Jake J. Abbott, Ph.D.

Associate Professor, Department of Mechanical Engineering, University of Utah
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EDUCATION

Johns Hopkins University, Baltimore, Maryland
Ph.D., Mechanical Engineering, 2006
Advisor: Dr. Allison M. Okamura

University of Utah, Salt Lake City, Utah
M.S., Mechanical Engineering, 2001
Mechatronics Certificate, 2001
Advisor: Dr. Sanford G. Meek

Utah State University, Logan, Utah
B.S., Mechanical Engineering, 1999

POSITIONS HELD

Associate Professor (2014-present)
Assistant Professor (2008-2014)
Department of Mechanical Engineering, University of Utah (Adjunct Faculty, School of Computing)

- **Wireless Magnetic Control of Medical Microrobots**: Developing methods to use nonuniform magnetic fields in the wireless control of robotic tools. The use of nonuniform fields will enable a break from the typical symmetric field-generation sources, allowing the generation of more powerful magnetic fields, which is desirable for useful *in vivo* applications. Potential application areas include the brain and spine, the urinary tract and prostate, the eye, and the inner ear. Major efforts have been focused on active capsule endoscopy, in which a camera pill is used to scan the gastrointestinal tract from stomach to intestines. Also considering the localization of capsule endoscopes using the same magnetic field used for actuation of the capsule. Techniques include both permanent-magnet and electromagnet field sources. Magnetic localization methods are also being addressed.
- **Magnetically Guided Cochlear Implants**: Magnetic guidance of a cochlear implant will reduce the trauma of the insertion surgery, and could result in more effective and power-efficient implants. The use of nonuniform fields for control enables the use of small and inexpensive magnetic systems. In order to conduct thorough *in vitro* experiments, we have also developed anatomically correct *scala tympani* phantoms.
- **Telemanipulated Retinal Surgery**: Developing systems and methods that enable head-mounted microsurgical manipulators to be remotely manipulated by retinal surgeons. The goal is to increase the safety and outcomes of retinal surgery, and to enable new types of retinal therapies never before possible.
- **Haptics and Telemanipulation**: Investigating the design and control of novel telemanipulators and telemanipulation control systems, which include a human user in the control loop. Investigating human models for haptics, including the control of admittance-type haptic devices. Investigating robotic models of manipulators that use piezoelectric stick-slip actuators, which are used for micro- and nanomanipulation, including microsurgery applications. Investigating haptic devices that render force/torque using magnetic fields, with the goal of unencumbered haptic devices for microsurgery simulation.

- **Robot-assisted Rehabilitation**: Using the Utah Treadport locomotion interface for gait rehab. Developing control systems to ensure stable but realistic walking simulation. Investigating the role of arm swing in gait rehab.

Postdoctoral Research Associate
Institute of Robotics and Intelligent Systems, ETH Zurich, 2005-2008

- **Project Team Leader, Biomedical Microrobots for Ocular Surgery**: Led a team of students in the development of wireless magnetically controlled intraocular microrobots for retinal therapeutic and diagnostic procedures. Supervise three Ph.D. students as well as multiple M.S. and B.S. students in this project. Developed 5-DOF control using magnetic fields, which had not been previously accomplished. Developed wireless sensing and actuation technologies, based on MEMS and chemical technology, including an optical luminescence-based oxygen sensor.
- **Deputy Project Leader, Swiss NSF NCCR Co-Me project Advanced Image Guided Surgical Interventions in Ophthalmology**: Project led by Bradley Nelson. This is a project with four subprojects within Switzerland (*Biomedical Microrobots for Ocular Surgery* is one of the subprojects). This position allowed me to gain experience working with funding agencies (reports, posters, site visits).
- **Project Team Leader, ARES**: Led a team of students participating in the European project "Assembling Reconfigurable Endoluminal Surgical System (ARES)." The project involved modular robots that can be swallowed and will assemble inside the G.I. tract for therapeutic and diagnostic procedures. ETH Zurich is one of four European universities participating in this project, led by Paolo Dario at Scuola Superiore Sant'Anna. Supervised two Ph.D. students as well as multiple M.S. and B.S. students in this project. Investigated magnetic self-assembly and disassembly, as well as induction coupling.
- **Microrobot Swimming with Artificial Flagella**: Found that swimming with helical propellers that mimic bacterial flagella and are powered by rotating magnetic fields is theoretically preferable to pulling with magnetic field gradients for *in vivo* applications. Investigated magnetic control of microrobots that swim with nanocoil propellers.
- **Other Contributions**: Contributed to a number of additional projects as an active member of the Institute of Robotics and Intelligent Systems. Contributions included technical expertise, idea generation, co-advising student projects, and paper editing.

Graduate Research Assistant
Department of Mechanical Engineering, Johns Hopkins University, 2002-2005

- **Virtual Fixture Design**: Categorized and tested methods for effective user assistance during bilateral telemanipulation.
- **Stability of Forbidden-Region Virtual Fixtures**: Analyzed the stability of forbidden-region virtual fixtures by analyzing the stability of equilibrium points of the system, using a discrete-time state-space approach. The method accounts for natural damping in the human user, making the method less conservative than other methods.
- **Passive Virtual Walls**: Created provably passive virtual walls, accounting for realistic effects such as encoder quantization, sampling time, and friction. Worked towards incorporation of these passive virtual walls as stable forbidden-region virtual fixtures on passive telemanipulators.
- **Novel Bilateral Telemanipulation Controllers**: Created a novel bilateral telemanipulation method called “pseudo-admittance,” which has desirable steady-hand properties, and easily allows for the implementation of guidance virtual fixtures.
- **Human Force Control Capabilities**: Found limits of human force control precision for nonisometric forces, with implications to various human-machine systems.
- **Other Contributions**: Contributed to many projects as an active member of the Haptic Exploration Lab, the Department of Mechanical Engineering, and the Engineering Research Center for Computer Integrated Surgical Systems and Technology (ERC-CISST). Contributions included technical expertise and idea generation, as well as mentoring undergraduate students.

Graduate Research Assistant
Department of Mechanical Engineering, University of Utah, 1999-2001

- **Pulse-Frequency-Modulated Control Systems**: Worked on the control of an artificial arm using electrical signals taken directly from peripheral nerves. Thesis involved analyzing methods of pulse frequency modulation and demodulation, creating a closed-loop model of a human/artificial arm system, creating control system design tools for systems with pulse frequency modulation, and analyzing the stability of the system.
- **Mechatronics Certificate**: Earned for significant coursework and research in mechatronics.

Sarcos/Center for Engineering Design
Salt Lake City, Utah, Summer/Fall 2000

- **Human Gait**: Researched the power, torque, and forces in the joints of human legs during gait cycles, for the design of a robotic exoskeleton device.

Abbott Laboratories
Salt Lake City, Utah, Summer 1999

- **Mechanical Design**: Designed ergonomic tools for Catheter Engineering, such as an easy-to-clean heparin trough and a hand-held lumen-loading tool.
- **Mechanical Drawings**: Consolidated product drawings into a generic format, reducing the number of drawings needed, and eliminating the need for drawing updates for every product change.

Celestica
Ft. Collins, Colorado, Summer 1998

- **Automated Visual Inspection**: Learned theory and operation of existing automated visual inspection (AVI) system used for surface mount parts, and evaluated the capabilities of that machine and two of its competitors in detecting large parts such as heat-sinks and screws, leading to the purchase of a new AVI system.
- **BGA Repair**: Learned technique of creating thermal profiles for repair of ball-grid-array (BGA) IC's, completed many profiles on existing and new products, and supported day-to-day operation and problem solving associated with BGA repair.

