**Hao Su, Ph.D.**

# Wyss Institute for Biologically Inspired Engineering

# School of Engineering and Applied Sciences, Harvard University

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| C:\Users\Wyss User\Desktop\static_qr_code_without_logo.jpg | 60 Oxford Street, Cambridge, MA, USAMobile: 508-762-7379Email: haosu@seas.harvard.edu |

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| --- | --- | --- |
| 03/2015-Present |  | **Harvard University, School of Engineering and Applied Sciences and**  **Wyss Institute for Biologically Inspired Engineering, Cambridge, MA**  Postdoctoral Research Fellow  Research area: soft exoskeleton, soft robotics, rehabilitation robotics  Advisor: Conor Walsh (walsh@seas.harvard.edu) |
| 02/2013 | **Worcester Polytechnic Institute, Worcester, MA**  Ph.D. in Mechanical Engineering  Dissertation: Force Sensing and Teleoperation of Continuum Robot for MRI-Guided Surgery  Research area: surgical robotics, image-guided surgery, haptics, telemedicine  Advisor: Gregory Fischer (gfischer@wpi.edu) |
| 07/2008 | **State University of New York at Buffalo, Buffalo, NY**  M.S. in Mechanical Engineering  Advisor: Venkat Krovi (vkrovi@buffalo.edu) |
| 06/2006 | **Harbin Institute of Technology, Harbin, China**  B.S. in Control Science and Engineering |

**EMPLOYMENT**

|  |  |  |
| --- | --- | --- |
| 03/2013–03/2015 |  | **Philips Research North America, Briarcliff Manor, NY**  Research Scientist  Research: minimally invasive surgical devices, image-guided intervention |
| 06/2012-08/2012 | **Mitsubishi Electric Research Laboratories, Cambridge, MA**  Research Intern |
| 06/2010-08/2010 | **Brigham & Women’s Hospital and Harvard Medical School, Boston, MA**  Research Intern |

**AWARDS AND HONORS**

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| --- | --- | --- |
| 11/2014 |  | Philips Innovation Transfer Award |
| 05/2012 |  | Best Medical Robotics Paper Runner-up, IEEE International Conference on Robotics & Automation |
| 05/2012 |  | International Conference on Robotics and Automation NSF Travel Fellowship Award |
| 03/2012 |  | Link Foundation Fellowship (1 of 2 recipients in North America) |
| 11/2011 |  | Dr. Richard J. Schlesinger Award, American Society for Quality |
| 05/2011 |  | International Conference on Robotics and Automation NSF Travel Fellowship Award |
| 11/2009 |  | Judges' Award, Robotics Innovations Competition and Conference |

**ACADEMIC TEACHING APPOINTMENTS**

|  |  |  |
| --- | --- | --- |
| 2016 Spring |  | **Lecturer and Project Mentor**  Medical Device Design – ES227 (a problem-based learning course)  School of Engineering and Applied Sciences, Harvard University, Cambridge, MA |
| 07/2007-07/2008 |  | **Teaching Assistant**  Department of Mechanical and Aerospace Engineering, SUNY Buffalo |

**PATENTS**

|  |  |  |
| --- | --- | --- |
| 10/2014 |  | A. Mehendale, F. Sahin G. Cole, **H. Su**, V. Parthasarathy, “Virtually-oriented Electromagnetic Tracking Coil for Catheter based Navigation” |
| 09/2014 |  | **H. Su**, D. Noonan, A. Tahmasebi, “Motorized Flexible Instrument Positioner with Articulated Linkages” |
| 09/2014 |  | R. Christian, B. Hendriks, **H. Su**, G. Cole, “Biopsy Tool for Detection of Peripheral Lung Cancer” |
| 07/2014 |  | G. Cole, **H. Su**, V. Parthasarathy, “A System for Enhancing Clinical Workflow in Navigation Bronchoscopy Procedures” |
| 06/2014 |  | **H. Su**, G. Cole, V. Parthasarathy, “Steerable Catheter with Articulated Revolute Joints” |
| 12/2013 |  | **H. Su**, G. Cole, V. Parthasarathy, “Handheld Catheter Driver with Endoscope Mount Utilizing Friction-Driven Wheel Mechanism” |
| 11/2013 |  | **H. Su**, G. Cole, V. Parthasarathy, “Rotatable Telescopic Stabilizer for Use of Catheter Inside an Endoscope” |
| 10/2013 |  | G.S. Fischer and **H. Su**, “System and Method for Under Actuated Control of Insertion Path for Asymmetric Tip Needles” |
| 08/2011 |  | G.S. Fischer, **H. Su**, and E. Alexander, "System and Method for Autism Spectrum Disorder Interventions" |
| 11/2010 |  | G.S. Fischer and **H. Su**, "Apparatus and Methods for MRI-Compatible Haptic Interfaces" |

