Xinghao Zhu

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Education

University of California Berkeley — California, USA
PhD Candidate — Aug. 2018 - Present

- Major: Control, Minors: Robotics, Learning, and Optimization, GPA: 4.0
- Research Interests: Robotic Manipulation, Contact Planning and Optimization, Control and Learning
- Research Advisor: Prof. Masayoshi Tomizuka (Member of the National Academy of Engineering)

Xi'an Jiaotong University (XJTU) — Xi'an, China
BEc. Major in Electrical Engineering & the Honors Youth Program — Sep. 2012 - July 2018

- Best Undergraduate Thesis Paper of XJTU in 2018 (awarded to top 1% of 4000)

Selected Research Experiences

Prioritize Easy Learning Before Tackling Complex Challenges — April 2023 - Present
Mechanical Systems Control Lab — California, USA

- Develop a residual temporal loss for RL by leveraging prior policies trained with unknown reward designs. Test in various complex robotic manipulation and locomotion tasks, including bimanual dexterous manipulation, robotic piano playing, and robotic soccer, demonstrating its effectiveness and adaptability in challenging environments

Contact Optimization for In-Gripper Object Slippage — Sep. 2022 - Present
Mechanical Systems Control Lab — California, USA

- Investigate the impact of slippage between robotic grippers and tools during manipulation. Introduce contact models into the contact sequence optimization, resulting in improved stability and performance

Learning from Demonstration with Differentiable SDF and Dynamics — Oct. 2022 - Mar. 2023
Mechanical Systems Control Lab — California, USA

- Proposed an approach to reconstruct and extract object shapes and trajectories from human demonstrations by utilizing differentiable rendering and signed-distance functions (SDF)
- Developed a robust gradient approximation technique for model-based robotic manipulation with the aid of differentiable simulation. Leveraged global contact sampling to optimize long-horizon trajectories, resulting in enhanced performance for dexterous manipulation tasks

Allowing Safe Contact in Robotic Trajectory Planning — Mar. 2022 - Sep. 2022
Google X — California, USA

- Advocated generating and tracking compliance references in operational and null spaces for robotic manipulation tasks. Proposed hybrid sampling- and gradient-based optimizer for solving the optimal control problem
- Implemented safe contact benchmarks for robotic manipulators, showcasing that our algorithm not only enhances manipulation efficiency and feasibility but also significantly improves the safety of the generated trajectories

Goal Conditioned Robotic Manipulation with Cumulative Offline RL — Mar. 2021 - Jan. 2022
Mechanical Systems Control Lab — California, USA

- Considerred goal-conditioned robotic pushing for planar objects with task-agnostic datasets. The policy was trained offline with Conservative Q-Learning and deployed to the real world after adaptation

Learning to Synthesize Volumetric Meshes from Tactile Imprints — May 2021 - Sep. 2021
Mitsubishi Electric Research Lab — Cambridge, USA

- Focused on learning to synthesize the volumetric mesh of the elastomer based on the image imprints acquired from vision-based tactile sensors (GelSlim) with a graph neural network (GNN)
- A self-supervised adaptation method and image augmentation techniques are proposed to transfer networks from simulation to reality, from primitive contacts to unseen contacts, and from one sensor to another

Learn to Grasp with Less Supervision — Mar. 2021 - Sep. 2021
Mechanical Systems Control Lab — California, USA

- Proposed a maximum likelihood grasp sampling loss (MLGSL) to learn robotic grasping from sparsely labeled datasets. MLGSL is used to train networks that evaluate thousands of grasp candidates simultaneously

- Results suggest that models based on MLGSL are 8x more data-efficient than current state-of-the-art techniques with a similar performance in physical experiments at a 91.8% grasp success rate

6-DoF Contrastive Grasp Proposal Network Mar. 2020 - Oct. 2020

Mechanical Systems Control Lab California, USA

- Proposed a contrastive grasp proposal network (CGPN) to infer 6-DoF grasps from a single-view depth image under domain shifts. Utilized contrastive learning and style-transfer techniques to bridge the sim-to-real gap
- Validated the algorithm with Fanuc robots in cluttered bin-picking scenes, demonstrated improvement in grasp success rate and computation time

