Applied Robotics:
Precision Placement in RoboCup@Work

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Abstract

In this demonstration we show how various approaches from different computer science domains have been combined to win the 2013 world championship title in the RoboCup@Work league. RoboCup@Work aims to facilitate the use of autonomous robots in industry. Among other contributions, we show how artificial intelligence can be successfully reintegrated into a noteworthy robotics solution. This entails (simultaneous) localization and mapping, navigation, object recognition and object manipulation. The platform used is ground based, capable of omnidirectional movement and equipped with a five degree of freedom arm featuring a parallel gripper.

1 Introduction

RoboCup@Work is a recently launched competition which aims at flexible robotic solutions in work-related scenarios. The leagues vision[1] is to "foster research and development that enables use of innovative mobile robots equipped with advanced manipulators for current and future industrial applications, where robots cooperate with human workers for complex tasks ranging from manufacturing, automation, and parts handling up to general logistics".

In contrast to the well developed robotic solutions deployed in common mass-production environments, RoboCup@Work targets smaller companies in which flexible multi-purpose solutions are required, which are not yet available in industry. Example tasks are finding and acquiring parts, transportation to and from dynamic locations, assembly of simple objects etc. From these industrial goals various scientific challenges arise. For example, in perception, path planning, grasp planning, decision making, adaptivity and learning, as well as in multi-robot and human to robot cooperation.

2 Swarmlab@work

SwarmLab@work is the team from Maastricht University, that competes in the @Work competition in RoboCup. The team has been established in the beginning of 2013, and has since won the @Work competitions of the 2013 RoboCup German Open and the 2013 RoboCup World Cup. Our robot is based on a stock KUKA youBot[2]. The youBot features mecanum wheels and is capable of omnidirectional drive. For manipulating objects it is equipped with a 5-DOF manipulator and a two-finger gripper. For perceiving the environment, two Hokuyo URG-04LX-UG01 light detection and ranging (LIDAR) sensors are mounted parallel to the floor on the front and back of the robot. In order to detect and recognize manipulation objects,

[1] `http://robocupatwork.org/`
[2] `http://youbot-store.com/`

(a) (b)

Figure 1: (a) shows the modified KUKA youBot, (b) shows an example precision placement test.

an ASUS Xtion PRO LIVE RGBD camera is installed on the last arm joint. The base computer features an Intel i7 CPU and is supported by an i5 notebook, which is mounted on a rack at the backside of the robot. Figure 1a shows the current setup. To tackle some of the previously mentioned scientific challenges, we use particle filter [3] for LIDAR based mapping/localization, a dynamic window approach [2] based trajectory rollout for path planning, scan registration [5] for fine positioning, and a force field [1] approach for recovery behavior. For detecting and recognizing manipulation objects a tree learning based [4] classifier is used, and inverse kinematics [6] for planning the arm trajectories.

3 Demonstration

In the proposed demonstration we will show a "precision placement test", i.e., acquiring certain objects from a service area followed by transportation to a destination area, where the environment is known in advance, but unmapped obstacles can be placed. Upon arrival at the destination area, the object will be placed with millimeter precision into object specific cavities. The cavities match the outline of the object with 10% tolerance for every dimension. Figure 1b shows an example setup for the precision placement test. In a video[3] we show the proposed demonstration, for which we require a 3x3 meter area of rigid floorspace.

References

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