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Robot Motion and Grasping for Blindfold Handover

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Abstract

Autonomous robots in human-robot interaction (HRI) recently are becoming part of human life as the number of services or personal robots increasingly used in our home. In order to fulfill the gap of HRI merit, we would like to propose a system of the autonomous robot motion and grasping creation for assisting the disabled person such as the blind people for handover tasks to help blind people in pick and place tasks. In this paper, we develop the robot motion to receive the object by handing over from the blindfold human to represent the blindness. To determine the target of the object and human hand, we implement the 6DOF pose detection using a point cloud and hand detection using the Single Shot Detection model in Deep learning for planning motion using 9DOF arm robot with hand. We finally experiment and evaluate the tasks from blindfold-robot handover tasks.

Keywords: Factory Automation, Motion Planning, Human-Robot Interaction.

1. Introduction

In order to push country economic, the smart automation in industrial sector is keys to improve nowadays. Since the merit of artificial intelligence research could facilitate various tasks in industrial. Therefore, we are able to develop the factory that could produce products faster with higher precision. In smart factory, the robot is important to assembly because it is more reliable and accuracy than human.

The manipulator robot actually is controlled by joint position however we usually control the robot in Cartesian space therefore we have to calculate the inverse kinematic (IK). One of popular method of IK recently is Trac-IK and KDL which can calculate the solution more than related method[1]. Since the robot also need to plan the trajectory according to the environments such as avoiding the collision or moving to the target. The recent motion planning method is Open Motion Planning Library which is popular, reliable and fast for solving the trajectory motion in various movement such as robot arm motion, vehicle, drone[2].

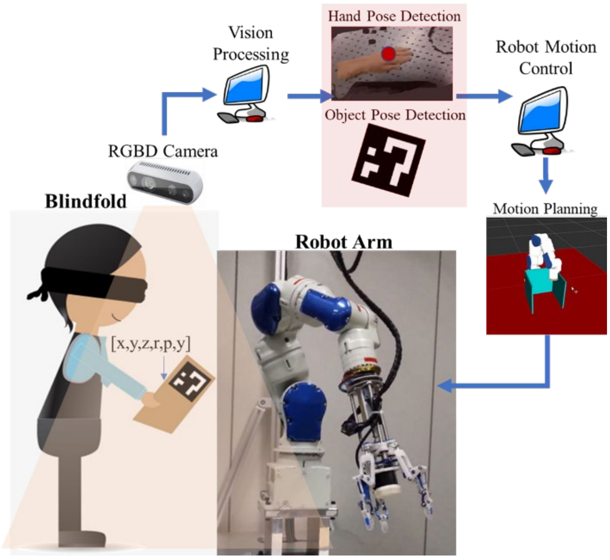

Fig. 1. The overview system of challenge experiment of handover tasks from blindfold

Since the robot could not move by itself, the user have to teach the robot to move according to the tasks. However, sometimes it is hard to teach the robot because of the difficult environment. Therefore, we proposed the teaching less system that the robot can generate motion according to the situation. We implement the perception system to let the robot can autonomously planning its motion depending on the tasks.

Collaborative robot (Cobot) becomes import recently since it helps the worker achieve the tasks easier and more reliable. There is the research on assembly tasks or Pick and Place recently[3]. However, the recent research is lack for implement the robot for disabled people therefore our application also can apply for service tasks for blind people. Since the blindness recently is lack support from the society, we therefore attempt to initiate the experiment that can apply for blindness using subject with blindfold.

In this paper, we propose the robot system that can generate motion to grasping the object from human in any poses by let the human blind their eye that the human cannot help the robot to grab the object. In addition, this system might be useful for blind people in service tasks such helping the blind people keep the thing to its place. In the rested paper, we organize the section in 5 section including

2. Concept of Motion Generation for Handover from Blindfold

In this section, we explain the overview system including robot hardware configuration, robot perception, motion planning and grasping pose for handover.

2.1. *Hardware Configuration*

From the beginning, we have proposed the concept idea and the objective of this system. Consequently, we design the hardware configuration. Firstly, we utilize the robot arm which is industrial robot from Motoman Yaskawa as an operator for getting the object from blindfold. The robot was construct by 7 degree of freedom including one joints in base, two joints in shoulder, two joints in elbow, and two joints in wrist. For grippe, we use D-Hand robot which 2 DoF that can control finger angle and gripper state. The robot is shown in the Fig. 2.

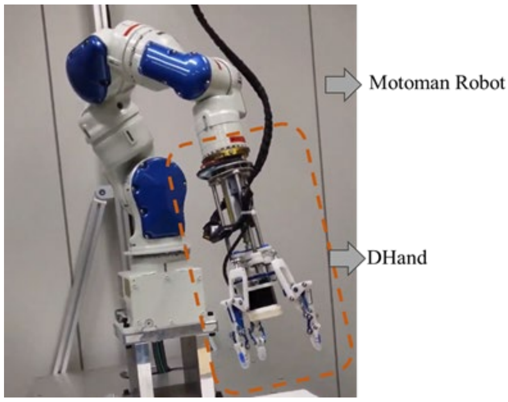

Fig. 2. The robot system and hand for grasping.

