JACK (HAOYING) ZHOU

Surgical Robotics Control, Simulation and Automation with AI Algorithms and Visual Perception
Target for Full-Time Positions and 2024 Summer Internship, Expected graduation on Dec 2025

hzhou6@wpi.edu 774-823-0984 Baltimore, Maryland, USA jackhaoyingzhou.github.io/ haoyingzhoujack
JackHaoyingZhou

EDUCATION

Ph.D. in Robotics Engineering

Worcester Polytechnic Institute

Sep 2020 - Present — Worcester, MA

GPA: 3.95/4.0 **Advisor**: Prof. Gregory S. Fischer
Research Topics: Surgical Robots, **the da Vinci Research Kit (dVRK)**, Surgery Simulation and Automation, Robot Learning, Visual Perception

M.Sc. in Mechanical Engineering

Boston University

Sep 2018 - May 2020 — Boston, MA

GPA: 3.78/4.0 **Advisor**: Prof. Calin Belta
Thesis Title: Imitation Learning with Dynamic Movement Primitives

Visiting Student (Mechanical Engineering)

University of California, Berkeley

Aug 2017 – May 2018 — Berkeley, CA

GPA: 3.95/4.0
Research Topics: Self-driving Racing Car, Control Theory, Bubble Recognition

B.Sc. in Mechanical Engineering

Beijing Institute of Technology

Sep 2014 - May 2018 — Beijing, China

PROFESSIONAL EXPERIENCE

Visiting Graduate Scholar

Johns Hopkins University

Jun 2023 - Present — Baltimore, MD

Advisor: Prof. Peter Kazanzides

- Core Developer of the AccelNet Surgical Robotics Challenge
- Conduct research on simulation environment construction the applications of various artificial intelligence algorithms for the dVRK
- Develop infrastructures to be shared with the dVRK community
- Investigate the dynamic model identification and gravity compensation of da Vinci Si surgical system
- Lead the live demonstrations of suturing needle grasping on the 2024 ISMR dVRK Workshop

Image-Guided Therapy Robotics Intern

Philips Research North America

May 2022 - Aug 2022 — Cambridge, MA

- Design a real-time synthetic motion simulator with GUI in Python using DICOM data as the solo input
- Leverage the Xbox game controller as alternative control input
- Implement analytical analysis on the simulator-generated data

Research Assistant

Worcester Polytechnic Institute

May 2021 - Present | Worcester, MA

- Lead and manage all dVRK related projects, including suturing automation, dynamic identification, customized controller teleoperation, kinematic & dynamic controller design and customized tool integration
- Lead the efforts on the dVRK hardware and software infrastructure maintenance and development
- Conduct user studies for research project investigation
- Conduct research on lower-limb exoskeleton walking strategy learning

Teaching Assistant

Worcester Polytechnic Institute

Sep 2020 - May 2021 | Worcester, MA

- TA for Control Engineering, Introduction to Dynamic Systems, Design of Machine Elements
- Design and Construct lab documents and GitHub repository for Control Engineering course
- Lead conference lectures for undergraduate courses
- Hold TA session to answer students' questions about homework assignments, labs and lectures

TECHNICAL SKILLS

Programming: Python | Matlab | C++ | Linux | Git | PyTorch | TensorFlow | ROS | ROS2 | PyQt | Arduino

Simulation: AMBF | Blender3D | Gazebo | VREP | Slicer | ITK | VTK | VMTK | Isaac Sim

Platform: the dVRK classic | the dVRK Si | Magic Leap 1 | NVIDIA Clara AGX

Design and Hardware: SolidWorks | Auto CAD | Machine Shop Training | 3D Printing

SELECTED PROJECTS

Suturing Automation with Robot Learning

Worcester Polytechnic Institute and Johns Hopkins University

Sep 2021 - Present | Worcester, MA & Baltimore, MD

- Implement imitation learning algorithms for suturing automation in the Asynchronous Multi-Body Framework (AMBF) simulator
- Design a novel pipeline and conduct user study for human demonstration data collection using the physical dVRK
- Investigate robot learning algorithms for suturing automation on the physical dVRK with sim-to-real approaches
- Leverage Dynamic Movement Primitives (DMP) and Local Weighted Regression (LWR) to find the optimal learning weights

