A.G. Gillies and R.S. Fearing, "A micromolded connector for reconfigurable millirobots," *J. Micromech. Microeng.* 20 (2010) 105011.

J7. J. Lee, B. Bush, R. Maboudian, and R.S. Fearing, "Gecko-inspired Combined Lamellar and Nanofibrillar Array for Adhesion on Non-planar Surface," *Langmuir*, DOI: 10.1021/la9029672 Oct. 2009.

J8. H. Ko, Z. Zhang, Y.-L. Chueh, J.C. Ho, R.S. Fearing, and A. Javey, "Wet and Dry Adhesion Properties of Self-Selective Nanowire Connectors" *Advanced Functional Materials*, DOI:10.1002/adfm.200901178, 25 August 2009.

J9. H. Ko, J. Lee, B.E. Schubert, Y.-L. Chueh, P.W. Leu, R.S. Fearing, and A. Javey, "Hybrid CoreShell Nanowire Forests as Self-Selective Chemical Connectors," *Nano Letters*, April 24, 2009, DOI: 10.1021/nl900343b

J10. E. Steltz and R.S. Fearing, "Dynamometer Power Output Measurements of Miniature Piezoelectric Actuators," *IEEE/ASME Trans. on Mechatronics*, vol. 14, no. 1, pp.1-10, 2009.

J11. 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.

J12. 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

J13. J. Lee and R.S. Fearing, "Contact Self-cleaning Synthetic Gecko Adhesive from Polymer Nanofibers," *Langmuir*, 10 Sep. 2008, doi:10.1021/la8021485.

- J14. 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>
- J15. 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.
- J16. 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
- J17. 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
- J18. 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).
- J19. 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.
- J20. 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).
- J21. 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.
- J22. 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.
- J23. 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).
- J24. 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.
- J25. 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.
- J26. 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.
- J27. 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.
- J28. 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.
- J29. M. Moll, K. Goldberg, M.A. Erdmann, and R. Fearing, "Aligning parts for microassembly," *Assembly Automation*, vol. 22, no. 1, pp. 46-54, 2002.
- J30. K. Autumn, Y. Liang, T. Hsieh, W. Zesch, W.-P. Chan, T. Kenny, R. Fearing, and R.J. Full, "Adhe-

sive force of a single gecko foot-hair”, *Nature*, vol. 405, pp. 681-685, June 8, 2000.

J31. 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.

J32. 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.

J33. 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.

J34. 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.

J35. 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.

J36. 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.

J37. R.S. Fearing and T.O. Binford, “Using a Cylindrical Tactile Sensor for Determining Curvature,” *IEEE Trans. on Robotics and Automation*, Dec. 1991.

J38. R.S. Fearing, “Tactile Sensing Mechanisms”, *Int. Journal of Robotics Research*, vol. 9, no. 3, June 1990.

J39. R.S. Fearing, “Simplified Grasping and Manipulation with Dexterous Robot Hands”, *IEEE Journal of Robotics and Automation* Vol RA-2, No.4, December 1986.

J40. 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**

I1. 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. K.C. Peterson and R.S. Fearing, “Experimental Dynamics of Wing Assisted Running for a Bipedal

