**Background**

Grasping is a crucial skill for advanced robotic applications and has huge implications for fields like assistive robotics, manufacturing, or logistics. Nevertheless, grasping unknown objects with multi-fingered hands at high success rates and in real-time is an unsolved problem. Existing methods are limited in the speed of grasp synthesis or the ability to synthesize a variety of grasps from the same observation.

Meanwhile, with the rapid development of affordable 3D cameras, many applications start to apply 3D cameras for their solutions, such as autonomous driving, robotics, remote sensing, and medical treatment. However, deep learning on 3D data is still challenging due to unstructured data and large computations.

Sim2real is also a popular topic in robotics applications since real-world data is expensive to collect. How to minimise the gap between the simulation and the real world is still an unsolved problem.

**Motivations**

A deep learning model trained on known objects with grasp poses can predict grasp poses from partial view from unseen objects. There are many ways to extract features from partial point cloud observation, such as  pointwise MLP methods, convolutional-based methods, graph-based methods, and other hybrid methods. Which method can work better for finding the optimal grasp poses from a partial observation, in terms of the performance and run time?

We have built the whole experimental setup in fig 1., including the hand, the Realsense 415 camera, and the robot arm in the gazebo simulator. A dataset of 180k grasp samples has been generated from the simulation. We will use DLR-HIT Hand II [1] as a five-fingered hand to grasp the unknown objects. It is a 15 degrees of freedom (DOF) fully actuated hand.

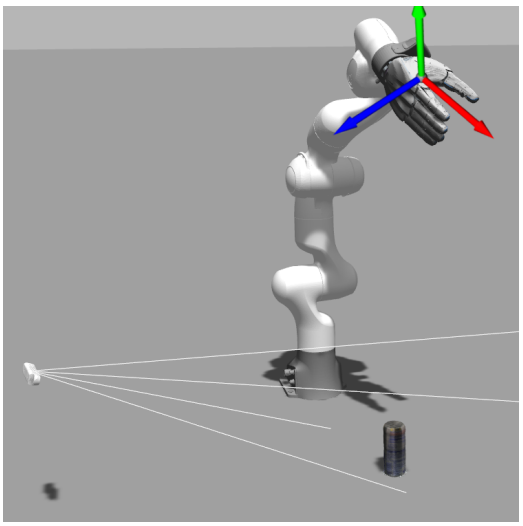

fig 1. Experimental setup in gazebo.

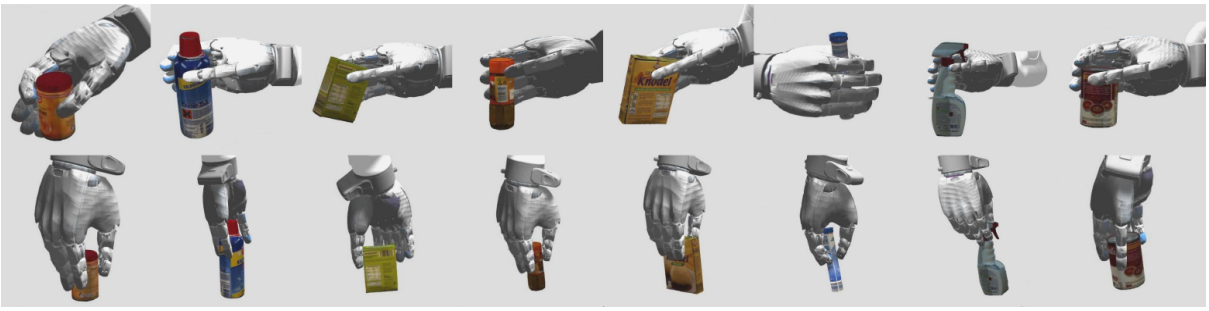

fig 2. Same grasp samples.

**Tasks**

- Literature research for the most advanced 3D deep learning algorithm for the purpose of grasp detection.
- Design a new model and train it on the current dataset
- Create a benchmark compared to the current baseline
- Conduct real-world grasping experiments

**Requirements**

- Solid programming in Python
- Familiar with Pytorch, ROS, Gazebo, Moveit
- Knowledge of robotics, deep learning, 3D computer vision
- Able to work independently

**Application and Contract**

This thesis is an external master thesis in cooperation with Agile Robots AG, located in the south of Munich. If you are interested in the offered thesis topics and would like to gain practical experience with 3D cameras, robot arms and robot hands, feel free to contact me.

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**References**

[1] https://www.dlr.de/rm/en/desktopdefault.aspx/tabid-11886/#gallery/28915

[2] H. Liu, K. Wu, P. Meusel, N. Seitz, G. Hirzinger, M. Jin, Y. Liu, S. Fan, T. Lan, and Z. Chen, "Multisensory five-finger dexterous hand: The dlr/hit hand ii," in 2008 IEEE/RSJ international conference on intelligent robots and systems. IEEE, 2008, pp. 3692–3697.

[3] A. Mousavian, C. Eppner, and D. Fox, "6-dof graspnet: Variational grasp generation for object manipulation," in Proceedings of the IEEE/CVF International Conference on Computer Vision, 2019, pp. 2901–2910.

[4] Q. Lu, M. Van der Merwe, B. Sundaralingam, and T. Hermans, “Multifingered grasp planning via inference in deep neural networks: Outperforming sampling by learning differentiable models,” IEEE Robotics & Automation Magazine, vol. 27, no. 2, pp. 55–65, 2020.

[5] M. Liu, Z. Pan, K. Xu, K. Ganguly, and D. Manocha, “Generating grasp poses for a high-dof gripper using neural networks,” arXiv preprint arXiv:1903.00425, 2019.

[6] “Deep differentiable grasp planner for high-dof grippers,” CoRR, vol. abs/2002.01530, 2020. [Online]. Available: https: //arxiv.org/abs/2002.01530

[7] J. Lundell et al., "Multi-finGAN: Generative coarse-to-fine sampling of multi-finger grasps", Proc. IEEE Int. Conf. Robot. Automat., pp. 4495-4501, 2021.