HAOYING(JACK) ZHOU

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EDUCATION

Worcester Polytechnic Institute *Sep 2020 - Present*
Ph.D. in Robotics Engineering, GPA: 3.95/4.0

Boston University *Sep 2018 - May 2020*
Master of Science in Mechanical Engineering, GPA: 3.78/4.0

University of California, Berkeley *Sep 2017 - May 2018*
Senior-year Exchange program, Mechanical Engineering, GPA: 3.95/4.0

Beijing Institute of Technology, China *Sep 2014 - May 2018*
Bachelor of Science in Mechanical Engineering

WORK EXPERIENCE

Visiting Graduate Scholar, *JHU LCSR, Baltimore, MD* *Jun 2023 - Present*
- Construct research on suturing tasks automation based on skills learned from demonstrations in simulation.
- Develop the software infrastructure of the 2021-2022 & 2023-2024 AccelNet Surgical Robotics Challenge available on surgical-robotics-ai.github.io/surgical-robotics-challenge-2023/challenge-2023.html.
- Design the framework for customized controller teleoperation and robot motion recording & replaying system.
- Build and test the whole robot system URDF model for daVinci Si surgical system in ROS.
- Generate a synthetic 6D pose estimation dataset in simulation and train deep learning models on the dataset.
- Construct models in the simulation for realistic da Vinci Patient Side Manipulator (PSM), novel suturing phantom & needle using Blender and the Asynchronous Multi-Body Framework (AMBF) simulator.
- Design and implement dynamic identification scripts to obtain the dynamic model of dVRK PSM for physical-model-based neural network integration.

Robotics Intern, *Philips Research North America, Cambridge, MA* *May 2022 - Aug 2022*
- Design a synthetic motion simulator with GUI in Python using 3D DICOM data as the only input.
- Implement phantom feature extraction, volume rendering and 3D volume visualization with VTK, ITK and VMTK.
- Construct data auto-generator based on the synthetic motion simulator with flexible configuration inputs.
- Integrate the simulator with Xbox controller as motion control input.
- Improve the image refreshing rate of the simulator from 0.15 fps to 5 fps.
- Implement analytical analysis on the generated data.

Research Assistant, *WPI AIM Lab, Worcester, MA* *May 2021 - Present*
- Manage and lead all da Vinci Research Kit(dVRK) related projects, including suturing automation, dynamic identification, customized controller teleoperation, kinematic & dynamic controller design and customized tool integration.
- Repair and then reactivate a first-generation da Vinci surgical system using dVRK software framework, actively maintenance, upgrade and develop both hardware and software infrastructures of the physical dVRK.
- Develop a solution to da Vinci surgical instruments lubrication and cable tightening.
- Lead and manage all user studies using the full physical dVRK or part of the dVRK system.
- Leverage Magic Leap 1 AR headset as an alternative stereo viewer for dVRK and enable eye focus tracking
- Implement suturing subtask automation using learning from demonstrations in simulation.
- Implement walking control automation for lower-limb exoskeleton using learning from demonstrations in simulation.

Teaching Assistant, *Worcester Polytechnic Institute, Worcester, MA* *Sep 2020 - May 2021*
- 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 & System:	Python, Matlab, C++, Linux, Git, Arduino, ROS, ROS2, PyQt, Pytorch, Tensorflow
Simulation:	Gazebo, Rviz, VREP, AMBF, Blender, Slicer, ITK, VTK, VMTK
Platform :	da Vinci Si surgical system, da Vinci surgical system, dVRK, Magic Leap 1
Design & Manufacturing:	Solidworks, Auto CAD, ANSYS FEA, Machining Skills

PUBLICATIONS

- Zhou, H., Jiang, Y., Gao, S., Wang, S., Kazanzides, P., & Fischer, G. S. (2024, Under Review). Suturing Tasks Automation Based on Skills Learned From Demonstrations: A Simulation Study. In 2024 International Symposium on Medical Robotics (ISMR). IEEE.

- Lin, F.*, Liu, H.*, Hou, S.*, Zhou, H.*, Yamado, K., Fischer, G. S., Li, Y. & Zhang, Z. (2024, Under Review). Loss Distillation via Gradient Matching for Point Cloud Completion with Weighted Chamfer Distance. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR).

- Yang K., Zhou, H., Ma, X., Meier, T. B., Nycz, C. J., & Fischer, G. S. (2024, Under Review). A Remote Teleoperation of the da Vinci Surgical System for People with Hand Disabilities. Journal of Medical Robotics Research.

- Barragan, J. A. , Zhang, J., Zhou, H., Munawar A., & Kazanzides P. (2024). Realistic Data Generation for 6-Dof Pose Estimation of Surgical Instruments. In 2024 IEEE International Conference on Robotics and Automation (ICRA). IEEE

- Jiang, Y., Zhou, H., & Fischer, G. S. (2023). Development and Evaluation of a Markerless 6 DOF Pose Tracking Method for a Suture Needle from a Robotic Endoscope. Journal of Medical Robotics Research.

- Gao, S., Wang, Y., Ma, X., Zhou, H., Jiang, Y., Yang, K., ... & Zhang, H. K. (2023). Intraoperative Laparoscopic Photoacoustic Image Guidance System in the da Vinci Surgical System. Biomedical optics express.

- Gao, S., Wang, Y., Zhou, H., Yang, K., Jiang, Y., Lu, L., ... & Zhang, H. K. (2023, April). Laparoscopic photoacoustic imaging system integrated with the da Vinci surgical system. In Medical Imaging 2023: Image-Guided Procedures, Robotic Interventions, and Modeling (Vol. 12466, pp. 62-70). SPIE.

