Xinghao Zhu

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Education

University of California Berkeley — California, USA
PhD Student — Aug. 2018 - May 2023 (Anticipated)

- Major: Control, Minors: Robotics and Learning, GPA: 4.0, PhD Prelim Score: 98/100
- Research Interests: Robotic Grasping and Manipulation, Optimization, Motion Planning, RL, Deep Learning
- Research Advisor: Prof. Masayoshi Tomizuka

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)

Skills

- **Languages**: Python, MATLAB, C/C++, Verilog HDL, Karel
- **Developer Tools**: Ubuntu, MuJoCo, Bullet, Kinect, RealSense, Ensenso, Arduino, 3D Printing
- **Control**: PID, LQR/LQG, MPC, Control Barrier, Impedance/Preview/Adaptive/Repetitive/Feedforward Control, Inverse Dynamics Control, Zero Phase Error Tracking Control, Disturbance Observer
- **Robotic**: ROS, Fanuc Robot Controller, Kinematics, Dynamics, Motion Planning Algorithms (RRT, TrajOpt, CFS, etc), Robotic Grasp Planning and Manipulation (GPD, GQCNN, GraspNet, etc), HRI, Soft Robot
- **Learning**: SVM, GDA, GMM, Search, PCA/CCA, Kalman/Particle Filter, Decision Tree, RL Algorithms (PPO, Q-Learning, SAC, etc), Meta Learning, Deep Models (Fast-RCNN, Transformers, PointNet, etc)

Research Experiences

Contact-Rich Robotic Manipulation with Offline Primitive Learning — Mar. 2020 - Present
Mechanical Systems Control Lab — California, USA

- Considered robotic pushing for planar objects with a contact dataset and an image-based primitive policy
- The policy takes depth images as states and decides the pushing primitives (i.e., object's mass distributions, contacts, target motions, etc.). The policy is trained offline with Conservative Q-Learning and adapts to the physical world with online fine-tuning through trials and errors

Learn to Grasp with Less Supervision — Nov. 2020 - Mar. 2021
Mechanical Systems Control Lab — California, USA

- Proposed a posterior grasp sampling loss (PGSL) to learn robotic grasping from sparsely labeled datasets. PGSL is used to train a fully convolutional network that evaluates thousands of grasp candidates simultaneously
- A novel variant of loss and model architectures are proposed and compared to predict planar grasps with a single-view depth image. A cluttered dataset is constructed to improve models' collision avoidance ability
- Results suggest that models based on PGSL 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

Robotic Rope Manipulation using Meta Reinforcement Learning — Aug. 2020 - Dec. 2020
Co-advised by Prof. Sergey Levine — California, USA

- Proposed an interpretable rope state estimator with gaussian mixture model (GMM) and coherent point drift
- Designed a meta-RL algorithm, includes a pre-trained contextual task encoder and a soft actor-critic (SAC), to manipulate the rope to a randomly given shape
- Validated the algorithm with Fanuc LR Mate 200iD robot, recognized improvement in sim-to-real gap handling

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
- Introduced rotated grasp proposal network and grasp refinement network into the planning framework
- Utilized contrastive learning and depth image style-transfer techniques to bridge the sim-to-real gap

- Validated the algorithm with Fanuc LR Mate 200iD robot in cluttered scenes, demonstrated 3% improvement in grasp success rate and 75% in computation time compared with prior state-of-the-art (SOTA)

Multi-Fingered Grasp Pose Detection using Point Cloud Aug. 2019 - Mar. 2020
Mechanical Systems Control Lab California, USA

- Proposed a multi-fingered grasp pose detection (MF-GPD) to plan grasps in clutter with a single-view image
- Utilized a cross-entropy sampler, a PointNet++ evaluator, and a local grasp optimizer to detect optimal grasps
- Validated the algorithm with BarrettHand BH282 in cluttered scenes, achieved 6% improvement in grasp success rate and 45% in computation time compared with prior SOTA

Robotic Bottle Flipping and Landing with TRPO and Adaptive MPC Aug. 2019 - Dec. 2019
Co-advised by Prof. Pieter Abbeel California, USA

- Introduced a robotic bottle flipping and landing framework using two Fanuc LR Mate 200iD manipulators
- Utilized trust region policy optimization (TRPO) and adaptive model predictive control (MPC) to throw and catch the bottle
- Designed a three-layer long short term memory (LSTM) network to approximate bottle's flying dynamics

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 with proposed models and solved with iterative palm pose optimization (PPO) joint position optimization (JPO)
- Proved the algorithm with BarrettHand, demonstrated effectiveness and robustness with noisy sensor readings

Publications and Patents

- **X. Zhu**, Y. Zhou, Y. Fan, L. Sun, and M. Tomizuka "Learn to Grasp with Less Supervision: A Data-Efficient Posterior Grasp Sampling Loss", submitted to *IEEE Robotics and Automation Letters*
- **X. Zhu**, Y. Fan, C. Wang, Y. Zhou, S. Jin and M. Tomizuka "Multi-Fingered Grasp Pose Detection using Point Cloud", submitted to *IEEE Robotics and Automation Letters*
- **X. Zhu***, L. Sun*, Y. Fan and M. Tomizuka "6-DoF Contrastive Grasp Proposal Network", accepted by *2021 IEEE International Conference on Robotics and Automation (ICRA)*
- **X. Zhu**, Y. Fan, S. Jin, C. Wang and 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*, T. Tang and 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** and 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 and M. Tomizuka "Contact Pose Identification for Peg-in-Hole Assembly under Uncertainties" accepted by *2021 American Control Conference (ACC)*
- **X. Zhu**, T. Tang and T. Kato "Adaptive Grasp Planning for Bin Picking" US Utility Patent Filed No. US/61004-1/236264

Work Experiences

Fanuc America Company (Fanuc Advanced Research Lab) June 2019 - Aug. 2019
Robotic Research Intern California, USA

- Proposed an adaptive grasp planner for precise robotic pick-and-place with target pose constraints
- Collaborated with full-time researchers in object detection and localization in the bin
- Deployed the algorithm to industrial scenarios and demonstrated 6% improvement in system cycle time

Award

5th China "Internet Plus" Innovation and Entrepreneurship Competition Oct. 2019
National Gold Award (rank 13/1,030,000 entrants) Zhejiang, China

- Designed and manufactured a continuous spiral heat exchange device to achieve SOTA heat transform performance in various scenarios
- Introduced optimal control and robust optimization to minimize energy consumption
- Received a $560,000 investment in the seed round