Vision and Tactile In-robot-hand Object Modelling

Grasping is an essential part of a service robot’s operation, from tidying up a room to bringing a requested object to a user. To achieve this action reliably for targeted objects, many state-of-the-art systems first estimate the 6 DoF pose of an object, and then, from the pose of the known object decide where and how to grasp it. This approach uses known 3D object models, potentially with textures as well. It is of course unimaginable to model ahead of time every single object the robot might encounter during its operation, and it is therefore necessary for the robot to be able to create those object models autonomously.

Once the object is in the robot gripper, the information about the kinematics of the robot, the depth sensor and the finger sensors can be combined to create such 3D models.

The goal of this thesis is to implement an autonomous object modelling system that will run on the Toyota HSR mobile manipulator. Assuming an object can be placed in the gripper by a handover, the information from the robot’s kinematics should be exploited to cleanly segment the object from the robot hand. The model is then to be constructed by merging the data from the depth sensor as well as the tactile data from the finger sensors to generate a complete 3D object model. This work will investigate the quality of the resulting models and quantify the improvement over the in-human-hand modelling approach developed in [1].

Tasks

- Use the method of [2] to separate the object from its background.
- Extend [1] to in-robot hand modelling using the kinematics of the robot to get relative poses.
- Investigate the use of tactile sensors [3] to compensate for the regions occluded by the fingers.
- Improve the IF-Nets shape completion component used in [1] by retraining it on objects more similar to the objects that are dealt with (i.e., YCB objects).
- Use the set of collected images, NOL [4] or an extension of NeRF to train a pose estimator and validate the usability of the object models.

Workload split

- Research and theory: 20%
- Programming and implementation: 50%
- Writing: 30%

Contact

Jean-Baptiste Weibel, weibel@acin.tuwien.ac.at
Timothy Patten, patten@acin.tuwien.ac.at
Matthias Hirschmanner, hirschmanner@acin.tuwien.ac.at

References