**LEADERSHIP AND PROFESSIONAL AFFILIATIONS**

* Associate editor, IEEE International Conference on Robotics and Automation (ICRA), 2015, 2016
* Associate editor (biomechanics and robotics theme), IEEE Engineering in Medicine and Biology Conference (EMBC), 2014, 2015, 2016
* Organizing committee, IEEE International Conference on Technologies for Practical Robot Applications (TePRA)
* Organizing committee and robotics session chair, Design of Medical Devices Conference, 2014
* Journal reviewer (IEEE Transactions Robotics, Mechatronics, Biomedical Engineering, IJRR, IJMRCAS etc.)
* Conference reviewer (ICRA, IROS, RSS, EMBC, ASME DSCC, haptics symposium, etc.)

**RESEARCH GRANTS**

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| --- | --- | --- | --- |
| 2013-2017 |  | **National Institute of Health, Research Project Grant (1R01CA166379)** |  |
|  |  | Team leader |  |
|  |  | MR-Guided Precision Conformal Ablation Therapy for Brain Tumors” ($3.8 Million)  PI: Gregory Fischer | |
| 2012-2016 |  | **National Institute of Health, Bioengineering Research Partnerships (R01CA111288)** |  |
|  |  | Team leader |  |
|  |  | Enabling Technologies For MR-Guided Prostate Interventions ($3.4 Million)  PI: Clare Tempany (Harvard Medical School) | |
| 2009-2012 |  | **Congressionally Directed Medical Research Programs New Investigator Award** |  |
|  |  | Team leader |  |
|  |  | Development of an MRI-Guided Intraprostatic Needle Placement System ($380K), PI: Gregory Fischer |  |

# MEDIA COVERAGE

1. “Inside an MRI, a Non-Metallic Robot Performs Prostate Surgery”, IEEE Spectrum, 07/2015
2. “MRI-Guided Robot: The Brains Behind Better Neurosurgery?”, IEEE Xplore Innovation Spotlight, 10/2015
3. “Engineering School Innovations: MRI-Compatible Piezoelectric Actuated Robot”, Automation World, 01/2012

# PEER-REVIEWED PUBLICATIONS (\* indicates shared authorship)

## Journals In Preparation/Under Review

1. **H. Su**, N. Karavas, C. Walsh, “Autonomous Multi-joint Soft Exoskeleton Suit with Hip and Ankle Assistance for Overground Walking”, Journal of NeuroEngineering and Rehabilitation, 2016
2. **H. Su**, J. Tokuda, C. Tempany, N. Hata, and G.S. Fischer, “MRI-guided Robotic Prostate Interventions”, Nature Reviews Urology, 2016
3. G. Li, **H. Su**, and G. S. Fischer, “Modeling and Control of Gaussian-based Continuous Rotation and Variable Curvature Needle Steering: An MRI-guided Approach”, IEEE Transactions on Robotics, 2016
4. G. Li, **H. Su**, and G. S. Fischer, “An 8-DOF Neurosurgical Robot for MRI-Guided Precision Conformal Ultrasonic Ablation of Metastatic Brain Tumor”, IEEE/ASME Transactions on Mechatronics, 2016
5. **H. Su**, W. Shang, G. Li, and G.S. Fischer, “Teleoperation System with Hybrid Pneumatic-Piezoelectric Actuation for MRI-Guided Needle Insertion with Haptic Feedback”, Annals of Biomedical Engineering, 2016
6. **H. Su**, Y. Ma, W. Shang, and G.S. Fischer, “Cylindrical Helix Imaging Coordinate(CHIC) Fiducial Registration System for Image-Guided Interventions”, Computerized Medical Imaging and Graphics, 2016