- Ornithopter,” IEEE Int. Conf. Intelligent Robots and Systems, to appear Sept. 2011.
- C2. P. Birkmeyer, A. G. Gillies, and R. S. Fearing, “CLASH: Climbing Vertical Loose Cloth,” IEEE Int. Conf. Intelligent Robots and Systems, to appear Sept. 2011.
- C3. Stanley S. Baek, Fernando L. Garcia Bermudez, and Ronald S. Fearing “Flight Control for Target Seeking by 13 gram Ornithopter” IEEE Int. Conf. Intelligent Robots and Systems, to appear Sept. 2011.
- C4. N.J. Kohut, A.M. Hoover, K.Y. Ma, S.S. Baek, and R.S. Fearing, “MEDIC: A Legged Millirobot Utilizing Novel Obstacle Traversal,” IEEE Int. Conf. Robotics and Automation, Shanghai May 2011.
- C5. S. Baek and R.S. Fearing, Flight forces and altitude regulation of 12 gram i-Bird IEEE BioRob, Tokyo Sept. 2010.
- C6. Aaron M. Hoover, Samuel Burden, Xiao-Yu Fu, S. Shankar Sastry, and R. S. Fearing, “Bio-inspired design and dynamic maneuverability of a minimally actuated six-legged robot” IEEE BioRob, Tokyo Sept. 2010.
- C7. C. Li, A. M. Hoover, P. Birkmeyer, P.B. Umbanhowar, R.S. Fearing, and D.I. Goldman, “Systematic study of the performance of small robots on controlled laboratory substrates” Micro Autonomous Systems & Technology at SPIE’s Defense, Security, & Sensing conference, Orlando, FL April 2010.
- C8. P. Birkmeyer, K. Peterson, and R.S. Fearing “DASH: A Dynamic 15g Hexapedal Robot,” IEEE Int. Conf. Intelligent Robots and Systems, St. Louis, MO Oct. 2009.
- C9. S.S. Baek, K.Y. Ma, R.S. Fearing, “Efficient Resonant Drive of Flapping Wing Robots” IEEE Int. Conf. Intelligent Robots and Systems, St. Louis, MO Oct. 2009.
- C10. F.G. Bermudez and Ronald S. Fearing, “Optical Flow on a Flapping Wing Robot,” IEEE Int. Conf. Intelligent Robots and Systems, St. Louis, MO Oct. 2009.
- C11. A.M. Hoover and R.S. Fearing “Analysis of off-axis performance of compliant mechanisms with applications to mobile millirobots,” IEEE Int. Conf. Intelligent Robots and Systems, St. Louis, MO Oct. 2009.
- C12. J.S. Humbert, I. Chopra, R.S. Fearing, R. J. Full, R. J. Wood, and M.H. Dickinson, “Development of micromechanics for micro-autonomous systems (ARL-MAST CTA Program,)” Proc. SPIE, Vol. 7318, 73180L (2009); DOI:10.1117/12.820881
- C13. 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.
- C14. A.M. 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.
- C15. A.M. Hoover and R.S. Fearing, “A Fast Scale Prototyping Process for Folded Millirobots,” IEEE Int. Conf. Robotics and Automation Pasadena, May 2008.
- C16. M.P. Reyes and R.S. Fearing, “Macromodel for the Mechanics of Gecko Hair Adhesion,” IEEE Int. Conf. Robotics and Automation Pasadena, May 2008.
- C17. 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.
- C18. 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.
- C19. 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.

C20. 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.

C21. 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.

C22. 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.

C23. 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.

C24. 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.

C25. 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.

C26. S. Avadhanula and R.S. Fearing, "Flexure Design Rules for Carbon Fiber Microrobotic Mechanisms," IEEE Int. Conf. on Robotics and Automation, Barcelona, April 2005.

C27. 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.

C28. 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.

C29. 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.

C30. 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.

C31. 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.

C32. 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.

C33. 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.

C34. 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.

C35. R.J. Wood, S. Avadhanula, M.Menon, and R.S. Fearing, "Microrobotics using Composite Materi-

als: the Micromechanical Flying Insect Thorax,” *IEEE Int. Conf. Robotics and Automation*, pp. 1842-1849, Sept. 2003, Taipei, Taiwan.

C36. 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.

C37. 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.

C38. 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.

C39. 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.

C40. M. Sitti and R.S. Fearing, “Nanomolding Based Fabrication of Synthetic Gecko Foot-Hairs,” *IEEE Nano*, August 2002, Washington, DC.

C41. 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.

C42. 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.

C43. 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.

C44. J.A. Thompson and R.S. Fearing, “Automating Microassembly with Ortho-tweezers and Force Sensing,” *IROS 2001*, Maui, HI, Oct. 29-Nov. 3, 2001.

C45. R.J. Wood and R.S. Fearing, “Flight Force Measurements for a Micromechanical Flying Insect,” *IROS 2001*, Maui, HI, Oct. 29-Nov. 3, 2001.

C46. 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.

C47. M. Sitti, T. Su, R.S. Fearing, D. Campolo, J. Yan, D. Taylor, T. Sands, “Development of PZT/PZNP-PT Unimorph Actuators for Micromechanical Flapping Mechanisms,” *IEEE Int. Conf. Robotics and Automation*, Seoul Korea, May 2001.

C48. 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.

C49. 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.

C50. 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.

C51. 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.

- C52. 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.
- C53. 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.
- C54. 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.
- C55. 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.
- C56. 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.
- C57. 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.
- C58. R.S. Fearing, G. Moy, and E. Tan, "Some Basic Issues in Teletaction", *IEEE Int. Conf. Robotics and Automation*, Albuquerque, NM April 1997.
- C59. 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.
- C60. B. Gray and R.S. Fearing, "A Surface Micromachined Microtactile Sensor Array", *IEEE Int. Conf. Robotics and Automation*, Minneapolis, MN April 1996.
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