PUBLICATIONS

Journal Publications

1. A. Pourkand and J. J. Abbott, "A Critical Analysis of Eight-electromagnet Manipulation Systems: The Role of Electromagnet Configuration on Strength, Isotropy, and Access", IEEE Robotics and Automation Letters, 3(4):2957-2962, 2018.
2. T. A. Howell, B. Osting, and J. J. Abbott, "Sorting Rotating Micromachines by Variations in Their Magnetic Properties", Physical Review Applied, 9:054021, 2018.
3. L. Leon, F. M. Warren, and J. J. Abbott, "Optimizing the Magnetic Dipole-field Source for Magnetically Guided Cochlear-implant Electrode-array Insertions", J. Medical Robotics Research, 3(1):1850004, 2018.
4. L. Leon, F. M. Warren, and J. J. Abbott, "An In-vitro Insertion-force Study of Magnetically Guided Lateral-wall Cochlear-implant Electrode Arrays", Otology & Neurotology, 39(2):e63-e73, 2018.
5. B. Hejrati, A. S. Merryweather, and J. J. Abbott, "Generating Arm-swing Trajectories in Real-time Using a Data-driven Model for Gait Rehabilitation with Self-selected Speed", IEEE Trans. Neural Systems and Rehabilitation Engineering, 26(1):115-124, 2018.
6. J. J. Abbott and B. Osting, "Optimization of Coreless Electromagnets to Maximize Field Generation for Magnetic Manipulation Systems", IEEE Magnetics Letters, 8:1300104, 2017.
7. S. E. Wright, A. W. Mahoney, K. M. Popek, and J. J. Abbott, "The Spherical-actuator-magnet Manipulator: A Permanent-magnet Robotic End-effector", IEEE Trans. Robotics, 33(5):1013-1024, 2017.

8. J. J. Abbott, J. B. Brink, and B. Osting, “Computing Minimum-power Dipole Solutions for Interdipole Forces using Nonlinear Constrained Optimization with Application to Electromagnetic Formation Flight”, IEEE Robotics and Automation Letters, 2(2):1008-1014, 2017.
9. L. B. Kratchman, T. L. Bruns, J. J. Abbott, and R. J. Webster III, “Guiding Elastic Rods with a Robot-manipulated Magnet for Medical Applications,” IEEE Trans. Robotics, 33(1):227-233, 2017.
10. K. M. Popek, T. Schmid, and J. J. Abbott, “Six-degree-of-freedom Localization of an Untethered Magnetic Capsule Using a Single Rotating Magnetic Dipole,” IEEE Robotics and Automation Letters, 2(1):305-312, 2017.
11. M. Nambi, P. S. Bernstein, and J. J. Abbott, “Effect of Haptic-interface Virtual Kinematics on the Performance and Preference of Novice Users in Telemanipulated Retinal Surgery ,” IEEE Robotics and Automation Letters, 2(1):64-71, 2017.
12. T. K. Arbuckle, M. Nambi, J. E. Butner, W. R. Provancher, and J. J. Abbott, “Human Velocity Control of Admittance-type Robotic Devices with Scaled Visual Feedback of Device Motion,” IEEE Trans. Human-Machine Systems, 46(6):859-868, 2016.
13. B. Hejrati, S. Chesebrough, K. B. Foreman, J. J. Abbott, and A. S. Merryweather, “Comprehensive Quantitative Investigation of Arm Swing During Walking at Various Speed and Surface Slope Conditions,” Human Movement Science, 49:104-115, 2016.
14. M. Nambi, P. S. Bernstein, and J. J. Abbott, “A Compact Telemanipulated Retinal-surgery System that uses Commercially Available Instruments with a Quick-change Adapter,” J. Medical Robotics Research, 1(2):1630001, 2016.
15. M. L. Burroughs, K. B. Freckleton, J. J. Abbott, and M. A. Minor, “A Sarrus-Based Passive Mechanism For Rotorcraft Perching,” J. Mechanisms and Robotics, 8:011010, 2016.
16. A. W. Mahoney and J. J. Abbott, “Five-degree-of-freedom Manipulation of an Untethered Magnetic Device in Fluid using a Single Permanent Magnet with Application in Stomach Capsule Endoscopy,” Int. J. Robotics Research, 35(1-3):129-147, 2016.
17. J. J. Abbott, “Parametric Design of Tri-axial Nested Helmholtz Coils,” Review of Scientific Instruments, 86(054701):1-10, 2015.
18. B. Hejrati, K. L. Crandall, J. M. Hollerbach, and J. J. Abbott, “Kinesthetic Force Feedback and Belt Control for the Treadport Locomotion Interface,” IEEE Trans. Haptics, 8(2):176-187, 2015.
19. A. J. Petruska, A. W. Mahoney, and J. J. Abbott, “Remote Manipulation with a Stationary Computer-Controlled Magnetic Dipole Source,” IEEE Trans. Robotics, 30(5):1222-1227, 2014.
20. L. Leon, M. S. Cavilla, M. B. Doran, F. M. Warren, and J. J. Abbott, “Scala-Tympani Phantom with Cochleostomy and Round-Window Openings for Cochlear-Implant Insertion Experiments,” J. Medical Devices, 8(041010):1-10, 2014.
21. A. W. Mahoney, N. D. Nelson, K. E. Peyer, B. J. Nelson, and J. J. Abbott, “Behavior of Rotating Magnetic Microrobots Above the Step-out Frequency with Application to Control of Multi-microrobot Systems,” Applied Physics Letters, 104(144101):1-4, 2014.
22. A. J. Petruska and J. J. Abbott, “Omnimagnet: An Omnidirectional Electromagnet for Controlled Dipole-Field Generation,” IEEE Trans. Magnetics, 50(7):8400810(1-10), 2014.
23. J. Greer, A. J. Petruska, A. W. Mahoney, M. Nambi, E. Bamberg, and J. J. Abbott, “Experimental Investigation of Wire Electrical Discharge Machining of NdFeB Permanent Magnets with an RC-type Machine,” J. Materials Engineering and Performance, 23(4):1392-1401, 2014.
24. A. W. Mahoney and J. J. Abbott, “Generating Rotating Magnetic Fields with a Single Permanent Magnet for Propulsion of Untethered Magnetic Devices in a Lumen,” IEEE Trans. Robotics, 30(2):411-420, 2014.
25. C. E. Doyle, J. J. Bird, T. A. Isom, J. C. Kallman, D. F. Bareiss, D. J. Dunlop, R. J. King, J. J. Abbott, and M. A. Minor, “An Avian-Inspired Passive Mechanism for Quadrotor Perching,” IEEE/ASME Trans. Mechatronics, 18(2):506-517, 2013.
26. A. J. Petruska and J. J. Abbott, “Optimal Permanent-Magnet Geometries for Dipole Field Approximation,” IEEE Trans. Magnetics, 49(2):811-819, 2013.
27. J. R. Clark, L. Leon, F. M. Warren, and J. J. Abbott, “Magnetic Guidance of Cochlear Implants: Proof-of-Concept and Initial Feasibility Study,” J. Medical Devices, 6(035002):1-8, 2012.
28. O. Ergeneman, J. Pokki, V. Počepcová, H. Hall, J. J. Abbott, and B. J. Nelson, “Characterization of Puncture Forces for Retinal Vein Cannulation,” J. Medical Devices, 5(044504), 2011.

