Hunter B. Gilbert
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Education

Ph.D. in Mechanical Engineering, Vanderbilt University, Spring 2016.
Dissertation: *Concentric Tube Robots: Design, Deployment, and Stability*
Advisor: Dr. Robert J. Webster III

B.S. in Mechanical Engineering, Rice University, Spring 2010, Summa Cum Laude.
Minor in Computational and Applied Mathematics

Honors and Awards

NSF Graduate Research Fellowship, 2013–2015

Vanderbilt University Fellowship, 2010–2015

Best Medical Robotics Paper Finalist, International Conference on Robotics and Automation, 2013 [6]

Best Application Paper Finalist, International Conference on Intelligent Robots and Systems, 2014 [5]

Undergraduate Awards: Phi Beta Kappa (2010), Alan J. Chapman Award in Mechanical Engineering (2010), Samuel T. Sikes Jr. Scholarship (2009), Chevron Scholarship (2009), W.L. Moody Award (2008), Jones Residential College Sophomore Scholar (2008), Graham C. Stebings Service Award (2008), Jones Residential College Extraordinary Dedication to College Award (2010), President's Honor Roll (all semesters), National Merit Scholarship

Publications

Journal Articles

[1] **H. B. Gilbert** and R. J. Webster III, "Rapid, reliable shape setting of superelastic nitinol for prototyping robots", *IEEE Robotics and Automation Letters*, vol. 1, no. 1, pp. 98–105, 2016.

[2] **H. B. Gilbert**, R. J. Hendrick, and R. J. Webster III, "Elastic stability of concentric tube robots: a stability measure and design test", *IEEE Transactions on Robotics*, vol. 32, no. 1, pp. 20–35, 2016.

[3] **H. B. Gilbert**, J. Neimat, and R. J. Webster III, "Concentric tube robots as steerable needles: achieving follow-the-leader deployment", *IEEE Transactions on Robotics*, vol. 31, no. 2, pp. 264–258, 2015.

[4] P. J. Swaney, **H. B. Gilbert**, R. J. Webster III, P. T. Russell III, and K. D. Weaver, "Endonasal skull base tumor removal using concentric tube continuum robots: a phantom study", *Journal of Neurological Surgery Part B: Skull Base*, vol. 76, no. 2, pp. 145–149, 2015.

[5] R. Wirz, L. Torres, P. J. Swaney, **H. B. Gilbert**, R. Alterovitz, R. J. Webster III, K. D. Weaver, and P. T. Russell III, "An experimental feasibility study on robotic endonasal telesurgery", *Neurosurgery*, vol. 76, no. 4, pp. 479–484, 2015.

[6] J Burgner, D. C. Rucker, **H. B. Gilbert**, P. J. Swaney, P. T. Russell III, K. D. Weaver, and R. J. Webster III, "A telerobotic system for transnasal surgery", *IEEE/ASME Transactions on Mechatronics*, vol. 19, pp. 996–1006, 2014.

[7] **H. B. Gilbert**, R. J. Hendrick, A. A. Remirez, and R. J. Webster III, "A robot for transnasal surgery featuring needle-sized tentacle-like arms", *Expert Review of Medical Devices*, vol. 11, pp. 5–7, 2014.

[8] **H. B. Gilbert**, D. C. Rucker, and R. J. Webster III, "Concentric tube robots: state of the art and future directions", *Springer Tracts in Advanced Robotics*, In Press (2013).

[9] D. C. Rucker, J. Das, **H. B. Gilbert**, P. J. Swaney, M. I. Miga, N. Sarkar, and R. J. Webster III, "Sliding mode control of steerable needles", *IEEE Transactions on Robotics*, vol. 29, pp. 1289–1299, 2013.

[10] P. J. Swaney, J. Burgner, **H. B. Gilbert**, and R. J. Webster III, "A flexure-based steerable needle: high curvature with reduced tissue damage", *IEEE Transactions on Biomedical Engineering*, vol. 60, pp. 906–909, 2013.

[11] K. D. Weaver, R. J. Webster III, P. J. Swaney, J. Burgner, P. T. Russell III, **H. B. Gilbert**, J. Bekeny, and R. J. Hendrick, "The use of teleoperated concentric tube robots for transsphenoidal parasellar surgery.", *Journal of Neurological Surgery Part B*, vol. 74-A123, 2013.

Peer-Reviewed Conference Papers

[1] R. J. Hendrick, **H. B. Gilbert**, and R. J. Webster III, "Designing snap-free concentric tube robots: a local bifurcation approach", in *IEEE International Conference on Robotics and Automation*, 2015, pp. 2256–2263.

[2] P. J. Swaney, **H. B. Gilbert**, R. J. Hendrick, O. Commichau, R. Alterovitz, and R. J. Webster III, "Transoral steerable needles in the lung: how non-annular concentric tube robots can improve targeting", in *Hamlyn Symposium on Medical Robotics*, 2015.

