Robo-Erectus RoboCup@Work 2016 Team Description Paper

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Abstract. This paper provides a brief description of Robo-Erectus @Work (RE@Work) that is set to participate in the RoboCup@work category in RoboCup 2016. The hardware is based on Kuka youBot with customized gripper. The software framework is developed under ROS environment. Some developed capabilities required for operating in industrial environments including features such as optimal manipulation and object recognition relating to sea port automation are also described.

1 Introduction

The Robo-Erectus (RE) project was started as early as 2002 in Advanced Robotics and Intelligent Control Centre (ARICC) of Singapore Polytechnic. It is one of the pioneer soccer-playing humanoid teams in the RoboCup Humanoid League. The team Robo-Erectus@Work (RE@Work) was established in 2013 and achieved the 4th place and 2nd place in RoboCup 2013 and 2015 @work category respectively. Our main research interests include mobile manipulation in industrial environment such as twist-lock pose estimation and grasping in uncertain environment for port automation, omni-directional localization and navigation in unconstrained environments, object recognition and handling in logistics environment and for youBot arm control, a novel trajectory planning based on geodesics is provided [3].

2 Robot Platform

Kuka youBot shown in Fig. 1 is the latest robot platform of team RE@work. It is equipped with 4 Omni-directional wheels and a 5-degree-of-freedom manipulator arm with a 2-finger gripper [1]. Two lightweight laser scanners (Hokuyo URG-04LX) are mounted in the front and rear of robot respectively to localize and navigate robot in competition arena. A softkinect 3D camera is mounted on the manipulator to conduct object recognition and visual servoing. The laptop is replaced by high level mini-pc for computer vision calculation and conduct the artificial intelligent strategy in competition and motion control of the robot. The competition arena set up in our centre is shown in Fig. 2.

Fig. 1. Kuka youBot platform.

Fig. 2. Competition arena.

3 Software Framework

The underlying software architecture shown in Fig. 3 is based on ROS framework [2]. The communication infrastructure of ROS is used to exchange data and commands between different components. For example, the publisher and subscriber are mostly used to grab data from sensors and control robot motion. The service and client are used to request specific service, and the response is given to client. Such as object recognition service, the client send request (including object name and color) to server and client is given the recognition result. Besides, some tools in ROS are utilized for visualization, testing and debugging, such as RVIZ.

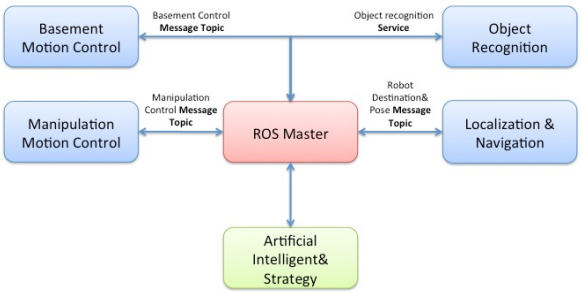

Fig. 3. Software framework based on ROS.

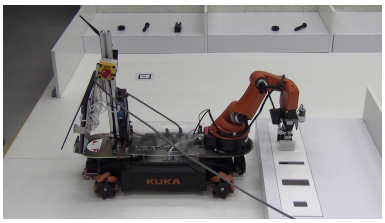

Fig. 4. Precision Placement Test.

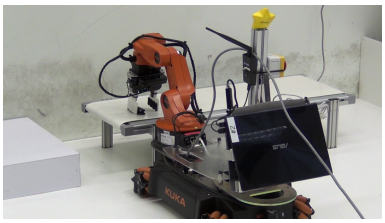

Fig. 5. Conveyor Belt Test.

4 Object Detection and Manipulation

Firstly a 2D object detection algorithm is developed which is suitable for most parts in the workstation. The 3D object recognition using the open source modules are on going such as Point Cloud Library (PCL). Based on ROS Moveit stack, we develop our own arm manipulating strategy to successfully control the youBot arm for the tests such as PPT (Fig. 4) and CBT (Fig. 5).

5 Acknowledgments

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