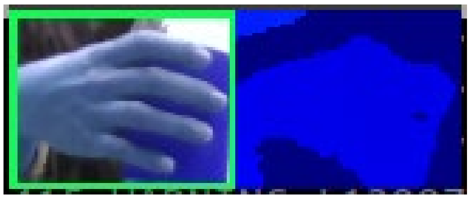

Fig. 3. Example color image and depth image from hand detection.

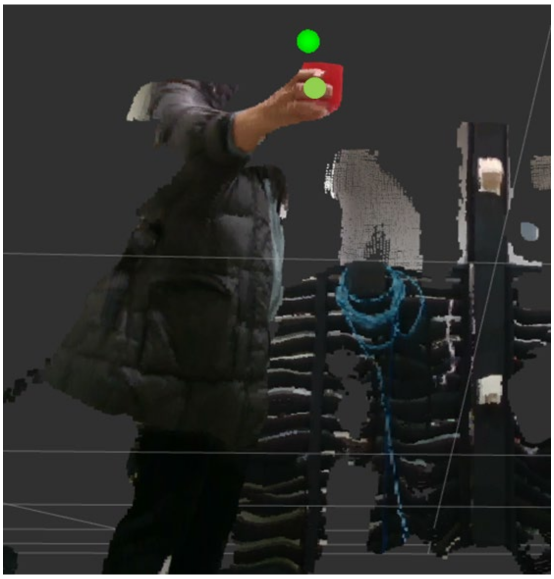

Fig. 4. 3D point cloud of hand and object position estimation for robot grasping.

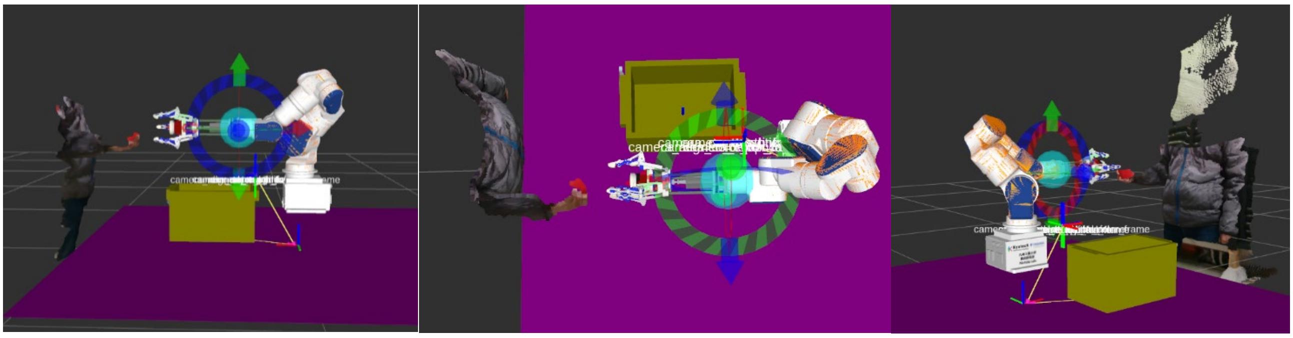

Fig. 5. 3D point cloud of environment and subject with robot model during handover experiment in different views