- Jiang, Y., Zhou, H., & Fischer, G. S. (2023, April). Markerless Suture Needle Tracking From A Robotic Endoscope Based On Deep Learning. In 2023 International Symposium on Medical Robotics (ISMR) (pp. 1-7). IEEE.

- Yang, K., Meier, T. B., Zhou, H., Fischer, G. S., & Nycz, C. J. (2022, July). A sEMG Proportional Control for the Gripper of Patient Side Manipulator in da Vinci Surgical System. In 2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC) (pp. 4843-4848). IEEE.

- Goldfarb, N., Zhou, H., Bales, C., & Fischer, G. S. (2021, November). Control of a lower limb exoskeleton using Learning from Demonstration and an iterative Linear Quadratic Regulator Controller: A simulation study. In 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC) (pp. 4687-4693). IEEE.

PROJECTS

Suturing Automation based on Imitation Learning, *WPI AIM Lab & JHU LCSR* *May 2021 - Present*

- Construct user study for human demonstration data collection, using a suturing simulation scene in AMBF simulator with dVRK Master Tool Manipulator (MTM) teleoperation.
- Implement imitation learning algorithm using Dynamic Movement Primitives (DMP) for suturing task automation.
- The algorithm achieves high generality in simulation for suturing automation, on the order of 91.5%, from experienced human subjects' demonstrations.
- Reduce the single-throw suturing task execution time by 20% in simulation.

Point Cloud Completion, *Worcester Polytechnic Institute* *May 2023 - Dec 2023*

- Purpose a novel chamfer distance loss function based on the Landau distribution for point cloud completion
- The purposed method outperforms the current state-of-the-art solutions and achieves new state-of-the-art results on some benchmark datasets.

Suture Needle Pose Estimation, *WPI AIM Lab & JHU LCSR* *Feb 2022 - Present*
- Implement marker-less suture needle 6 DOF pose estimation in simulation using two different methods: keypoint-based and pure image. Both methods leverage deep learning networks for inference.
- MRI Scan 3-Dmed Soft Tissue Suture Pad, construct the volume based on the scanning DICOM data and then import into the AMBF simulator to construct a realistic simulation scene.
- Build 1:1 models of da Vinci surgical instrument and suture needle in Blender with AMBF add-on for sim-to-real purposes.
- Generate synthetic datasets for 6D pose estimation using AMBF simulator and dVRK MTM.
- The keypoint-based method wins the second prize on 2021 AccelNet Surgical Robotics Challenge
- Achieve estimated position errors around 2 mm and orientation errors around 5 degrees.

da Vinci Research Kit Infrastructure Development, *Worcester Polytechnic Institute* *Mar 2021 - Present*
- Develop a replacement solution including both mechanical and electronically design for dVRK PSM broken encoders.
- Purpose a replacement solution for dVRK ECM broken brakes.
- Deploy dVRK hardware and software infrastructures to a full da Vinci surgical system purchased from eBay.
- Implement dynamic identification via convex optimization on dVRK PSM.
- Design and validate surgical instrument recovery solution including joint lubrication and cable tightening, decreasing the mechanical noise of the surgical instruments by two or three orders of magnitude when operating.
- Integrate Magic Leap 1 with dVRK as an alternative stereo viewer.

dVRK Photoacoustic Instrument Integration and Automation, *Worcester Polytechnic Institute* *Jan 2022 - Aug 2023*
- Construct a customized da Vinci surgical instrument using ultrasound probe for photoacoustic scanning.
- Utilize four April Tags and computer vision techniques to find the transformation between the probe and the endoscope.
- Construct the kinematic model for dVRK PSM with customized instrument loaded in both Python and MATLAB.
- Build a ROS network among three clients to enable scanning automation and vision perception.

da Vinci Surgical System Customized Teleoperation, *Worcester Polytechnic Institute* *Nov 2021 - Jun 2022*
- Develop multiple ROS packages for teleoperating dVRK PSM with Razer Hydra controller and Geomagic Touch haptic device, demonstrate on 2022 WPI Touch Tomorrow and 2022 Boston DeviceTalks representing WPI PracticePoint.
- Leverage sEMG sensors and a motion capture system to construct teleoperation framework to control dVRK PSM.

Lower-Limb Exoskeleton Imitation Learning, *Worcester Polytechnic Institute* *Sep 2020 - Mar 2021*
- Construct and optimize an algorithm on imitation learning with Task-Parameterized Gaussian Mixture Model (TPGMM) applied to human walking strategies for lower-limb exoskeleton.
- Collect data using motion capture system with real-life human motion.
- Leverage AMBF simulator for simulating the exoskeleton and human lower limb movements.
- Design and implement iLQR controller to above algorithm and managed to find the optimal weight matrix.

Reach-to-Grasp Imitation Learning, *, Boston University* *Oct 2018 - May 2020*
- Design a generalized research-to-grasp automation algorithm using learning from demonstrations with DMP in Python.
- Leverage VREP for simulating robot arm motions.
- Collect human demonstration data using joystick controller
- Implement 6D pose imitation learning algorithm on the end-effector of Baxter Robot for reach-to-grasp tasks.
- Write and defend my Master's Thesis based on the project, full-text available on open.bu.edu/handle/2144/40948

Other selected project:

- Visual Inertial Odometry with Multi-Scale Constraint Kalman Filter, Worcester Polytechnic Institute
- FaceSwap and 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
- Object Tracking Mechatronics System Design and Manufacturing, University of California, Berkeley