Suturing Needle and dVRK Surgical Instrument Pose Estimation

Worcester Polytechnic Institute and Johns Hopkins University

Feb 2022 - Present | Worcester, MA & Baltimore, MD

- Investigate 6D pose estimation algorithms for suturing needles and dVRK surgical instruments using deep learning methods
- Conduct research on dVRK surgical instrument segmentation from endoscopic images in the AMBF simulation environment using GDR-Net
- Construct 1:1 model for dVRK surgical instruments and suturing needles using Blender3D and deploy to the AMBF simulation environment

Dynamic Identification for the dVRK

Worcester Polytechnic Institute and Johns Hopkins University

Nov 2022 - Present Worcester, MA & Baltimore, MD

- Investigate the dynamic model identification and gravity compensation of da Vinci classic and Si surgical system using the Euler-Lagrange method and optimization approaches
- Conduct research on force estimation under interaction using a hybrid model combined the model-based approach and the learning-based approach

Endoscopy Image Segmentation

Johns Hopkins University

Nov 2023 - Present Baltimore, MD

- Investigate the dVRK instrument segmentation from the endoscope images using AI algorithms, including Mask R-CNN and Vision Transformer
- Employ invisible UV/IR dye for ground truth labeling
- Construct markerless da Vinci surgical instrument segmentation and pose estimation dataset
- Deploy image analysis algorithms on NVIDIA Clara AGX system

dVRK Infrastructure development

Worcester Polytechnic Institute

Mar 2021 - Present Worcester, MA

- Design a novel replacement solution on broken joint encoders of the dVRK Patient Side Manipulator
- Develop the replacement solution on defective joint brakes of the dVRK Endoscopy Camera Manipulator
- Surgical tool lubrication and cable tension recovery
- Reactivate the High Resolution Stereo Viewer (HRSV), including the internal monitor replacement and customized design for the viewer height-adjustment actuator

Point Cloud Completion

Worcester Polytechnic Institute

May 2023 - Feb 2024 Worcester, MA

- Proposed a novel chamfer distance loss function for point cloud completion task
- Achieved new state-of-the-art results on some benchmark dataset

dVRK Customized Instrument Integration

Worcester Polytechnic Institute

Jan 2022 - Aug 2023 Worcester, MA

- Integrated photoacoustic probe with the dVRK
- Constructed the kinematic model for the customized instrument with the probe integrated and enabled the control
- Developed the autonomous scanning system using ROS for image overlay

dVRK Customized Teleoperation

Worcester Polytechnic Institute

Nov 2021 - Jun 2022 Worcester, MA

- Implemented dVRK PSM teleoperation using ROS framework and Razer Hydra game controller
- Leveraged sEMG sensors signals to teleoperate dVRK PSM
- Enabled dVRK PSM teleoperation with the 3D Systems Geomagic Touch haptic device
- Present Demonstrations of the dVRK teleoperation using customized controllers on 2022 DeviceTalks and WPI Touch Tomorrow

Lower-Limb Exoskeleton Walking Strategy Learning

Worcester Polytechnic Institute

Sep 2020 - Mar 2021 Worcester, MA

- Investigated a learning from demonstrations algorithm for human walking strategies on lower-limb exoskeleton in the AMBF simulation environment
- Implemented Iterative Linear Quadratic Regulator to find the optimal weight matrix

Imitation Learning for Reaching-to-Grasping Task

Boston University

Oct 2018 - May 2020 Boston, MA

- Investigated learning from demonstrations algorithms for reaching-to-grasping task in VREP simulation environment
- Leveraged joystick for the Baxter Robot end-effector control and human data collection
- Wrote and defended my Master's Thesis based on the research project

PUBLICATIONS

Journal Articles

- S. Gao, ..., **H. Zhou**, *et al.*, "Intraoperative laparoscopic photoacoustic image guidance system in the da vinci surgical system," *Biomedical optics express*, vol. 14, 2023.
- Y. Jiang, **H. Zhou**, and G. S. Fischer, "Development and evaluation of a markerless 6 dof pose tracking method for a suture needle from a robotic endoscope," *Journal of Medical Robotics Research*, vol. 08, 2023.