29. A. W. Mahoney and J. J. Abbott, “Managing Magnetic Force Applied to a Magnetic Device by a Rotating Dipole Field,” Applied Physics Letters, 99(134103):1-3, 2011.
30. A. W. Mahoney, J. C. Sarrazin, E. Bamberg, and J. J. Abbott, “Velocity Control with Gravity Compensation for Magnetic Helical Microswimmers,” Advanced Robotics, 25:1007-1028, 2011.
31. M. Nambi, W. R. Provancher, and J. J. Abbott, “On the Ability of Humans to Apply Controlled Forces to Admittance-Type Devices,” Advanced Robotics, 25:629-650, 2011.
32. J. R. Clark, F. M. Warren, and J. J. Abbott, “A Scalable Model for Human Scala-Tympani Phantoms,” J. Medical Devices, 5(014501):1-5, 2011.
33. M. P. Kummer, J. J. Abbott, B. E. Kratochvil, R. Borer, A. Sengul, and B. J. Nelson, “OctoMag: An Electromagnetic Systems for 5-DOF Wireless Micromanipulation,” IEEE Trans. Robotics, 26(6):1006-1017, 2010.
34. C. Bergeles, K. Shamaei, J. J. Abbott, and B. J. Nelson, “Single-Camera Focus-Based Localizing of Intraocular Devices,” IEEE Trans. Biomedical Engineering, 57(8):2064-2074, 2010.
35. B. J. Nelson, I. K. Kaliakatsos, and J. J. Abbott, “Microrobots for Minimally Invasive Medicine,” Annual Review of Biomedical Engineering, 12:55-85, 2010.
36. Z. Nagy, M. Fluckiger, R. Oung, I. K. Kaliakatsos, E. W. Hawkes, B. J. Nelson, K. Harada, E. Susilo, A. Menciassi, P. Dario, and J. J. Abbott, “Assembling Reconfigurable Endoluminal Surgical Systems: Opportunities and Challenges,” Int. J. Biomechatronics and Biomedical Robotics, 1(1):3-16, 2009.
37. L. Zhang, J. J. Abbott, L. X. Dong, K. E. Peyer, B. E. Kratochvil, H. Zhang, C. Bergeles, and B. J. Nelson, “Characterizing the Swimming Properties of Artificial Bacterial Flagella,” Nano Lett., 9(10):3663-3667, 2009.
38. J. J. Abbott, K. E. Peyer, M. Cosentino Lagomarsino, L. Zhang, L. X. Dong, I. K. Kaliakatsos, and B. J. Nelson, “How Should Microrobots Swim?,” Int. J. Robotics Research, 28(11-12):1434-1447, 2009.
39. L. Zhang, J. J. Abbott, L. X. Dong, B. E. Kratochvil, D. Bell, and B. J. Nelson, “Artificial Bacterial Flagella: Fabrication and Magnetic Control,” Applied Physics Letters, 94(064107), 2009.
40. O. Ergeneman, G. Dogangil, M. P. Kummer, J. J. Abbott, M. K. Nazeeruddin, and B. J. Nelson, “A Magnetically Controlled Wireless Optical Oxygen Sensor for Intraocular Measurements,” IEEE Sensors J., 8(1):29-37, 2008.
41. J. J. Abbott, O. Ergeneman, M. P. Kummer, A. M. Hirt, and B. J. Nelson, “Modeling Magnetic Torque and Force for Controlled Manipulation of Soft-Magnetic Bodies,” IEEE Trans. Robotics, 23(6):1247-1252, 2007.
42. J. J. Abbott and A. M. Okamura, “Pseudo-admittance Bilateral Telemanipulation with Guidance Virtual Fixtures,” Int. J. Robotics Research, 26(8):865-884, 2007.
43. J. J. Abbott, Z. Nagy, F. Beyeler, and B. J. Nelson, “Robotics in the Small, Part I: Microrobotics,” IEEE Robotics and Automation Mag., 14(2):92-103, 2007.
44. J. J. Abbott and S. G. Meek, “Digital Emulation of Pulse Frequency Modulation for Neuroprosthetic Sensory Feedback,” IEEE Trans. Neural Systems and Rehabilitation Engineering, 15(1):131-135, 2007.
45. J. J. Abbott and A. M. Okamura, “Stable Forbidden-Region Virtual Fixtures for Bilateral Telemanipulation,” J. Dynamic Systems, Measurement, and Control, 128(1):53-64, 2006.
46. J. J. Abbott and A. M. Okamura, “Effects of Position Quantization and Sampling Rate on Virtual-Wall Passivity,’” IEEE Trans. Robotics, 21(5):952-964, 2005.

Conference Publications/Presentations

1. I. Nelson, T. A. Ogden, P. Wadsworth, M. Mroz, J. J. Abbott, and S. E. Naleway, “Freeze Casting Using Tri-axial Magnetic Field Control to Fabricate Materials Inspired by Bone”, TMS Annual Meeting and Exhibition, 2019, to appear.
2. L. N. Pham and J. J. Abbott, “A Soft Robot to Navigate the Lumens of the Body Using Undulatory Locomotion Generated by a Rotating Magnetic Dipole Field”, IEEE/RSJ Int. Conf. Intelligent Robots and Systems, 2018, to appear.

3. A. Pourkand and J. J. Abbott, “A Critical Analysis of Eight-electromagnet Manipulation Systems: The Role of Electromagnet Configuration on Strength, Isotropy, and Access”, IEEE/RSJ Int. Conf. Intelligent Robots and Systems, 2018, to appear.
4. D. E. Usevitch and J. J. Abbott, “Translational and Rotational Arrow Cues (TRAC) Outperforms Triplanar Display During 6-DOF Navigations for use in IGS Manual Alignment Tasks”, Hamlyn Symp. Medical Robotics, pp. 104-105, 2018.
5. I. Nelson, T. A. Ogden, S. Al Khateeb, J. Graser, T. D. Sparks, J. J. Abbott, and S. E. Naleway, “Freeze Casting of Surface-Magnetized TiO2 and Fe3O4 Using a Uniform Magnetic Field to Fabricate Materials Inspired by Bone”, TMS Annual Meeting and Exhibition, 2018.
6. R. Zhang, A. J. Boyles, and J. J. Abbott, “Six Principal Modes of Vibrotactile Display via Stylus”, IEEE Haptics Symp., pp. 313-318, 2018.
7. J. J. Abbott and H. C. Fu, “Controlling Homogeneous Microrobot Swarms In Vivo Using Rotating Magnetic Dipole Fields”, Int. Symp. Robotics Research, 2017.
8. K. M. Popek, T. Hermans, and J. J. Abbott, “First Demonstration of Simultaneous Localization and Propulsion of a Magnetic Capsule in a Lumen using a Single Rotating Magnet”, IEEE Int. Conf. Robotics and Automation, pp. 1154-1160, 2017. **Best Paper Award in Medical Robotics**.
9. D. Bareiss, J. van den Berg, J. J. Abbott, and K. K. Leang, “Study of Improved Pilot Performance using Automatic Collision Avoidance for Tele-operated Unmanned Aerial Vehicles”, IEEE Int. Symp. Safety, Security and Rescue Robotics, pp. 118-124, 2016.
10. M. Nambi, P. S. Bernstein, and J. J. Abbott, "A Compact Retinal-surgery Telemanipulator that uses Disposable Instruments," In N. Navab et al. (Eds.): MICCAI 2015, Part I, LNCS 9349, pp. 258–265, Springer, 2015.
11. K. M. Popek and J. J. Abbott, "6-D Localization of Magnetic Capsule Endscope Using at a Stationary Rotating Magnetic Dipole Field," Hamlyn Symp. Medical Robotics, pp. 47-48, 2015.
12. A. J. Petruska, J. B. Brink, and J. J. Abbott, "First Demonstration of a Modular and Reconfigurable Magnetic-Manipulation System," IEEE Int. Conf. Robotics and Automation, pp. 149-155, 2015. **Finalist, Best Robotic Manipulation Paper Award**.
13. O. R. Barnes, B. Hejrati, and J. J. Abbott, "An Underactuated Wearable Arm-swing Rehabilitator for Gait Training," IEEE Int. Conf. Robotics and Automation, pp. 4998-5003, 2015.
14. N. D. Nelson and J. J. Abbott, "Generating Two Independent Rotating Magnetic Fields with a Single Magnetic Dipole for the Propulsion of Untethered Magnetic Devices," IEEE Int. Conf. Robotics and Automation, pp. 4056-4061, 2015.
15. S. E. Wright, A. W. Mahoney, K. M. Popek, and J. J. Abbott, "A Spherical-magnet End-effector for Robotic Magnetic Manipulation," IEEE Int. Conf. Robotics and Automation, pp. 1190-1195, 2015.
16. A. W. Mahoney and J. J. Abbott, "5-DOF Manipulation of an Untethered Magnetic Device in Fluid using a Single Permanent Magnet,: Robotics: Science and Systems, pp. 1-9, 2014.
17. J. B. Brink, A. J. Petruska, D. E. Johnson, and J. J. Abbott, "Factors Affecting the Design of Untethered Magnetic Haptic Interfaces," IEEE Haptics Symp., pp. 107-114, 2014. **Best Paper Award**.
18. A. W. Mahoney and J. J. Abbott, “5-DOF Manipulation of a Magnetic Capsule in Fluid using a Single Permanent Magnet: Proof-of-concept for Stomach Endoscopy,” Hamlyn Symp. Medical Robotics, pp. 114-115, 2013. **Best Poster Award**
19. A. W. Mahoney, S. E. Wright, and J. J. Abbott, "Managing the Attractive Magnetic Force between an Untethered Magnetically Actuated Tool and a Rotating Permanent Magnet," IEEE Int. Conf. Robotics and Automation, pp. 5346-5351, 2013.
20. N. D. Nelson, J. Delacenserie, and J. J. Abbott, "An Empirical Study of the Role of Magnetic, Geometric, and Tissue Properties on the Turning Radius of Magnetically Driven Screws," IEEE Int. Conf. Robotics and Automation, pp. 5352-5357, 2013.
21. A. J. Petruska and J. J. Abbott, "An Omnidirectional Electromagnet for Remote Manipulation," IEEE Int. Conf. Robotics and Automation, pp. 814-819, 2013.
22. K. M. Popek, A. W. Mahoney, and J. J. Abbott, "Localization Method for a Magnetic Capsule Endoscope Propelled by a Rotating Magnetic Dipole Field," IEEE Int. Conf. Robotics and Automation, pp. 5328-5333, 2013.