Optimization Model for Planning Grasps with Multi-Fingered Hands Aug. 2018 - June 2019

Mechanical Systems Control Lab California, USA

- Proposed an optimization model to solve the grasp planning problem with geometrical qualities and collisions
- Relaxed the optimization and solved with iterative palm pose optimization joint position optimization
- Validated the algorithm with BarrettHand, demonstrated effectiveness and robustness under noise

Selected Publications and Patents

- **X. Zhu**, M. Tomizuka, L. Shao "Diff-LfD: Contact-aware Model-based Learning from Visual Demonstration for Robotic Manipulation via Differentiable Physics-based Rendering and Simulation", in submission
- **X. Zhu**, W. Lian, B. Yuan, D. Freeman, M. Tomizuka "Allowing Safe Contact in Robotic Goal-Reaching: Planning and Tracking in Operational and Null Spaces", accepted by *2023 IEEE International Conference on Robotics and Automation (ICRA)*
- **X. Zhu**, L. Sun, X. Zhang, M. Tomizuka "Adaptive Voxel Grasp Network", in submission
- **X. Zhu**, S. Jain, M. Tomizuka, J. Baar "Synthesizing and Simulating Volumetric Meshes from Vision-based Tactile Imprints", accepted by *2022 IEEE International Conference on Robotics and Automation (ICRA)*
- **X. Zhu**, S. Jain, M. Tomizuka, J. Baar "Learning to Synthesize Volumetric Meshes from Vision-based Tactile Imprints", accepted by *2022 IEEE International Conference on Robotics and Automation (ICRA)*
- **X. Zhu**, Y. Zhou, Y. Fan, J. Chen, M. Tomizuka "Learn to Grasp with Less Supervision: A Data-Efficient Maximum Likelihood Grasp Sampling Loss", accepted by *2022 ICRA*
- **X. Zhu**, Y. Fan, C. Wang, Y. Zhou, S. Jin, M. Tomizuka "Multi-Fingered Grasp Pose Detection using Point Cloud", submitted to *IEEE Robotics and Automation Letters (RAL)*
- **X. Zhu***, L. Sun*, M. Tomizuka "6-DoF Contrastive Grasp Proposal Network", accepted by *2021 ICRA*
- **X. Zhu**, Y. Fan, C. Wang, M. Tomizuka "Why Does Robotic Dexterous Hand Grasp Fail?" accepted by *2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*
- **X. Zhu***, S. Jin*, C. Wang*, M. Tomizuka "Real-time State Estimation of Deformable Objects with Dynamical Simulation" accepted by *2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*
- Y. Fan, **X. Zhu**, M. Tomizuka "Optimization Model for Planning Precision Grasps with Multi-Fingered Hands", accepted by *2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*
- S. Jin, **X. Zhu**, C. Wang, M. Tomizuka "Contact Pose Identification for Peg-in-Hole Assembly under Uncertainties" accepted by *2021 American Control Conference (ACC)*
- X. Zhang, S. Jin, C. Wang, **X. Zhu**, M. Tomizuka "Learning Insertion Primitives with Discrete-Continuous Hybrid Action Space for Robotic Assembly Tasks" accepted by *2022 ICRA*
- C. Wang, Y. Zhang, X. Zhang, Z. Wu, **X. Zhu**, S. Jin, T. Tang, M. Tomizuka "Offline-Online Learning of Deformation Model for Cable Manipulation with Graph Neural Networks" accepted by *RAL*
- C. Wang, H. Lin, S. Jin, **X. Zhu**, L. Sun, M. Tomizuka "BPOMP: A Bilevel Path Optimization Formulation for Motion Planning" accepted by *2022 ACC*
- **X. Zhu**, T. Tang, T. Kato "Adaptive Grasp Planning for Bin Picking" *US Utility Patent* No. 61004-1/236264

Work Experiences

- Robotic research intern @ **Fanuc Advanced Research Lab**, June 2019 - Aug. 2019
- AI resident @ **Google X**, May 2022 - Sep. 2022
- Research intern @ **Mitsubishi Electric Research Lab**, May 2021 - Aug. 2021 & Jan. 2023 - Present