## Journals

1. **H. Su**, G.Li, D. C. Rucker, R. J. Webster III, and G.S. Fischer, “A Concentric Tube Continuum Robot with Piezoelectric Actuation for MRI-Guided Closed-Loop Targeting”, Annals of Biomedical Engineering, vol. 3, no. 1, pp. 1-11, 2016
2. **H. Su**, W. Shang, G. Cole, G. Li, K. Harrington, A. Camilo, J. Tokuda, C. M. Tempany, N. Hata, G. S. Fischer, "Piezoelectrically Actuated Robotic System for MRI-Guided Prostate Percutaneous Therapy," in IEEE/ASME Transactions on Mechatronics , vol.20, no.4, pp.1920-1932, 2015
3. **H. Su**\*, G. Li\*, G.A. Cole, W. Shang, J. Pilitsis, and G. S. Fischer, “Robotic System for MRI-Guided Stereotactic Neurosurgery”, IEEE Transactions on Biomedical Engineering, vol. 62, no. 4, pp. 1077-1088, 2015

## Book Chapters

1. **H. Su** and G. S. Fischer, “MRI-guided Surgical Robotics”, Encyclopedia of Medical Robotics, World Scientific Publishers, 2016
2. **H. Su** and G. S. Fischer, “High-field MRI-Compatible Needle Placement Robots for Prostate Interventions: Pneumatic and Piezoelectric Approaches”, eds. T. Gulrez and A. Hassanien, Advances in Robotics and Virtual Reality, Springer-Verlag, 2011
3. H. Huang, **H. Su**, and, C. Ru, “Piezoelectric Driven Ultrasonic Cell Manipulator”, eds. T. Sobh and X. Xiong, Prototyping of Robotic Systems: Applications of Design and Implementation, IGI Global, 2011
4. H. Huang, D. Sun, **H. Su**, and J. Mills, “Force Sensing and Control of Robot-Assisted Cell Injection”, eds. T. Gulrez and A. Hassanien, Advances in Robotics and Virtual Reality, Springer-Verlag, 2011
5. G. Cole, K. Harrington, **H. Su**, A. Camilo, J. Pilitsis, G. S. Fischer, “Closed-Loop Actuated Surgical System Utilizing In-Situ Real-Time MRI Guidance”, Springer Tracts in Advanced Robotics, eds. O. Khatib, V. Kumar, G. Sukhatme, Springer-Verlag, 2012

