Object Completion Network for Instance-Aware Digital Twin Building

MSc. Project Proposal at the Autonomous Multi-Robots Lab, Cognitive Robotics, TU Delft

Brief description: When humans observe a part of an object, we often rely on our imagination and past experiences to complete the entire object, which greatly aids us in our daily activities. For example, when you want to place a big box beneath a desk, we may only see a part of the desk and the box from one angle. However, we can mentally reconstruct the complete shapes of the box and desk to determine if the box can fit underneath. Similarly, while driving on a road and considering changing lanes, if we notice a large front of a truck approaching in the adjacent lane, we can infer the size and length of the whole body, prompting us to delay lane change until it passes. This ability to "imagine" based on partial observations is crucial for robots interacting with the physical world. We aim to develop neural network-based methods to complete object shapes based on partial observations. Related works include [1] [2], with a representative result shown in Figure 1.

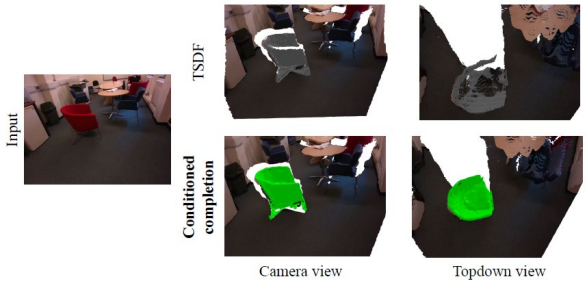

Fig. 1. Object completion [1]. The gray object on the top is incomplete. The green object at the bottom is the completed object with a 3D completion network.

We have developed a new method, an instance-aware semantic particle map (currently unpublished), to represent the environment. However, a challenge arises when parts of objects are not observed, resulting in incomplete representations. With your work on object completion, we aim to address this issue by filling in the missing parts of each object, thereby creating complete digital twins of real-world objects. These completed digital twins will be invaluable for navigation and manipulation tasks in various applications.

In this project, you will:

1) Review the current status of object completion and make a plan.
2) Use dataset like shapenet to train your shape completion network.
3) Improve the performance and integrate it to our map.

Requirements: Programming skills in Python. Knowledge in deep learning is preferred.

Start date: No later than September, 2024.

For further questions or to apply, please contact Clarence Chen <g.chen-5@tudelft.nl>. When applying, please provide a short motivation, up to date CV, a transcript of your current degree program and intended start date.

Group information: http://www.autonomousrobots.nl/

References:

[1] Xu, Binbin, Andrew J. Davison, and Stefan Leutenegger. "Learning to complete object shapes for object-level mapping in dynamic scenes." 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2022.

[2] Hidalgo-Carvajal, D., Chen, H., Bettelani, G.C., Jung, J., Zavaglia, M., Busse, L., Naceri, A., Leutenegger, S. and Haddadin, S., 2023. Anthropomorphic Grasping with Neural Object Shape Completion. IEEE Robotics and Automation Letters.