23. A. W. Mahoney, N. D. Nelson, E. M. Parsons, and J. J. Abbott, "Non-ideal Behaviors of Magnetically Driven Screws in Soft Tissue," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, pp. 3559-3564, 2012.
24. K. M. Miller, A. W. Mahoney, T. Schmid, and J. J. Abbott, "Proprioceptive Magnetic-Field Sensing for Closed-loop Control of Magnetic Capsule Endoscopes," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, pp. 1994-1999, 2012.
25. B. Hejrati, D. Hull, J. Black, J. J. Abbott, and J. M. Hollerbach, "Investigation of the Treadport for Gait Rehabilitation of Spinal Cord Injury," Int. Conf. IEEE Engineering in Medicine and Biology Society, pp. 4553-4558, 2012.
26. A. W. Mahoney and J. J. Abbott, "Control of Untethered Magnetically Actuated Tools with Localization Uncertainty using a Rotating Permanent Magnet" 2012 IEEE Int. Conf. Biomedical Robotics and Biomechatronics, pp. 1632-1637, 2012.
27. A. Damani, M. Nambi, and J. J. Abbott, "An Empirical Study of Static Loading on Piezoelectric Stick-Slip Actuators of Micromanipulators," Int. Symp. Experimental Robotics, 2012.
28. A. W. Mahoney, D. L. Cowan, K. M. Miller, and J. J. Abbott, "Control of Untethered Magnetically Actuated Tools at any Position using a Rotating Permanent Magnet" 2012 IEEE Int. Conf. Robotics and Automation, pp. 3375-3380, 2012.
29. M. Nambi, A. Damani, and J. J. Abbott, "Toward Intuitive Teleoperation of Micro/Nano-Manipulators with Piezoelectric Stick-Slip Actuators," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, pp. 445-450, 2011.
30. C. E. Doyle, J. J. Bird, T. A. Isom, C. J. Johnson, J. C. Kallman, J. A. Simpson, R. J. King, J. J. Abbott, and M. A. Minor, "Avian-Inspired Passive Perching Mechanism for Robotic Rotorcraft," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, pp. 4975-4980, 2011.
31. J. R. Clark, L. Leon, F. M. Warren, and J. J. Abbott, "Investigation of Magnetic Guidance of Cochlear Implants," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, pp. 1321-1326, 2011.
32. M. Nambi, W. R. Provancher, and J. J. Abbott, "Revisiting the Effect of Velocity on Human Force Control," In A. M. L. Kappers et al. (Eds.): EuroHaptics 2010, Part I, LNCS 6191, pp. 144-151, 2010.
33. A. V. Shah, S. Teuscher, E. W. McClain, and J. J. Abbott, "How to Build an Inexpensive 5-DOF Haptic Device using Two Novint Falcons, In A. M. L. Kappers et al. (Eds.): EuroHaptics 2010, Part I, LNCS 6191, pp. 136-143, 2010.
34. T. W. R. Fountain, P. V. Kailat, and J. J. Abbott, "Wireless Control of Magnetic Helical Microrobots using a Rotating-Permanent-Magnet Manipulator," IEEE Int. Conf. Robotics and Automation, pp. 576-581, 2010. **Finalist, Best Medical Robotics Paper Award**
35. M. P. Kummer, J. J. Abbott, B. E. Kratochvil, R. Borer, A. Sengul, and B. J. Nelson, "OctoMag: An Electromagnetic Systems for 5-DOF Wireless Micromanipulation," IEEE Int. Conf. Robotics and Automation, pp. 1610-1616, 2010. **Best Manipulation Paper Award**
36. B. E. Kratochvil, M. P. Kummer, J. J. Abbott, O. Ergeneman, and B. J. Nelson, "OctoMag: An Electromagnetic Systems for 5-DOF Wireless Manipulation," IEEE Int. Conf. Robotics and Automation, pp. 1080-1081, 2010, Video. **Finalist, Best Video Award**
37. L. Zhang, J. J. Abbott, L. X. Dong, B. E. Kratochvil, H. Zhang, K. E. Peyer, and B. J. Nelson, "Micromanipulation Using Artificial Bacterial Flagella," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, 2009, pp. 1401-1406, 2009.
38. Z. Nagy, S. Miyashita, S. Muntwyler, A. K. Cherukuri, J. J. Abbott, R. Pfeifer, and B. J. Nelson, "Morphology Detection for Magnetically Self-Assembled Modular Robots," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, 2009, pp. 5281-5286, 2009.
39. C. Bergeles, K. Shamaei, J. J. Abbott, and B. J. Nelson, "Wide-Angle Localization of Intraocular Devices from Focus," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, 2009, pp. 4523-4528, 2009.
40. C. Bergeles, K. Shamaei, J. J. Abbott, and B. J. Nelson, "Wide-Field Intraocular Imaging and Localization," Int. Conf. Medical Image Computing and Computer Assisted Intervention, pp. 540-548, 2009.
41. C. Bergeles, G. Fagogenis, J. J. Abbott, and B. J. Nelson, "Tracking Intraocular Microdevices Based on Colorspace Evaluation and Statistical Color/Shape Information," IEEE Int. Conf. Robotics and Automation, pp. 3934-3939, 2009.