Conference Proceedings

- C. J. Allison, **H. Zhou**, A. Munawar, *et al.*, "Towards a modern and lightweight rendering engine for dynamic robotic simulations," in *arXiv preprint*, 2024.
- J. A. Barragan, J. Zhang, **H. Zhou**, *et al.*, "Realistic data generation for 6d pose estimation of surgical instruments," in *International Conference on Robotics and Automation (ICRA)*, IEEE, 2024.
- J. Wu, **H. Zhou**, P. Kazanzides, *et al.*, "Surgicai: A fine-grained platform for data collection and benchmarking in surgical policy learning," in *arXiv preprint (NeurIPS Accepted)*, 2024.
- H. Yang, **H. Zhou**, G. S. Fischer, *et al.*, "A hybrid model and learning-based force estimation framework for surgical robots," in *arXiv preprint (IROS Accepted)*, 2024.
- **H. Zhou**, Y. Jiang, S. Gao, *et al.*, "Suturing tasks automation based on skills learned from demonstrations: A simulation study," in *International Symposium on Medical Robotics (ISMR)*, IEEE, 2024.
- **H. Zhou**[*], F. Lin[*], H. Liu[*], *et al.*, "Loss distillation via gradient matching for point cloud completion with weighted chamfer distance," in *arXiv preprint (IROS Accepted)*, 2024.
- S. Gao, Y. Wang, **H. Zhou**, *et al.*, "Laparoscopic photoacoustic imaging system integrated with the da vinci surgical system," in *Medical Imaging: Image-Guided Procedures, Robotic Interventions, and Modeling*, SPIE, 2023.
- Y. Jiang, **H. Zhou**, and G. S. Fischer, "Markerless suture needle tracking from a robotic endoscope based on deep learning," in *International Symposium on Medical Robotics (ISMR)*, IEEE, 2023.
- K. Yang, T. B. Meier, **H. Zhou**, *et al.*, "A semg proportional control for the gripper of patient side manipulator in da vinci surgical system," in *International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*, 2022.
- N. Goldfarb, **H. Zhou**, C. Bales, *et al.*, "Control of a lower limb exoskeleton using learning from demonstration and an iterative linear quadratic regulator controller: A simulation study," in *International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*, 2021.

SELECTED COURSE PROJECTS

Visual Inertial Odometry with Multi-Scale Constraint Kalman Filter

Worcester Polytechnic Institute

FaceSwap and Neural Radiance Fields (NeRF) Implementation
Worcester Polytechnic Institute

Adaptive Robustness Control Design for UAV with ROS Gazebo
Worcester Polytechnic Institute

Laboratory Animal Surgery
Worcester Polytechnic Institute

Autonomous Racing Car Dynamic and Control Design
University of California, Berkeley

Real-Time Bubble Recognition
University of California, Berkeley

Object Tracking Mechatronics System Design and Manufacturing
University of California, Berkeley

AWARDS AND CERTIFICATES

Dr. Glenn Yee Graduate Student Tuition Award
Worcester Polytechnic Institute, Fall 2024

Dr. Glenn Yee Graduate Student Travel Award
Worcester Polytechnic Institute, Spring 2024

CITI Program Training - Social & Behavioral Research
Johns Hopkins University

CITI Program Training - Human Subjects in Biomedical Research
Worcester Polytechnic Institute

Radiation Safety Training
Johns Hopkins University

MRI Safety Training
Worcester Polytechnic Institute

LANGUAGES

Chinese ●●●●●

English ●●●●●