Team eR@sers at Education Description Paper

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Abstract. A service robot is a robot that can assist humans to perform common daily tasks in shared environment, such as houses, offices or hospitals. With this in mind, the final goal of a service robot must be making human life easier and more comfortable. Also, a robot can be an excellent companion, for example, for elderly or lonely people, making their life better and happier. To achieve this, a service robot must be capable of understanding spoken and visual commands in a natural way from humans, navigate in known and unknown environments while avoiding static and dynamic obstacles, recognize and manipulating objects, detect and identify people, among several other tasks that a person might request.
This paper describes our current research topics and main findings as well as the efforts to implement all the developed software in the Turtlebot platform. We have improved the abilities of robots with various techniques that we have been applying to other robot systems. We briefly introduce them and our latest related research in this description paper.

1 Team Summary

Team eR@sers was formed around 2000 to participate in RoboCup 4 legged league. Thereafter, the team joined the @home leage where eR@sers achieved a first place at RoboCup 2008, 2010, second place in RoboCup 2009, 2012, 2017, and third place in RoboCup 2018, and its social robot HSR obtained the @Home Innovation Award in 2016. Furthermore, Team eR@sers was finalist in World Robot Summit (WRS) 2018. Following this tradition, eR@sers @Education Team formed at the end of 2019 after a workshop organised by the World Robot Summit Junior category committee and, since then, we have been developing our own architecture aim to introduce service robotics to new students avid to participate in the major @Home categories; after two years, while new members are learning the basis on service robots, senior students are focusing on the development of a custom robot for the at Home Open Platform League.

We mainly focus on the adaptability to the environmental changes and on the integration between the sensory-motor data and symbolic representation, utilizing only the neuro-dynamical model. All developed functions can be packed in ROS modules and almost all training data comes from real sources; the system has been tested in real environments.

2 Robot Architecture

2.1 Hardware Architecture

Robot Tobias, first of his name, has the following hardware architecture (see Figure 1):

ACTUATORS:

- **Mobile base**: Kobuki base with a differential pair configuration.
- **Manipulator**: 4-DOF anthropomorphic arm with 5 Dynamixel servomotors.
- **Head**: 2-DOF (Pan and tilt) with 2 Dynamixel servomotors.
- **Sound**: One speaker for synthetic speech generation.

SENSORS:

- **RGB-D Camera**: XTion Pro sensor
- **Microphone**: Olympus ME31 directional microphone.
- **Laser**: Hokuyo rangefinder URG-04LX-UG01.

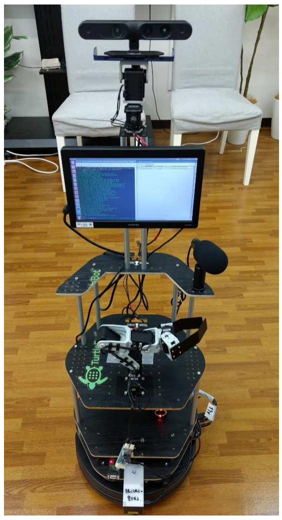

Fig. 1: Robot Tobias.

2.2 Software platform

Our software platform implements a series of finite-state machines easy to use for newbie developers, where each state is coded in SMACH "a task-level architecture for rapidly creating complex robot behavior" (as descibed in `http://wiki.ros.org/smach`). While students get more familiar with ROS, C++ and Python, they can start editing existing and creating their own states to perform more complex tasks. The goal it to generate advance level students and graduate students able to develop ROS nodes and services performing low level robot skills to be used in the @Home category.

3 Innovative technology and scientific contribution

3.1 PAOLA: robot Position and Orientation to the Line of Action

We have been working on the robot-object manipulation problem and we have found that by using a multimodal feedback approach we get the best results. In our current architecture, we use laser-based SLAM and a RGBD sensor. In the object manipulation task, the robot adjusts its initial pose with respect to obstacles and target objects through RGBD data, so it can perform object grasping in different configuration spaces while avoiding collisions.

We propose in [1] [2] an active object manipulation systems using a 3-DOF RGBD camera (height, pan and tilt movements) on top of a service robot and a 6-axis force sensor in the hand. Through this sensors, the robot is able to detect the obstacle's position and orientation in robot coordinates while the different states of the manipulation process take place (we call this process *robot Position and Orientation to the Line of Action* or PAOLA), and we plan to use this logic in Robot Tobias by adding contact sensors to its hand.

In particular, the robot arrives near the target within an uncertainty given by the localisation system based on 2D laser scans, but with a localisation error big enough to affect the performance in the grasping step using only the arm's inverse kinematics. Therefore, we propose the use of the upper RGBD camera to update the robot's relative position to the furniture and to locate the target object, and then we use the contact sensor in the robot manipulator to detect when the robot reaches it.

3.2 Object recognition and Motion Planning

On the other hand, in the recognition task, in [3] and [4] we propose a series of strategies for object recognition in human-made environments. We have proven the feasibility of the proposed methods by evaluating the performance in the object recognition task as part of the Storing Groceries and Clean Up tasks in the RoboCup at Home international competition and in the Tidy Up task in en World Robot Summit.

Finally, the Follow-Me implementation greatly follows the motion planning techniques described in [5] as follows. Beliefs generated by the perception module are validated in this module with information of the knowledge management layer. Once validated or recognized, a belief is considered knowledge and either stored or used to trigger an Action Planner, which will generate a plan of action or sequence of physical operations to achieve the desired goals. However, if something unexpected happens while executing a plan, the Action Planner triggers the generation of a new plan.

4 Link to Team Video

Team eR@sers: `https://youtu.be/dHg2zaitPvk`

5 Team Members

Currently, the team is formed by Ryuji Iino (Team Leader), Kensuke Suzuki, Reiji Nakano, and Masato Hirose (Figure 2), and it's supervised by Luis Contreras, Yoshiaki Mizuchi and Hiroyuki Okada.

Fig. 2: Team eR@sers, students and mentors.

References

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