42. C. Bergeles, K. Shamaei, J. J. Abbott, and B. J. Nelson, "On Imaging and Localizing Untethered Intraocular Devices with a Stationary Camera," IEEE Int. Conf. Biomedical Robotics and Biomechatronics, pp. 489-494, 2008. **Finalist, Best Paper Award** and **Finalist, Best Student Paper Award**.
43. O. Ergeneman, J. J. Abbott, G. Dogangil, and B. J. Nelson, "Functionalizing Intraocular Microrobots with Surface Coatings," IEEE Int. Conf. Biomedical Robotics and Biomechatronics, pp. 232-237, 2008.
44. Z. Nagy, R. Oung, J. J. Abbott, and B. J. Nelson, "Experimental Investigation of Magnetic Self-Assembly for Swallowable Modular Robots," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, pp. 1915-1920, 2008.
45. G. Dogangil, O. Ergeneman, J. J. Abbott, S. Pane, H. Hall, S. Muntwyler, and B. J. Nelson, "Toward Targeted Retinal Drug Delivery with Wireless Microrobots," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, pp. 1921-1926, 2008.
46. B. E. Kratochvil, L. X. Dong, L. Zhang, J. J. Abbott, and B. J. Nelson, "Nanohelices as Motion Converters," IEEE/RSJ Int. Conf. Intelligent Robots and Systems 2008, pp. 4141-4142, 2008, *Video*.
47. Z. Nagy, O. Ergeneman, J. J. Abbott, M. Hutter, A. M. Hirt, and B. J. Nelson, "Modeling Assembled-MEMS Microrobots for Wireless Magnetic Control," IEEE Int. Conf. Robotics and Automation, pp. 874-879, 2008.
48. J. J. Abbott, K. E. Peyer, L. X. Dong, and B. J. Nelson, "How Should Microrobots Swim?," Int. Symp. Robotics Research, 2007.
49. Z. Nagy, J. J. Abbott, and B. J. Nelson, "The Magnetic Self-Aligning Hermaphroditic Connector: A Scalable Approach for Modular Microrobots," IEEE/ASME Int. Conf. Advanced Intelligent Mechatronics, 2007.
50. J. J. Abbott, O. Ergeneman, M. P. Kummer, A. M. Hirt, and B. J. Nelson, "Modeling Magnetic Torque and Force for Controlled Manipulation of Soft-Magnetic Bodies," IEEE/ASME Int. Conf. Advanced Intelligent Mechatronics, 2007. *The definitive version of this work is in the journal paper with the same title.*
51. M. P. Kummer, J. J. Abbott, S. Dinser, and B. J. Nelson, "Artificial Vitreous Humor for In Vitro Experiments," IEEE Int. Conf. Engineering in Medicine and Biology Society, pp. 6406-6409, 2007.
52. O. Ergeneman, G. Dogangil, J. J. Abbott, M. K. Nazeeruddin, and B. J. Nelson, "A Magnetically Controlled Wireless Intraocular Oxygen Sensor: Concept, Prototype, and In Vitro Experiments," IEEE Int. Conf. Engineering in Medicine and Biology Society, pp. 4189-4193, 2007. *The definitive version of this work is in the journal paper "A Magnetically Controlled Wireless Optical Oxygen Sensor for Intraocular Measurements."*
53. M. P. Kummer, J. J. Abbott, K. Vollmers, and B. J. Nelson, "Measuring the Magnetic and Hydrodynamic Properties of Assembled-MEMS Microrobots," IEEE Int. Conf. Robotics and Automation, pp. 1122-1127, 2007.
54. J. J. Abbott, O. Ergeneman, M. P. Kummer, A. M. Hirt, and B. J. Nelson, "A Continuous Model for Magnetization Torque on Axially Symmetric Bodies," Joint MMM/Intermag Conf., 2007 (poster). *The definitive version of this work is in the journal paper "Modeling Magnetic Torque and Force for Controlled Manipulation of Soft-Magnetic Bodies."*
55. J. J. Abbott and A. M. Okamura, "Pseudo-admittance Bilateral Telemanipulation with Guidance Virtual Fixtures," IEEE Symp. Haptic Interfaces for Virtual Environment and Teleoperator Systems, pp. 169-175, 2006. **Finalist, Best Student Paper Award**. *The definitive version of this work is in the journal paper with the same title.*
56. J. J. Abbott, P. Marayong, and A. M. Okamura, "Haptic Virtual Fixtures for Robot-Assisted Manipulation," In S. Thrun, R. Brooks, and H. Durrant-Whyte, editors, Robotics Research: Results of the 12th International Symposium ISRR, pp. 49-64. Springer, 2007. *The definitive version of this work is published as a book chapter with the same title.*
57. M. Wu, J. J. Abbott, and A. M. Okamura, "Effect of Velocity on Human Force Control," Proc. Joint Eurohaptics Conf. and Symp. Haptic Interfaces for Virtual Environment and Teleoperator Systems (World Haptics), pp. 73-79, 2005.
58. J. J. Abbott and A. M. Okamura, "A Sufficient Condition for Virtual Wall Passivity with Quantization Effects," ASME Int. Mechanical Engineering Congress and Exposition, pp. 1065-

1073, 2004. *The definitive version of this work is in the journal paper "Effects of Position Quantization and Sampling Rate on Virtual-Wall Passivity."*

59. I. Emeagwali, P. Marayong, J. J. Abbott, and A. M. Okamura, "Performance Analysis of Steady-Hand Telemanipulation versus Cooperative Manipulation," Symp. Haptic Interfaces for Virtual Environment and Teleoperator Systems, pp. 316-322, 2004.
60. J. J. Abbott, G. D. Hager, and A. M. Okamura, "Steady-Hand Teleoperation with Virtual Fixtures," IEEE Int. Workshop on Robot and Human Interactive Communication (RO-MAN), pp. 145-151, 2003.
61. J. J. Abbott and A. M. Okamura, "Analysis of Virtual Fixture Contact Stability for Telemanipulation," IEEE/RSJ Int. Conf. Intelligent Robots and Systems, pp. 2699-2706, 2003. *The definitive version of this work is in the journal paper "Stable Forbidden-Region Virtual Fixtures for Bilateral Telemanipulation."*
62. J. J. Abbott and A. M. Okamura, "Virtual Fixture Architectures for Telemanipulation," IEEE Int. Conf. Robotics and Automation, pp. 2798-2805, 2003.

Book Chapters and Nonreviewed Papers

1. K. E. Peyer, A. W. Mahoney, L. Zhang, J. J. Abbott, and B. J. Nelson, "Bacteria-Inspired Microrobots," in M. J. Kim et al. (eds.), *Microbiorobotics: Biologically Inspired Microscale Robotic Systems*, pp. 165-199, 2012.
2. O. Ergeneman, C. Bergeles, M. P. Kummer, J. J. Abbott, and B. J. Nelson, "Wireless Intraocular Microrobots: Opportunities and Challenges," in J. Rosen et al. (eds.), Surgical Robotics: Systems Applications and Visions, pp. 271-311, 2011.
3. A. M. Okamura and J. J. Abbott, "Virtual Fixtures for Telemanipulation: Control and Applications in Robot-Assisted Minimally Invasive Surgery," SPIE Robotics and Machine Perception Technical Group Newsletter, 13(1), April 2004.

