BOLUN ZHANG

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EDUCATION

Ph.D. Mechanical Engineering, University of Wisconsin-Madison (expected) July 2024
Minor in Computer Science
Advisor: Prof. Michael Zinn

M.S. Mechanical Engineering, University of Wisconsin-Madison May 2017

B.S. Mechanical Engineering, University of Wisconsin-Madison May 2015

AREA OF EXPERTISE

Robotics, Haptics, Medical device, Controls, Teleoperation, Mechatronics, Microcontroller, Electro-mechanical design, Prototyping, Psychophysics, Human perception, User studies

COMPETENCES

Software Skills Python, Java, C, Matlab, Simulink Realtime, Solidworks, ROS, Linux, Adobe Illustrator
Prototyping Lathe (80 hours), Mill (120 hours), 3D-printing, Laser-cutting
Languages Chinese (native speaker), Japanese (full professional proficiency)

RESEARCH

Teleoperated power injector with haptic feedback for angiography (2022-present)

· Leveraging pressure measurement to provide haptic feedback to clinicians, aiming to avoid extravasation
· Reformed a commercial dual-barrel power injector into a bilateral teleoperation system
· Using B&R PLC to interface the mechanical system of the injector and custom electronics
· Modeled hemodynamics, built a in-vitro phantom to emulate common carotid artery
· Performed system identification, applied control techniques to ensure fast response and stability of the bilateral system
· Exploring different haptic feedback approach, such sensory substitution (force substituted by vibrotactile rendering) to provide useful information (such as potential occlusion in the blood vessel) to human operators
· Running user studies to validate the haptic approach

Perceptual dimensions of linear impedances of kinesthetic rendering (2021-2022)

· Explored how novice users distinguish among a set of haptic effects and what are the dominant characteristics in these haptic effects recognized by novice users
· Programmed a GUI in Matlab App Designer for data collection and Simulink Realtime execution
· Conducted user studies to develop dissimilar matrix among a set of haptic stimuli via clustering method
· Used multi-dimensional scaling method to extract perceptual space of the haptic stimuli
· Interpreted the dimensions of perceptual space using linear regression of adjective ratings
· Mapped between the parameter space (mass-damper-spring) and the perceptual space

The effect of parameter variations on perceived realism of kinesthetic rendering (2020-2021)

· Explored the importance of parameter accuracy in kinesthetic-type haptic modeling and rendering
· Prototyped a single DOF high performance impedance-type device to simulate real-world objects
· Modeled objects using haptic models including Dahl friction, sinusoidal detent and stiffness
· Conducted user studies to measure perceptions of realism with varying parameter values
· Fitted power model to realism curves to gain intuition into sensitivity of haptic model parameters

Robot learning by demonstration including manipulation with orientation slip (2019-2020)

· Performed robot learning by demonstration via custom instrumented tongs with position and force measurement
· Modeled and recognized prehensile orientation slip in human demonstrations of constrained interactions
· Conducted a user study to validate the novel method and replayed human demonstrations on a Sawyer robot leveraging orientation slip to avoid robot kinematic constraints

MR-compatible admittance-type haptic device design and fabrication (2017-2019)

· Solved the challenge that only non-ferrous parts could be integrated in the drive-train
· Fabricated the prototype using 3D-printing and machining on lathe and mill
· Ran proof-of-concept experiments to validate device capability and closed-loop controls

OTHER PROJECT

Motorized Marble Maze (2022-2023)

· Built a large-scale 2-axis motorized marble maze actuated by stepper motors
· Designed and fabricated the drive-trains with four-bar-linkage mechanism for safety and efficiency
· Recognized as *"the most popular demo"* of UW-Madison Engineering EXPO 2023

TEACHING PROFILE

Teaching Awards

· **Distinguished Teaching Award**, Pi Tau Sigma 2016 - 2017
· **Distinguished Teaching Award**, Pi Tau Sigma 2018 - 2019

Course Instructor

· ME 342 - Design of Machine Elements Summer 2019, Summer 2022, Summer 2023

Curriculum Design

· ME 376 - Introduction to Mechatronics Fall 2022 - Current
Designing lab activities, editing lab handouts, building lab equipment for a required ME undergraduate course.

Teaching Assistant

· ME 376 - Introduction to Mechatronics Fall 2023
· ME 447 - Computer Control of Machines and Processes Spring 2023
· ME 445 - Mechatronics in Controls and Product Realization Fall 2022
· ME 446 - Automatic Controls Fall 2019, Spring 2020, Summer 2020
· ME 739 - Advanced Robotics Spring 2020, Spring 2023
· ME 340 - Dynamic Systems Fall 2015, Spring 2016, Fall 2016, Spring 2017
· ME 342 - Design of Machine Elements Fall 2018, Spring 2019
Drafted the semester-long project that gave students hands-on experience by designing a two-stage gear reducer.

Volunteer

· College of Engineering New Educator Orientation Fall 2023
Trained new TAs' presentation skills, shared teaching experiences and answered questions from new TAs.

PUBLICATIONS

B. Zhang, M. Hagenow, B. Mutlu, M. Gleicher and M. Zinn, "Assessing the Perceived Realism of Kinesthetic Haptic Renderings Under Parameter Variations," 2022 IEEE Haptic Symposium (HAPTICS), 2022, pp. 1-6, doi: 10.1109/HAPTICS52432.2022.9765610. **Selected for plenary session.**

M. Hagenow, **B. Zhang**, B. Mutlu, M. Zinn and M. Gleicher, "Recognizing Orientation Slip in Human Demonstrations," 2021 IEEE International Conference on Robotics and Automation (ICRA), 2021, pp. 2790-2797, doi: 10.1109/ICRA48506.2021.9561856.

B. Zhang, M. Hagenow, B. Mutlu, M. Gleicher and M. Zinn, "Characterizing the Effects of Haptic Rendering Parameter Variations on Perceived Kinesthetic Rendering Accuracy," 2021 IEEE World Haptics Conference (WHC), 2021, pp. 868-868, doi: 10.1109/WHC49131.2021.9517158.

K. Gabardi, P. Dills, **B. Zhang** and M. Zinn, "Factors Affecting the Stable Range of Damping and Mass in Admittance Type Haptic Devices," 2021 IEEE World Haptics Conference (WHC), 2021, pp. 865-865, doi: 10.1109/WHC49131.2021.9517150.

B. Zhang, D. Farley, H. Ploeg, and M. Zinn. "Validation of Feedback Control Approach for an Implantable Limb Lengthening Device." Proceedings of the 2017 Design of Medical Devices Conference. 2017 Design of Medical Devices Conference. Minneapolis, Minnesota, USA. April 10–13, 2017. V001T03A006. ASME. https://doi.org/10.1115/DMD2017-3456