

JACK (HAOYING) ZHOU

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

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haoyingzhoujack

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 and the applications of various AI/ML algorithms for the dVRK
- Develop infrastructures to be shared with the dVRK community
- Led the dVRK workshop demonstration at 2024 ISMR

Image-Guided Therapy Robotics Intern

Philips Research North America

May 2022 - Aug 2022 Cambridge, MA

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

RESEARCH TOPICS

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

Surgical Instrument Segmentation and Pose Estimation

Worcester Polytechnic Institute and Johns Hopkins University

Feb 2022 - Present Worcester, MA & Baltimore, MD

- Investigate dVRK surgical instruments segmentation and pose estimation algorithms using learning-based approaches
- Construct 1:1 and photorealistic model for dVRK surgical instruments and suturing needles in the AMBF simulation environment
- Construct a dataset of surgical instrument detection tasks

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

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

TECHNICAL SKILLS

Programming: Python Matlab C++ Linux

Git PyTorch Tensorflow ROS ROS2

PyQt Arduino

Simulation: AMBF Blender3D Gazebo

VREP Slicer ITK VTK 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

LANGUAGES

Chinese
English



SELECTED PROJECTS

Endoscopy Image Segmentation

Johns Hopkins University

📅 Nov 2023 - Present

📍 Baltimore, MD

- Investigate the dVRK instrument segmentation and tracking from the endoscope images using AI algorithms on NVIDIA AGX
- Employ invisible UV/IR dye for ground truth labeling
- Construct markerless da Vinci surgical instrument image segmentation and pose estimation dataset

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
- Designed the kinematic model and implemented autonomous scanning 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

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

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
- Designed and implemented Iterative Linear Quadratic Regulator to find the optimal weight matrix

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.