## Refereed Conference Articles

1. **H. Su**, Y. Ding, I. Galiana, J. Speeckaert, N. Karavas, P. Malcolm, C. Siviy, C. J. Walsh, “Evaluation of Force Tracking Controller with Soft Exosuit for Hip Extension Assistance”, The International Symposium on Wearable Robotics, Segovia, Spain, 2016
2. **H. Su\***, W. Shang\*, G. Li, and G.S. Fischer, “Teleoperation System with Hybrid Pneumatic-Piezoelectric Actuation for MRI-Guided Needle Insertion with Haptic Feedback”, IEEE/RSJ International Conference on Intelligent Robots and Systems - IROS 2013, Tokyo, Japan, Nov. 2013
3. W. Shang, **H. Su**, G. Li, C. Furlong, and G.S. Fischer, “A Fabry-Perot Interferometry Based MRI-Compatible Miniature Uniaxial Force Sensor for Percutaneous Needle”, IEEE SENSORS 2013, Baltimore, MD, Nov. 2013.
4. G. Li, **H. Su**, W. Shang, J. Tokuda, N. Hata, C. Tempany, and G. S. Fischer, “A Fully Actuated Robotic Assistant for MRI-Guided Prostate Biopsy and Brachytherapy", SPIE Medical Imaging, Orlando, USA, 2013
5. W. Ji, J.D. Matte, G. Li, Y. Ma, **H. Su**, W. Shang, and G.S. Fischer, Reconfigurable Fiducial-Integrated Modular Needle Driver for MRI-Guided Percutaneous Interventions, Design of Medical Devices Conferences (DMD), Minneapolis, MN, April 2013.
6. Y. Ma, I. Dobrev, W. Shang, **H. Su**‎, S. Janga, G. S. Fischer, “CHIC: Cylindrical Helix Imaging Coordinate Registration Fiducial for MRI-Guided Interventions”, In Proceedings of the 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), San Diego, USA, 2012.
7. **H. Su**, D. Cardona, W. Shang, G. Cole, C. Rucker, R. Webster III and G. Fischer, “A MRI-Guided Concentric Tube Continuum Robot with Piezoelectric Actuation: A Feasibility Study”, IEEE ICRA International Conference on Robotics and Automation, Minnesota, USA, 2012
8. **H. Su**, W. Shang, A. Camilo, J. Tokuda, N. Hata, C. Tempany, and G. S. Fischer, “A networked modular hardware and software system for MRI-guided robotic prostate interventions", SPIE Medical Imaging (Image-Guided Procedures, Robotic Interventions, and Modeling Conference), San Diego, USA, 2012
9. G. S. Fischer, G.A. Cole, and **H. Su**, “Approaches to Creating and Controlling Motion in MRI”, In Proceedings of the 33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Boston, USA, 2011 (Invited Paper)
10. E. Alexander, L. Dickstein-Fischer, X. Yan, **H. Su**, and G. S. Fischer, “An Affordable Compact Humanoid Robot for Autism Spectrum Disorder Interventions in Children”, In Proceedings of the 33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Boston, USA, 2011
11. **H. Su**, I. Iordachita, X. Yan, G. A. Cole, and G. S. Fischer, “Reconfigurable MRI-Guided Robotic Surgical Manipulator: Prostate Brachytherapy and Neurosurgery Applications”, In Proceedings of the 33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Boston, USA, 2011
12. **H. Su**, G.A. Cole, N. Hata, C. Tempany, and G. S. Fischer, “Real-time MRI-Guided Transperineal Needle Placement Prostate Interventions with Piezoelectrically Actuated Robotic Assistance”, Radiological Society of North America 97th Scientific Assembly and Annual Meeting, Chicago, USA ,2011
13. **H. Su**, M. Zervas, C. Furlong and G. S. Fischer, “A Miniature MRI-compatible Fiber-optic Force Sensor Utilizing Fabry-Perot Interferometer”, SEM Annual Conference & Exposition on Experimental and Applied Mechanics, Uncasville, CT, USA, 2011
14. **H. Su**, M. Zervas, G.A. Cole, C. Furlong and G.S. Fischer, “Real-time MRI-Guided Needle Placement Robot with Integrated Fiber Optic Force Sensing”, IEEE ICRA 2011 International Conference on Robotics and Automation, Shanghai, China, 2011
15. H. Huang, **H. Su**, H. Chen, J. K. Mills, “Piezoelectric Driven Non-toxic Injector for Automated Cell Manipulation”, in Stud Health Technol Inform 163 (2011), 231-235. Published by IOS Press
16. **H. Su**, A. Camilo, G. Cole, C. Tempany, N. Hata and G. S. Fischer, “High-Field MRI-Compatible Needle Placement Robot for Prostate Interventions”, in Stud Health Technol Inform 163 (2011), 623-629. Published by IOS Press
17. G. Cole, K. Harrington, **H. Su**, A. Camilo, J. Pilitsis, G. S. Fischer, “Closed-Loop Actuated Surgical System Utilizing In-Situ Real-Time MRI Guidance”, 12th International Symposium on Experimental Robotics (ISER2010), New Delhi & Agra, India, 2010
18. **H. Su**, L. Dickstein-Fischer, K. Harrington, Q. Fu, W. Lu, H. Huang, G. Cole and G.S. Fischer, “Cable-Driven Elastic Parallel Humanoid Head with Face Tracking for Autism Spectrum Disorder Interventions”, In Proceedings of the 32nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Buenos Aires, Argentina, 2010
19. Y. Wang, **H. Su**, K. Harrington and G. Fischer, “Sliding Mode Control of Piezoelectric Valve Regulated Pneumatic Actuator for MRI-Compatible Robotic Intervention”, ASME Dynamic Systems and Control Conference, Boston, USA, 2010
20. **H. Su**, W. Shang, G. Cole, K. Harrington and G. Fischer, “Design of a Haptic Device for MRI-Guided Prostate Needle Brachytherapy”, IEEE Haptics Symposium, Boston, USA, 2010
21. **H. Su** and G. Fischer, “A 3-Axis Optical Force/Torque Sensor for Prostate Needle Placement in Magnetic Resonance Imaging Environments,” IEEE International Conference on Technologies for Practical Robot Applications, Boston, USA, 2009
22. Y. Wang G. Cole, **H. Su**, J. Pilitsis, G. Fischer, “MRI Compatibility Evaluation of a Piezoelectric Actuator System for a Neural Interventional Robot”, In Proceedings of the 31st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Minneapolis, USA, 2009
23. **H. Su** and V. Krovi, "Decentralized Motion Control of Payload Transport by Nonholonomic Mobile Manipulators," ASME Dynamic Systems and Control Conference, Ann Arbor, USA, 2008