Ph.D. Dissertation and Master's Thesis (Includes Students Advised and Co-advised)

1. C. R. Thornley, 2018, “On the Practicality of Six-degree-of-freedom Magnetic Actuation for Wireless Microrobotics,” Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
2. L. Leon, 2017, “Magnetic Guidance of Cochlear-implant Electrode Arrays at Clinical Scale,” Ph.D. Dissertation, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
3. K. Popek, 2017, “Magnetic Localization and Closed-loop Propulsion for Active Capsule Endoscopy Using a Single Magnetic Dipole Source,” Ph.D. Dissertation, School of Computing, University of Utah, Salt Lake City, Utah.
4. B. Hejrati, 2016, “Advances in Robot-assisted Gait Rehabilitation with Self-selected Speed,” Ph.D. Dissertation, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
5. M. Nambi, 2015, “Intuitive Telemanipulation of Micromanipulators with Piezoelectric Stick-slip Actuators with Application in Retinal Surgery,” Ph.D. Dissertation, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
6. O. R. Barnes, 2015, “A Wearable Underactuated Kinesthetic Device for Inducing Arm Swing During Gait Rehabilitation,” Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
7. S. E. Wright, 2014, “A Singularity-free Mechanism for Holonomic Orientation Control of a Spherical Permanent Magnet,” Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
8. A. W. Mahoney, 2014, "Advanced Methods for Controlling Untethered Magnetic Devices Using Rotating Magnetic Fields," Ph.D. Dissertation, School of Computing, University of Utah, Salt Lake City, Utah.
9. A. J. Petruska, 2014, "Design and Control of a Magnetic Dipole Source for Noncontact Manipulation," Ph.D. Dissertation, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.

10. M. L. Burroughs, 2014, "A Sarrus-based Passive Mechanism for Rotorcraft Perching," Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
11. A. Damani, 2013, “An Empirical Model of Piezoelectric Stick-Slip Actuation of the Kleindiek MM3A Micromanipulator,” Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
12. T. K. Arbuckle, 2012, “Velocity-Control Performance with a Fingertip Controlled Admittance-Type Haptic Device,” Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
13. J. Greer, 2011, “Wire Electrical Discharge Machining of Helical Devices from Permanent Magnets,” Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
14. C. E. Doyle, 2011, “Avian-Inspired Passive Landing Mechanisms for Perching Rotorcraft,” Master’s Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
15. J. R. Clark, 2011, “Toward Improved Cochlear Implant Insertion Using Magnetic Guidance,” Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.
16. J. J. Abbott, 2005, "Virtual Fixtures for Bilateral Telemanipulation," Ph.D. Dissertation, Department of Mechanical Engineering, Johns Hopkins University, Baltimore, Maryland.
17. J. J. Abbott, 2001, "Design Tools for Pulse-Frequency-Modulated Control Systems: Error Analysis and Limit-Cycle Prediction," Master's Thesis, Department of Mechanical Engineering, University of Utah, Salt Lake City, Utah.

AWARDS/HONORS

Best Paper Award in Medical Robotics, 2017
IEEE International Conference on Robotics and Automation

Best Robotic Manipulation Paper Award Finalist, 2015
IEEE International Conference on Robotics and Automation

Outstanding Research Award, 2014
Department of Mechanical Engineering, University of Utah

Second Place in Poster Session, 2014
Symposium on Cochlear Implants in Children

Best Paper Award, 2014
IEEE Haptics Symposium

Best Poster Award, 2013
Hamlyn Symposium on Medical Robotics

Outstanding Teaching Award, 2010-2011
Department of Mechanical Engineering, University of Utah

Best Manipulation Paper Award, 2010
IEEE International Conference on Robotics and Automation

Best Medical Robotics Paper Award Finalist, 2010
IEEE International Conference on Robotics and Automation

Best Video Award Finalist, 2010
IEEE International Conference on Robotics and Automation

Best Paper Award Finalist and Best Student Paper Award Finalist, 2008
IEEE International Conference on Biomedical Robotics and Biomechatronics

Best Student Paper Award Finalist, 2006
Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems

Teaching Assistant Award, 2005
Department of Mechanical Engineering, Johns Hopkins University

Teaching Assistant Award Finalist, 2005
Whiting School of Engineering, Johns Hopkins University

Wayne Brown Fellowship, 1999
Awarded by College of Engineering, University of Utah

Outstanding Senior Award, 1999
Number one ranking senior in Utah State University Mechanical Engineering Class of 1999

Academic Excellence Award, 1998
One of the top three juniors in Utah State University Mechanical Engineering Class of 1999

PRESS COVERAGE

February 26, 2011: *KUTV News*, U: Virtual Reality Treadmill Helping Spinal Cord Injury Patients
This television segment features the use of the Treadport for rehabilitation of patients with incomplete spinal-cord injuries.

April 20, 2010: *The Daily Utah Chronicle*, Microrobots aid surgery
Research in the Telerobotics Lab is featured.

January 15, 2010: Jake Abbott interviewed on the "Science to go with the show" podcast accompanying the *UEN-TV SciFi Friday* movie.

November 12, 2009: The paper "How Should Microrobots Swim?" featured on MDLinx.com.

May 1, 2009: Jake Abbott interviewed on the "Science to go with the show" podcast accompanying the *UEN-TV SciFi Friday* movie.

March 31, 2009: *Utah Public Radio Science Questions*, Robotic Surgery
Jake Abbott discusses surgical robotics.

March 2, 2009: *Ars Technica*, Microscopic magnetic mimic of microbial motor made
Artificial bacterial flagella featured.

March 2, 2009: The paper "Artificial Bacterial Flagella: Fabrication and Magnetic Control,", which originally appeared in *Applied Physics Letters*, was chosen to appear in the *Virtual Journal of Nanoscale Science and Technology* 19(9).

January 13, 2009: *Euronews*, Honey, I shrunk the Endoscopy: the wonders of micro-medicine
The swallowable modular robot project ARES, intraocular microrobots, and helical-propeller microrobots are featured.

December 5, 2008: *Nouvo*, Chérie, j'ai rétréci le médecin!
The swallowable modular robot project ARES, intraocular microrobots, and helical-propeller microrobots are featured on Swiss TV.

December 1, 2008: *Science Daily*, A Surgeon You Can Swallow
The swallowable modular robot project ARES is featured.

October 21, 2008: The paper "On Imaging and Localizing Untethered Intraocular Devices with a Stationary Camera," presented at the IEEE International Conference on Biomedical Robotics and Biomechatronics, is a finalist for both the Best Paper Award and the Best Student Paper Award.

September 22, 2008: *Technology Review*, Building a Self-Assembling Stomach-Bot
The swallowable modular robot project ARES is featured.

September 4, 2008: *The Economist*, Swallow the surgeon
Jake Abbott discusses intraocular microrobots. The swallowable modular robot project ARES is also featured.

August 17, 2008: *BBC News Click*, Looking ahead to tiny technology
Intraocular microrobots and helical-propeller microrobots featured.

PATENTS PENDING AND PROVISIONAL PATENTS

1. "Spherical Mechanism for Magnetic Manipulation," A. W. Mahoney, S. E. Wright, and J. J. Abbott, (U. of Utah), 2013.
2. "Magnetic Manipulation of an Untethered Device with a Magnetic Actuator," A. W. Mahoney and J. J. Abbott, (U. of Utah), 2013.
3. "An Extendable and Retractable Knife for Cataract Surgery," B. K. Ambati, B. Raeymaekers, J. J. Abbott, M. Cavilla, and M. Doran, (U. of Utah), 2012.
4. "Omnidirectional Electromagnet," A. J. Petruska and J. J. Abbott, (U. of Utah), 2012.
5. "Control of Magnetically Actuated Tools in any Position using a Rotating Magnetic Source", A. W. Mahoney and J. J. Abbott, (U. of Utah), 2011.
6. "Cochlear Implant Insertion Method and System," J. J. Abbott, J. R. Clark, and F. M. Warren, (U. of Utah), 2010.
7. "Magnetic Manipulation and Navigation System for a Magnetic Element," M. P. Kummer, J. J. Abbott, B. E. Kratochvil, and B. J. Nelson (ETH Zurich), 2009.
8. "Ophthalmoscopy Using Direct Sensing of the Flat Aerial Image Created by an Aspheric Lens," K. Shamaei Ghahfarokhi, C. Bergeles, J. J. Abbott, and B. J. Nelson (ETH Zurich), 2008.
9. "A Magnetically Controlled Wireless Optical Oxygen Sensor for Intraocular Measurements," O. Ergeneman, G. Dogangil, J. J. Abbott, K. Vollmers, and B. J. Nelson (ETH Zurich), 2007.

