RED@Work 2017 Team Description Paper

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Abstract. This paper is devoted to the main results of the RED (Robotics Engineering Department), ITMO University team for 2017 @Work League competition. The work on the project starts in June 2016. The team members visited RoboCup 2016 without project, and got a good experience in robotics in common. As the main platform we use a Kuka YouBot, equipped with a camera and a scanning range finder. The main middle-ware is ROS "Robot Operating System".

1 Introduction

New approach Industry 4.0 in modern manufacturing implies cooperation in heterogeneous network and autonomy of each agent inside [1]. For solving these tasks we focused on the mobile robot autonomy, because it's close to our department speciality "Control systems and Computer Science". RoboCup@Work is a great demonstration of the fully autonomous system for industrial application. The next step will be a cooperation between different types of agents for solving complex tasks [2,3]. RoboCup 2017 is the first participation for the RED team. In Russia, St. Petersburg there are many strong robotic schools with background in World Robot Olympiad for school students. It was a good impulse for university teams to participate in international competition [4,5,6,7]. Interesting and challenging tasks became the main factor in the selection of this competition. Kuka YouBot (fig. 1) mobile robot was suitable for competition rules.

Fig. 1. The common view of the system.

2 Hardware

The main robotic system of team RED@Work is omni-directional platform with mecanum wheels. Gripper will be equipped with flexible fingers. For localization and mapping task a laser scanner Hokuyo URG-04LX is used. Manipulator is equipped with a camera for object recognition. For computer vision and computations the laptop is placed on a board.

3 Modeling

One of the main aspects in robotic system development is preliminary modeling, and V-REP is widely used software for this purpose. V-REP simulator (fig. 2) starts to be the main instrument for navigation and manipulation software development. The robot simulator V-REP with integrated development environment is based on a distributed control architecture, each object can be individually controlled via a ROS node. ROS is the main middle-ware between different libraries and custom scripts.

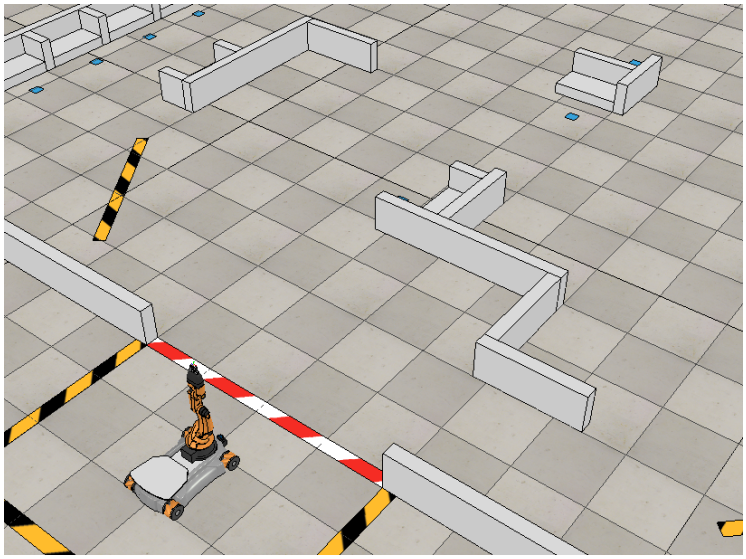

Fig. 2. Simulation of the working environment for RoboCup@Work competition.

4 Referee box talker

"Task regulation" package provides communication between a referee box and YouBot's manipulator and platform driving nodes. The main topics in referee box are:

- "benchmark-state" – the information about current scenario;
- "task-info" – scenario specification.

There are three scenarios: a basic navigation test, a basic manipulation test, a basic transportation test. The execution of the scenario is divided into several stages:

1. preparation – getting information from referee box;
2. calibration – system initialization;
3. execution – sending commands to drivers.

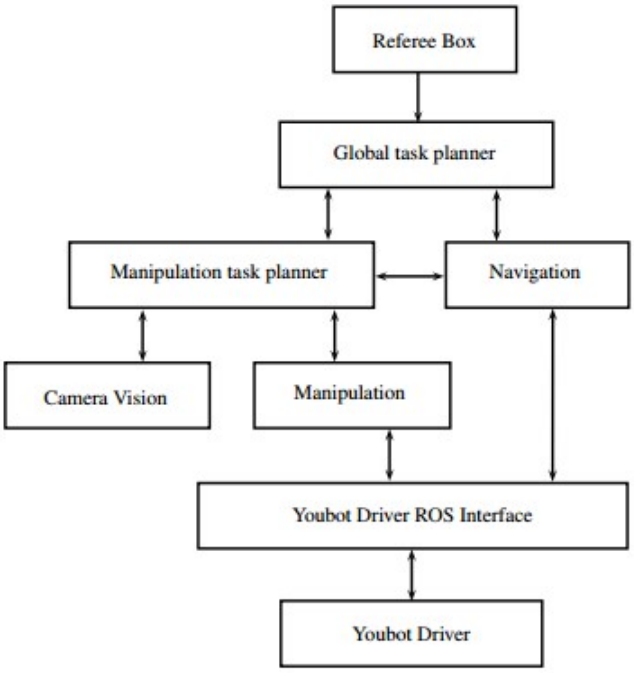

Fig. 3. Simple project scheme.

5 Navigaion

To navigate a robot into the area we use Hokuyo URG-04LX-UG01. It is set on the front of the base. The software part is based on the standard ROS navigation stack. The main changes are aimed to optimize the key parameters of the ROS nav-stack. Current developments are focused on new approaches to the implementations of the recovery behavior and the safe behavior when the robot operates in the service area.

6 Manipulation

For manipulation task we use a package based on "YouBot arm kinematics", exponential smoothing filter is used for trajectory control synthesis. The final

trajectory is transferred to the joint velocity controller. The controller is an action server implemented into YouBot driver ROS interface for the good quality of the trajectory following, more detailed information in [3] is described. Also, we have a strong background in control theory [8] and identification [9,10]. It helps to make precise trajectory following.

7 Image processing

The main vision system is 2D RGB camera Logitech HD Pro Webcam C920. For object recognition a camera is put in a position with the optical perpendicular axis of the surface. It makes computer vision algorithms more stable. The object recognition is performed with a serial implementation of the filters "median blur" and "canny edge detector". By filtering the list of objects, we found objects with reference parameters.

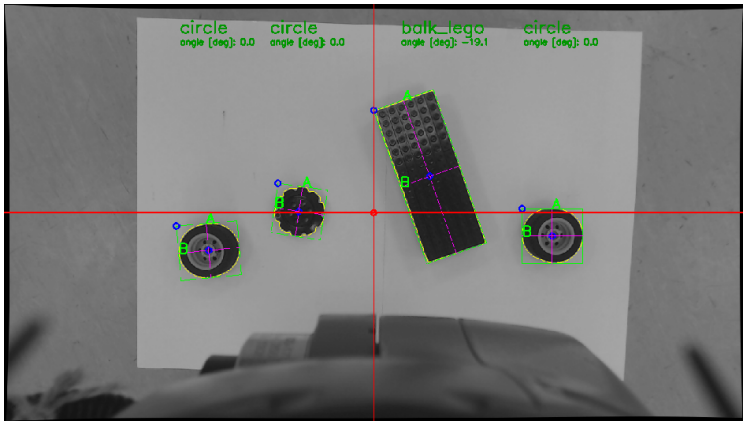

Fig. 4. Image from the robot's camera.

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