**INVITED TALKS**

1. “Force Sensing, Teleoperation and Control of Continuum Robot for MRI-Guided Surgery”, Boston Children's Hospital, Harvard Medical School, 10/2012
2. “Teleoperated Needle Placement for Real-time MRI-guided Prostate Interventions”, 9th Interventional MRI Symposium (iMRI), Boston, MA, USA, 09/2012
3. “Small, Dexterous and under Control: from Robotic Tentacles to MRI-Guided Surgical Interventions”, Mitsubishi Electric Research Laboratories, 07/2012
4. “Toward Real-Time MRI-Guided Steerable Needle Robots: Experiments with Bevel and Concentric Tube Needles”, IEEE ICRA Workshop on Needle Steering, 05/2012
5. “Force Sensing and Control of MRI-Compatible Robotic System for Prostate Percutaneous Intervention”, Brigham and Women’s Hospital, Harvard Medical School, 05/2010
6. “Cooperative Control of Nonholonomic Mobile Manipulator Collective”, Queen’s University, Kingston, Canada, 11/2008

**MENTORSHIP**

PhD Students: Evelyn Park (Harvard) and Chris Siviy (Harvard)

Undergraduate Students: Jessica Herrmann (Harvard), Frank Dubose (Harvard), Harnek Gulati (Harvard), Cassie Lowell (Harvard)

**REVIEW/EDITORIAL SERVICES**

## Reviewer for Journal Articles

* IEEE/ASME Transactions on Mechatronics
* Journal of Robotics and Computer-Integrated Manufacturing
* Measurement Science and Technology (Institute of Physics)
* Journal of Intelligent and Robotic Systems
* ASME Journal of Dynamic Systems, Measurement and Control
* International Journal of Medical Robotics and Computer Assisted Surgery
* Smart Materials and Structures
* Medical Engineering & Physics
* Robotica
* IEEE Transactions on Biomedical Engineering

## Reviewer for Conference Proceedings

* IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob)
* Robotics: Science and Systems Conference (RSS)
* IEEE International Conference on Robotics and Automation (ICRA)
* Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)
* Performance Metrics for Intelligent Systems (PerMIS'10) Workshop
* ASME Dynamic Systems and Control Conference (DSCC)
* IEEE/RSJ International Conference on Intelligent RObots and Systems (IROS)
* IEEE Haptics Symposium Conference