SUPPORT (CURRENT AND PRIOR)

1. NSF (EFMA), "EFRI C3 SoRo: Magneto-electroactive Soft, Continuum, Compliant, Configurable (MESo-C3) Robots for Medical Applications Across Scales", Jake Abbott (PI), Yong Lin Kong, Kam Leang, On Shun Pak, and Rajesh Rajamani. $1,999,910. 9/15/2018-8/14/2022.
2. NSF (IIS: Robust Intelligence), "EAGER: Toward Magnetic Manipulation of Nonmagnetic Objects", Jake Abbott (PI) and Tucker Hermans. $248,739. 9/1/2018-8/30/2020.
3. NIH (NEI), "Quantifying the Benefits of Head-mounting in Telemanipulated Robotics Eye Therapies," Jake Abbott (PI), Paul Bernstein, and Balamurali Ambati. $384,707. 3/1/17-2/28/19.
4. NSF (IIS: Cyber Human Systems), "CHS: Small: Toward a New Generation of Untethered Magnetic Haptic Interfaces," Jake Abbott (PI) and David Johnson. $500,000. 8/1/2014-7/31/2018.
5. NIH (NIDCD), "Magnetic Guidance for Improved Cochlear-Implant Insertion," Jake Abbott (PI), Tim Ameel, Albert Park, Frank Warren, and Robert Webster. $1,842,850. 8/1/2014-7/31/2019.
6. NSF (CMMI: Sensors, Dynamics, and Control), "Collaborative Research: Shepherding Biomedical Microswimmers Using Magnetic Fields," Jake Abbott (PI). $230,427. 8/15/2014-12/31/2018. This project is in collaboration with Henry Fu at the University of Nevada, Reno.

7. Intuitive Surgical (Technology Research Grant), "Adding Microforceps Capability to Retinal Microsurgery Systems," J. J. Abbott (PI) and P. Bernstein (co-I). $50,000. 1/1/2014-1/31/2015.
8. Given Imaging, "Exploration of Magnetic Capsule Endoscopy using a Single Permanent Magnet," J. J. Abbott (PI). $28,000. 08/26/13-02/25/14.
9. NASA (Space Technology Research Fellowship), "Modular Magnetic Mobile Manipulators for Microgravity Environments," J. J. Abbott (PI) and J. Brink (Graduate Student). $85,992. 08/01/13-01/02/15.
10. Intuitive Surgical (Technology Research Grant), "Intuitive Telemanipulation System for Retinal Microsurgery based on Piezoelectric Stick-Slip Actuator Technology," J. J. Abbott (PI) and P. Bernstein (co-I). $50,000. 1/1/2013-1/31/2014.
11. University of Utah Research Foundation (Technology Commercialization Project), "Nitinol Ring-Capsulotome for Cataract Surgery," B. Raeymaekers (PI), J. J. Abbott (co-PI), and B. Ambati (co-PI). $56,372. 01/01/13-12/31/13.
12. NSF (National Robotics Initiative), "NRI: Small: Robotic Treadmill Therapy for Lower Spinal Cord Injuries," J. M. Hollerbach (PI) and J. J. Abbott (co-PI). $908,999. 9/1/12-8/30/15.
13. University of Utah Research Foundation (Seed Grant), "A Wearable Robotic Arm-Swing Device for Improved Gait Rehabilitation," J. J. Abbott (PI). $28,000. 7/1/11-6/30/12.
14. NSF (IIS: Robust Intelligence), "CAREER: Nonuniform-Magnetic-Field Control for Medical Microrobots," J. J. Abbott (PI). IIS-0952718. $499,793. 4/1/10-3/31/15.

TEACHING

***Dynamics*, University of Utah (Fall 2018)**
First time teaching this class in Fall 2018. Required sophomore-level course with approximately 80 students. Using Pearson's *MasteringEngineering* software for first time.

***Mechatronics II*, University of Utah (Spring 2011, Spring 2014, Fall 2015)**
First time teaching this class in 2011. Required junior-level course with approximately 150 students. Developed all new lectures, homework assignments, and exams. Class has significant laboratory and project components, run by a team of six laboratory TAs. Lab assignments were used from previous incarnations of the class. Topics include dynamic system modeling and control, hydraulic systems, and programmable logic controllers.

***Mechatronics I*, University of Utah (Fall 2010, Fall 2013)**
First time teaching this class in 2010. Required junior-level course with approximately 150 students. Developed all new lectures, homework assignments, and exams. Class has significant laboratory and project components, run by a team of six laboratory TAs. Lab assignments were used from previous incarnations of the class. Topics include sensors and actuators, signal conditioning, state-machine design, and mechanisms (gears, cams, linkages). For 2013, worked with other *Mechatronics* instructors to select new textbooks for the two-semester sequence.

***State-Space Methods*, University of Utah (Spring 2010, Spring 2012, Spring 2013, Spring 2016)**
In the first time teaching this 5000/6000 course, taught as a combined graduate course and senior elective, I developed all new lectures, homework assignments, and exams. Topics involve analysis and design of time-domain multi-input/multi-output linear systems. In the second time teaching, I added a large online component, in which students watch video tutorials prepared by me before coming to class. The class period is then used as an extended discussion, rather than a traditional lecture. In my third teaching of this course, I went back to traditional lectures, but left the online videos available as supplementary material.

***Classical Control Systems*, University of Utah (Fall 2009, Fall 2011, Fall 2012)**
In the first time teaching this 5000/6000 course taught as a combined graduate course and senior elective, developed all new lectures, homework assignments, and exams. Incorporated control of sampled-data systems, which had not been taught in this course previously. Topics involve analysis and design of complex-frequency-domain (Laplace) single-input/single-output linear systems. In the second time teaching, switched to better text and reordered some lecture material.

***Haptics*, University of Utah (Spring 2009, Spring 2017)**
Co-developed and co-taught a new class on haptics for virtual and telemanipulated environments with Dr. William Provancher in Spring 2009. The class is a combination of traditional lectures and literature readings, and consists of newly designed lab sections that develop hands-on experience programming haptic devices. A large portion of the grade focuses on a class project that must represent new research with scientific value. Taught this class again (solo) in Spring 2017.

Teaching Assistant for *Theory of Robotics and Mechatronics*, ETH Zurich (Fall 2007)
Trained new teaching assistant in screw theory material, and gave multiple lectures.

Redesign and Teaching Assistant for *Theory of Robotics and Mechatronics*, ETH Zurich (Fall 2006)
Worked together with a Ph.D. student to redesign the *Theory of Robotics and Mechatronics* class, building upon the existing class, but incorporating elements of screw theory and the product-of-exponentials formulation of robotics. Also the teaching assistant for that class for Winter 2006 semester, giving multiple lectures, and conducting a weekly help session.

Teaching Assistant for *Design and Analysis of Dynamic Systems*, Johns Hopkins University (Spring 2004)
Responsibilities included setting up labs, running lab sections, holding office hours, and grading. I also gave two lectures.

Teaching Assistant for *Introduction to Robotics*, Johns Hopkins University (Fall 2002)
Responsibilities included holding office hours and grading (including preparing keys). I also prepared and gave two lectures.