[3] L. G. Torres, A. Kuntz, **H. B. Gilbert**, P. J. Swaney, R. J. Hendrick, R. J. Webster III, and R. Alterovitz, "A motion planning approach to automatic obstacle avoidance during concentric tube robot teleoperation", in *IEEE International Conference on Robotics and Automation*, 2015, pp. 2361–2367.

[4] P. York, P. J. Swaney, **H. B. Gilbert**, and R. J. Webster III, "A wrist for needle-sized surgical robots", in *IEEE International Conference on Robotics and Automation*, 2015, pp. 1776–1781.

[5] J. Burgner, **H. B. Gilbert**, J Granna, P. J. Swaney, and R. J. Webster III, "Workspace characterization for concentric tube continuum robots", in *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2014.

[6] J. Burgner, **H. B. Gilbert**, and R. J. Webster III, "On the computational design of concentric tube robots: incorporating volume-based objectives", in *IEEE International Conference on Robotics and Automation*, 2013, pp. 1185–1190.

[7] **H. B. Gilbert** and R. J. Webster III, "Can concentric tube robots follow the leader?", in *IEEE International Conference on Robotics and Automation*, 2013, pp. 4866–4872.

[8] P. J. Swaney, J. Burgner, R. A. Lathrop, **H. B. Gilbert**, K. D. Weaver, and R. J. Webster III, "Minimally-invasive intracerebral hemorrhage removal using an active cannula", in *IEEE International Conference on Robotics and Automation*, 2013, pp. 219–224.

[9] J. Burgner, **H. B. Gilbert**, P. J. Swaney, P. T. Russell III, and R. J. Webster III, "Continuum robots based on precurved nitinol tubes: evaluation of a prototype for transnasal skull base surgery", in *Annual Meeting of the German Society for Computer and Robot-assisted Surgery*, 2012.

[10] **H. B. Gilbert**, P. J. Swaney, J. Burgner, K. D. Weaver, P. T. Russell III, and R. J. Webster III, "A feasibility study on the use of concentric tube continuum robots for endonasal skull base tumor removal", in *Hamlyn Symposium on Medical Robotics*, 2012.

[11] P. J. Swaney, J. Burgner, T. S. Pheiffer, D. C. Rucker, **H. B. Gilbert**, J. E. Ondrake, A. L. Simpson, E. C. Burdette, M. I. Miga, and R. J. Webster III, "Tracked 3d ultrasound targeting with an active cannula", in *SPIE Medical Imaging*, 2012.

[12] P. J. Swaney, J. M. Croom, J. Burgner, **H. B. Gilbert**, D. C. Rucker, P. T. Russell III, K. D. Weaver, and R. J. Webster III, "Design of a quadramanual robot for single-nostril skull base surgery", in *ASME Dynamic Systems and Control*, 2012.

[13] J. Burgner, P. J. Swaney, D. C. Rucker, **H. B. Gilbert**, S. T. Nill, P. T. Russell III, K. D. Weaver, and R. J. Webster III, "A bimanual teleoperated system for endonasal skull base surgery", in *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2011, pp. 2517–2523.

Poster Presentations

[1] **H. B. Gilbert**, R. A. Lathrop, R. J. Hendrick, and R. J. Webster III, *Towards a clinically-ready transnasal concentric tube system*, Poster, IDEAS: Surgical Robotics: Defining Grand Challenges for Surgery and Robotics, 2015.

[2] **H. B. Gilbert**, J. Burgner, S. Patil, P. J. Swaney, R. Alterovitz, and R. J. Webster III, *Toward planning as control and tissue sparing needles*, Poster, In the Pathways to Clinical Needle Steering: Recent Advances and Future Applications Workshop at the IEEE International Conference on Robotics and Automation, 2012.

Invited Presentations

1. University of Utah, Salt Lake City, UT, February 2016
2. Louisiana State University, Baton Rouge, LA, February 2016
3. Technische Universität Darmstadt, Darmstadt, Germany, January 2016.
4. Max Planck Institute, Stuttgart, Germany, January 2016.

Grants

National Institutes of Health R01: *Robotic Natural Orifice Skull Base Surgery* ($1,790,618, 7/1/13 – 6/30/17). I helped my dissertation advisor create this grant proposal by co-writing the specific aims, technical approaches, and project milestones. I also co-wrote descriptions of the state-of-the-art in concentric tube robot research, as it pertains to transnasal surgical procedures.

Vanderbilt Discovery Grant: *Curvilinear Brain Surgery: Hope for Inoperable Patients* ($100,000, 6/1/13 – 5/31/15) I assisted my advisor in the preparation of this internal grant, including the selection of the research thrusts and the writing of a substantial part of the proposed research approach.