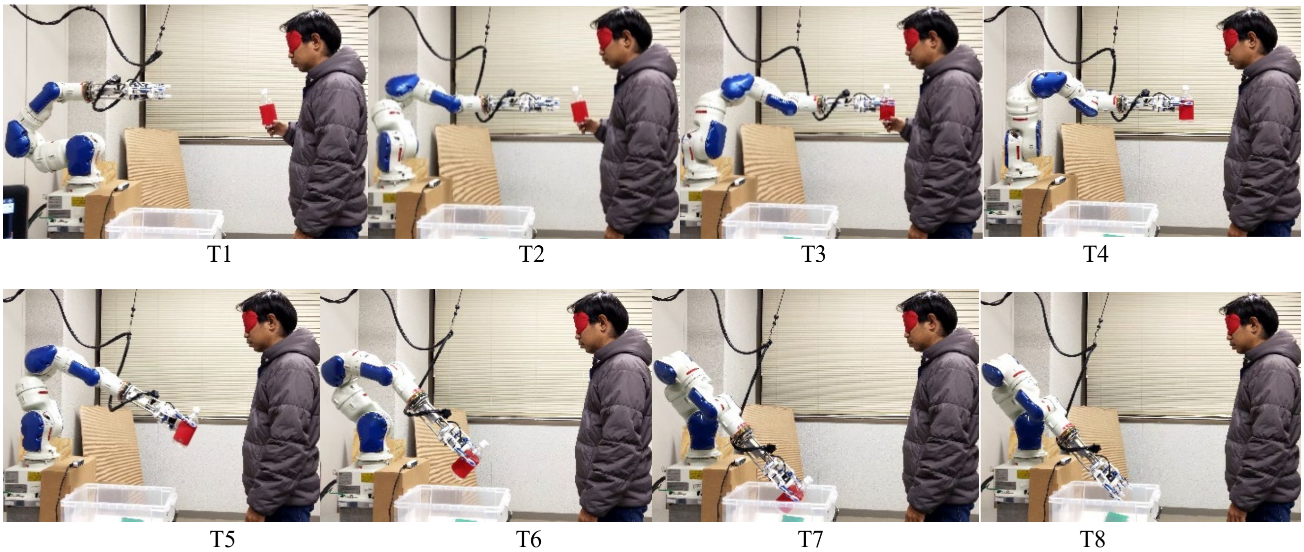

Fig. 6. The snapshots during object handover experiment from blindfold to robot

2.2. *Perception*

We develop perception system in order to estimate the target position for motion which is based on the hand detection and object position estimation. Firstly, we employ RGBD camera to getting image. In perception, hand detection is implemented using Deep Learning based Single Shot Detection[4] then we extract the location of hand from color image and depth image. We estimate the hand position by project the depth image in Cartesian space. Afterward we extract area of the points cloud of hand and object in the palm. We then remove the hand point by skin filter and get only object point and estimation the position. Fig 3 shows the result when the robot can detect the hand extracting in color and depth image. Fig. 4 shows the results in point cloud of position estimation of hand and object which the upper point represents object and lower point represents hand position.

2.3. *Motion Planning*

Since the robot knew the position of the object, we then can plan the motion for the robot. Firstly, we set the home pose to initialize the robot joints to prepare for grasping object from blindfold. When the robot can detect hand and object then it would plan motion using OMPL and KDL inverse kinematic. In this implementation, we utilize MoveIt API for organize the motion plan and collision protection among the environment. After complete detection, then robot would approach the object prepare for grasping then move to grasp from blindfold who does know the current object pose and robot hand position that human cannot help the robot grip object easier. Therefore, our system is pretty unique among the current research that usually let human know robot hand and can help robot to grip object.

3. Experiment

From the above section, we explained our system and the configuration then in this section we explain the demonstration and evaluation of our system. Since we proposed this system for handover from blindfold in factory automation or human service sector. We then invite subject to do experiment and blind his eye to preventing subject helping robot to grasp which is unique experiment comparing to recent research and slightly challenge.

The experiment starts from the robot initializing position and wait for subject hand detection with object. In fig. 6 shows experiment snapshot during the handover from blindfold starting from T0 to T8. In T0 the robot prepares for hand detection in home pose. After the robot can detect hand then the robot moves to pre-grep position in T2. T3, the robot moves move to grasp from subject handover the object robot without seeing the robot because subject is blindfold. T4 after handover completely, the robot moves to post-grip position. Then in T5 and T6 robot move to place the bottle into the box at the pre-place position. T7 and T8, the robot put the bottle into the box softly.

In fig. 5 shows the 3D image captured during the handover experiment. The first, second and third show the side view, top view and front side view respectively.

4. Conclusion and Future Works

This paper proposed the autonomous motion planning of manipulator robot to utilize in factory automation for handover tasks. The handover tasks are important for assembly production since there are many worker and robot operating together. However, our paper also is designed to utilize for blind people as a service robot. Because this system can assist blind people for keeping things to their place. This might help blind people live easier.

In this paper, we already present the system for motion plan where the system can be employed for factory and human life such as blind people. For the perception in this system, we implement hand position estimation using deep learning to deploy for motion planning. For the motion system, we utilize The Open Motion Planning Library and KDL inverse kinematic which are capable to plan the motion to grasp the object from handover tasks. By the experiment and result, we conclude that the robot could generate the motion and grasping for handover task For the future work, we would like to the improve robust pose estimation for grasping using 6DoF pose detection. Since robot can know the object pose then the robot can grasp with the reliable position. Moreover, we would like to improve the reliable of system for real service task to assist blind people to improve human life.

References

1. Beeson, Patrick, and Barrett Ames. TRAC-IK: An open-source library for improved solving of generic inverse kinematics. In 2015 IEEE-RAS 15th International Conference on Humanoid Robots (Humanoids), pp. 928-935. IEEE, 2015.
2. Sucan, I.A., Moll, M. and Kavraki, L.E., 2012. The open motion planning library. IEEE Robotics & Automation Magazine, 19(4), pp.72-82.
3. Zhu, Z. and Hu, H., 2018. Robot learning from demonstration in robotic assembly: A survey. Robotics, 7(2), p.17.
4. Liu, Wei, Dragomir Anguelov, Dumitru Erhan, Christian Szegedy, Scott Reed, Cheng-Yang Fu, and Alexander C. Berg. "SSD: Single shot multibox detector." In European conference on computer vision, pp. 21-37. Springer, Cham, 2016.

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