STUDENT ADVISING

University of Utah

- Ph.D. Students: Matt Cavilla, Babak Hejrati (2016, co-advised with John Hollerbach), Lisandro Leon (2017), Arthur Mahoney (2014), Manikantan Nambi (2015), Andrew Petruska (2014), Lan Pham, Katie Popek (2017), Nick Posselli, Ashkan Pourkand, A.J. Sperry, David Usevitch, Ruisi Zhang
- M.S. Students: Troy Arbuckle (2012, co-advised with William Provancher), Owen Barnes (2014), Joseph Brink (2014), Michelle Burroughs (2014, co-advised with Mark Minor), Matt Cavilla (2015, co-advised with Bart Raeymaekers), James Clark (2010), Aayush Damani (2012), Michael Doran (2015, co-advised with Bart Raeymaekers), Courtney Doyle (2011, co-advised with Mark Minor), Jeremy Greer (2011, co-advised with Eberhard Bamberg), Cameraon Hendricks, Nathan Nelson (2016), Colton Thornley (2018), Sam Wright (2015)

ETH Zurich (supervised, officially advised by Bradley Nelson)

- Ph.D. Students: Michael Kummer, Olgac Ergeneman, Zoltan Nagy, Christos Bergeles, Ioannis Kaliakatsos
- M.S. Students: Gorkem Dogangil, Kamran Shamaei, Ali Sengul, Raymond Oung, Zoltan Nagy
- B.S. Students: Kathrin Peyer, Oliver Braun, Markus Tobler, Ali Sengul

PROFESSIONAL ACTIVITIES

Memberships

- American Society of Mechanical Engineers (ASME)
- Institute of Electrical and Electronics Engineers (IEEE)

Activities

- Associate Editor, International Journal of Robotics Research, 2017-present.
- Associate Editor, IEEE Transactions on Robotics, 2014-present.

- Ad Hoc Member of Study Section BTSS, National Institutes of Health, 2017 (twice), 2018.
- Panelist, National Science Foundation, 2017, 2016, 2015, 2014, 2013 (twice).
- Panelist, Canada Foundation for Innovation, 2014.
- Program Committee, Robotics: Science and Systems, 2014.
- Panelist, Israel Science Foundation, 2013.
- Associate Editor, IEEE International Conference on Robotics and Automation, Karlsruhe, Germany, May 2013.
- Member, 2nd Roadmapping Workshop on US Medical and Healthcare Robotics, University of Southern California, July 2012.
- Associate Editor, IEEE International Conference on Robotics and Automation, Twin Cities, Minnesota, May 2012.
- Session Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems: Micromanipulation, San Francisco, September 2011.
- Juror, EuroHaptics: Best Demonstration Award, Amsterdam, Netherlands, 2010.
- Panelist, National Science Foundation, 2010.
- Associate Editor, IEEE International Conference on Robotics and Automation, Anchorage, Alaska, May 2010.
- Session Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems: Medical Robotic Systems, St. Louis, Missouri, October 2009.
- Student, Winter School on Medical Robotics and Computer-Integrated Interventional Systems, Baltimore, Maryland, January 2009.
- Program Committee, IEEE International Conference on Biomedical Robotics and Biomechatronics, Scottsdale, Arizona, October 2008.
- Session Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems: Videos, Nice, France, September 2008.
- Local Organizing Committee, Robotics Science and Systems Workshop on Underwater Robotics at the Microscale, June 2008.
- Session Chair, IEEE/ASME International Conference on Advanced Intelligent Mechatronics: Modular Robots, Zurich, Switzerland, September 2007.
- Local Organizing Committee, IEEE/ASME International Conference on Advanced Intelligent Mechatronics, Zurich, Switzerland, September 2007.
- Session Co-Chair, IEEE International Conference on Robotics and Automation: Medical Microrobots, Rome, Italy, April 2007.

University Service

- Department of Mechanical Engineering External Relations Committee, Fall 2011-2014
- Department of Mechanical Engineering Graduate Committee, Fall 2009-present
- Department of Mechanical Engineering Strategic Planning Committee, Summer 2010-present
- Department of Mechanical Engineering Seminar Committee, Fall 2010-2014

Invited Talks

- "Magnetic Manipulation for Medical Robotics," Vanderbilt University, 2/8/18.
- "Magnetic Manipulation for Biomedical Robotics," Washington State University, 4/27/16.
- "Magnetic Manipulation Methods for Biomedical Robotics," Harvard University, 4/23/14.
- "Magnetic Manipulation Methods for Biomedical Robotics," University of Nevada, Reno, 9/20/13.
- "Nonuniform Fields for Magnetic Control" IROS Workshop on Magnetically Actuated Multiscale Medical Robots, Algarve, Portugal, 10/12/12.
- "Magnetic Manipulation Methods for Biomedical Robotics," Stanford University, 4/24/12.
- "Magnetic Manipulation Methods for Biomedical Robotics," University of Texas at Arlington, 3/29/12.
- "Exploring New Methods for Magnetic Control of Medical Micro/Meso-robots," Guest Lecture: *Current Research in Bioengineering*, University of Utah, 1/25/12.
- "Exploring New Methods for Magnetic Control of Medical Micro/Meso-robots," Max Planck Institute of Intelligent Systems, Stuttgart, Germany, 8/16/11.

- "Robotics for Eye Surgery and Research," Guest Lecture: *Advances in Vision Research*, University of Utah, 4/20/11.
- "Robotics for Eye Surgery and Research," Guest Lecture: *Advances in Vision Research*, University of Utah, 2/17/10.
- "From Micro to Nano Robotics," Micro System Workshop, Gothenburg, Sweden, 5/7/08.
- "Wireless Magnetic Intraocular Microrobots," Northwestern University, Evanston, 3/5/08.
- "Wireless Magnetic Intraocular Microrobots," University of British Columbia, Vancouver, 3/3/08.
- "Wireless Magnetic Intraocular Microrobots," Columbia University, New York City, 2/29/08.
- "Wireless Magnetic Intraocular Microrobots," Yale University, New Haven, 2/27/08.
- "Wireless Magnetic Intraocular Microrobots," Vanderbilt University, Nashville, 2/25/08.
- "Wireless Magnetic Intraocular Microrobots," University of California, Berkeley, 2/11/08.
- "Wireless Magnetic Intraocular Microrobots," University of Utah, Salt Lake City, 2/7/08.
- "Wireless Magnetic Intraocular Microrobots," University of Toronto, 2/5/08.
- "Robot-Assisted Surgery," National Academy of Engineering German-American Frontiers of Engineering Symposium, Hamburg, Germany, 4/27/07.
- "Expanding the Reach of Robots in Medicine," Drexel University, Philadelphia, 2/07.
- "Expanding the Reach of Robots in Medicine," George Washington University, Washington, D.C., 2/07.
- "Microrobotics at ETH Zurich," Greater Zurich Area Press Tour, Zurich, Switzerland, 7/06.
- "Virtual Fixtures for Bilateral Telemanipulation," Northwestern University, Evanston, 8/05.
- "Virtual Fixtures for Bilateral Telemanipulation," Utah State University, Logan, 3/05.

Technical Reviews

- Science Robotics
- Applied Physics Letters
- IEEE Transactions on Robotics
- IEEE Robotics and Automation Magazine
- IEEE Robotics and Automation Letters
- IEEE Transactions on Haptics
- IEEE Transactions on Control Systems Technology
- International Journal of Robotics Research
- International Journal of Medical Robotics
- Advanced Robotics
- ASME Journal of Dynamic Systems, Measurement, and Control
- ASME Journal of Computing and Information Science in Engineering
- IEEE/ASME Transactions on Mechatronics
- Journal of Micromechanics and Microengineering
- Journal of Biomedical Microdevices
- Journal of Measurement Science and Technology
- Sensors and Actuators A
- Presence
- IEEE Transaction on Magnetics
- IEEE Magnetics Letters
- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE/RJS International Conference on Intelligent Robots and Systems (IROS)
- Haptics Symposium
- World Haptics Conference
- International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)
- IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob)
- Medical Image Computing and Computer-Assisted Intervention Conference (MICCAI)
- Robotics: Science and Systems Conference (RSS)

Passed Fundamentals of Engineering Exam (FE/EIT), 1998