Korea Institute of Science and Technology: *Development of Next-Generation Micro Surgical Robot Based on Open Platform* ($200,000, 1/1/14 – 12/31/18). I wrote much of the background material for the state-of-the-art in concentric tube continuum robots.

National Institutes of Health R21: *Curing Epilepsy with a Needle* ($426,050, 6/1/15 – 5/31/17). I helped in the selection and writing of the specific aims and technical approach.

Experience

Concentric Tube Robots as Manipulators
I contributed the theory of elastic stability for concentric tube robots, which uses a mechanics-based model to predict buckling and snapping behaviors in concentric tube robots. I also created an accurate statics model for a superelastic Nitinol flexure-based miniature robotic wrist placed at the tip of a concentric tube robot.

Concentric Tube Robots as Steerable Needles
I analyzed the ability of concentric tube robots to behave as steerable needles, where the shaft of the robot must follow the path traced by the tip as the needle advances. I produced model-predicted design requirements for exactly correct behavior and also developed techniques for approximating needle-like behavior.

Endonasal Skull Base Surgical System Design
I contributed several critical design elements to a surgical robot built for endonasal skull base surgery, including the specification of design requirements. I was also in charge of the user interface software, model-based controller development, and the network design for communication between system components.

Research Tools for Flexible Robots
I developed several research tools for flexible robots used by myself and other members of my advisor's lab, as well as collaborators from other institutions. I created a system for shape setting superelastic Nitinol parts in the lab using high temperature, closed loop resistive feedback and published the system and algorithm design. I also developed optimized algorithms for simulating the mechanics of concentric tube robots in real-time C++ code, used for both closed loop control and design simulation.

Undergraduate Research
In the Physics of Strings group in the Computational and Applied Mathematics department, I helped create an experimental setup for validation of inverse model predictions in vibrating strings. In the Mechatronics and Haptics Interfaces Lab in the Mechanical Engineering department, I designed and built a mechatronic system which vibrated to induce sensations of motion for proprioceptive feedback at the human elbow.

Java Programmer, GrayMatter, Inc. , Metairie, LA **2007**
As a summer internship I was a member of the GrayMatter, Inc. DARPA Grand Challenge team which built an autonomous vehicle.

Teaching

Students Advised/Mentored

Christopher Marince, Master's Student, Vanderbilt University 2014
Thesis: *Design of a 7 Degree-of-freedom Haptic Robot*. I was Christopher's primary mentor, and guided him in his project to create a haptic robot with full six degree-of-freedom force feedback and scissor grip feedback.

Sani Sulaiman, Undergraduate Student, Vanderbilt University 2012
I advised Sani during his summer research experience for undergraduates; he designed a real-time control system for a five degree-of-freedom industrial robot under my guidance.

Courses

Introduction to Robotics, Vanderbilt University 2015
I helped my advisor develop the curriculum for this course. I also guest lectured for three of the class periods, covering the topics of Jacobian singularities, trajectory generation, and resolved-rate control.

Basics in Engineering, Harpeth Hall High School 2012 – 2014
I created the curriculum and taught a 4 week short course on engineering to high school girls, which included modules about structural design, electric motors, and medical robotics.

Undergraduate Mechatronics, Vanderbilt University 2011
As a teaching assistant during the inaugural year of this undergraduate course at Vanderiblt, I helped develop the homework project assignments. I graded assignments, held office hours to help students with their homework and final projects, and assisted in the evaluation of the final projects.

System Dynamics, Vanderbilt University 2010
I presented supplemental course material during lab sessions and organized labs as a teaching assistant. Student evaluations were "Overall" 4.09/5, "Is an effective leader" 4.27/5. As part of this assistantship, I learned valuable lessons about laboratory design and helped my advisor and another graduate student collect data to support the use of haptics in system dynamics labs.

Introduction to Engineering Computation, Rice University 2007
I assisted students with lab assignments once per week for the duration of the course. This involved helping the students understand algorithms and MATLAB coding.

Project Teams Mentored

Fluid-Powered Rod Robot 2015
I guided this Introduction to Robotics project team in the mathematical modeling of the statics of slender rods for a fluid-powered jet-actuated robot.

Baxter Teleoperation 2014
I provided expert advice and guidance to this project team in Introduction to Robotics in the development of teleoperation algorithms for Rethink Robotics' Baxter robot.

User-controlled Dynamic Wheelchair Center-of-gravity 2011
I guided this senior design project team in the development of the mechatronic system for a wheelchair with user-adjustable center of gravity.

Professional Activities

Memberships

Institute of Electrical and Electronics Engineers (IEEE), Student Member since 2010

Technical Reviews

IEEE Transactions on Robotics, International Journal of Robotics Research, IEEE Transactions on Control Systems Technology, IEEE Robotics and Automation Letters, IEEE International Conference on Robotics and Automation, IEEE International Conference on Intelligent Robots and Systems