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Human-Demonstration based Approach for Grasping Unknown Objects

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Abstract - This video presents a grasp planning of multiple robots via learning by human demonstration. In order to make a robot grasp an unknown object, the robot is required to figure out an appropriate grasping skill such as grasping points and approaching directions for the target object. After a shape of an unknown object has been reconstructed, the robot learns a natural and intuitive grasping skill by human demonstration.

Keywords - Grasp planning, learning by demonstration

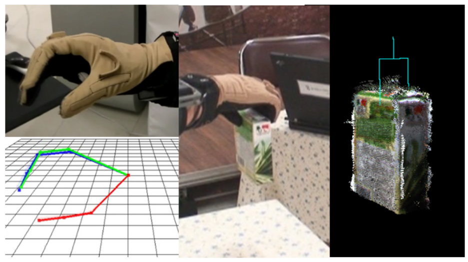

Fig. 1 Grasp skill learning by human demonstration.

1. Grasp Planning by Human Demonstration

In this video, we show a grasp planning that makes a robot possible to recognize unknown objects, learn grasping skills from human, and grasp the target objects. When a robot is faced with an unknown object, a human demonstrator teaches the robot a grasping skill to handle it. The main information of the grasping skill is accessible grasping points and approaching directions to the target object. Because this information is directly connected to the shape of the object, the robot needs to recognize the 3D model for the object [1]. If a demonstrator shows an appropriate grasping skill to the robot, the learned grasping information is attached to the reconstructed object model.

In order to train a grasping skill, we applied two subprocesses such as vision based object modeling and extraction of grasp information using a data glove. During the object modeling process, acquisition of the entire object shape is required. A robot observes the target object from all directions and produces a reconstructed 3D model. Because of the narrow field of view in a single direction, a robot with a stereo camera cannot acquire enough 3D images of the object. Therefore, we use sequential depth images, which are captured from different viewpoints by moving around the object [2]. Then, the robot merges all the depth images using corresponding points between the acquired images. Finally, the robot extracts the 3D model of the target object by segmenting the object region.

After an object model is reconstructed, the robot adds grasp information to the model. A demonstrator wears a data glove with a gyro sensor as shown in the Fig. 1. The obtained information from the demonstrator includes both an approaching direction of a hand to the target object and a grasping width between a thumb finger and an index finger. The applied data glove has joint angles of 22 channels, and the attached gyro sensor indicates a rotation angle of the arm. By combining the grasp information into the reconstructed model, the robot figures out the grasping points by the pose of the object. Figure 1 shows the grasping skill is initiated by the human demonstrator.

When we consider the placed pose of the object according to the robot position, the learned grasping point may be unsuitable for grasping with only one side hand. In that case, the robot determines a more accessible arm to grasp the object.

2. Experiment

Two different types of robots, a wheeled robot and a humanoid robot, were assigned as the executive robots. The network-based collaboration between two robots enables to overcome the physical limitations of a single robot [3]. The humanoid combined the acquired grasp information with the reconstructed object model by the wheeled robot. After estimating the current position of the target object, the humanoid robot successfully grasped the object.

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