Swarmlab@Work Team Description Paper 2013

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Abstract. This paper introduces the *swarmlab@work* team submission to the RoboCup@Work World Championship 2013 in Eindhoven, the Netherlands. We give an overview of the hardware platform, the software framework and technical challenges in navigation, object recognition and manipulation. We outline present and future research interests and discuss relevance to industrial tasks.

1 Introduction

Swarmlab is the research laboratory of the Department of Knowledge Engineering at Maastricht University that focuses on designing Autonomous Systems. The laboratory is headed by Dr. Karl Tuyls and Prof. Dr. Gerhard Weiss and is sponsored by the Netherlands Organization for Scientific Research (NWO) and Maastricht University. The general research goal and mission of the lab is to create adaptive systems and robots that are able to autonomously operate in complex and diverse environments. Examples of such systems vary from electronic auction agents and unmanned vehicles, to autonomous robotic surgery devices, and domestic and assistive robotics. Characteristic of these technologies is that they can operate without human control, learn as they function and independently make decisions. These systems are capable of learning from their environment and peers in order to solve complex tasks. For this purpose we draw inspiration from nature, investigating techniques such as swarm intelligence (social insect behavior as found in honeybees and ants), reinforcement learning, evolutionary algorithms, and evolutionary game theory.

The *Swarmlab@Work* team has been established in the beginning of 2013. Currently the team consist of 5 PhD candidates and 2 senior faculty members. The team's mission is (a) to apply Swarmlab research achievements in the area of industrial robotics and (b) identify new research challenges that connect to the core Swarmlab research areas: autonomous systems, reinforcement learning and multi-robot coordination.

Fig. 1. Swarmlab@Work modified youBot.

2 Description of the hardware

Our robot is based on a stock KUKA youBot[1]. The youBot features mecanum wheels and is capable of omnidirectional drive. For object manipulation it is equipped with a 5-DOF robotic manipulator and a two-finger parallel gripper with a detachable Logitech webcam. The youBot is outfitted with two Hokuyo URG-04LX LIDARs mounted on the front and back of the robot. Additionally, we installed a 0.65 m pole on the back plate of the robot. Attached to the backside of the pole is a soft stop trigger and on top an Asus Xtion PRO LIVE RGB-D sensor. To overcome the computational limitations imposed by the internal Intel Atom based computer, a notebook with an Intel i5 CPU is added to support on-board computation. For wireless monitoring and debugging we use a TP-Link 300Mbps high gain wireless adapter. Figure 1 shows a photo of the current setup.

3 Description of the software

Framework: To facilitate software reuse the Swarmlab@Work system is implemented using the framework of the open source *Robot Operating System (ROS)* [3]. ROS provides many useful tools, hardware abstraction and a message passing system between nodes. Nodes are self contained modules that run independently and communicate which each other over so called *topics* using a one-to-many subscriber model and the TCP/IP protocol. Naturally, this is of great importance when working with distributed systems. In addition, the modularity enables to easily create various configurations for different settings; to run our system on ROS-enabled robots, only the parameters need to be adapted according to the robot's motion and sensor model.

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

Navigation: The youBot has a holonomic mobile platform with a rectangular footprint. In order to use its full potential, we use c-space collision maps for path planning and navigation in tight spaces and to position the robot parallel to the manipulation locations, i.e., shelves.

Perception and Manipulation: We use the RGB-D sensor data to locate and identify objects. Once an object has been located, the robotic manipulator is positioned close to a graspable position above the object using the inverse kinematics module. The image-feed from the Logitech webcam is used to readjust the end-effector location to a graspable position and monitor the process while following through on the grasp.

4 Present and future research focus

In addition to navigation, perception and manipulation, we focus on the following research topics:

- To increase the range of graspable objects and reliability, we are currently working on equipping the youBot with an universal gripper based on the jamming principle of granular material [1].
- Multi-robot navigation and collision avoidance [2], e.g., for the competitive transportation test (CTT).
- (Inhomogenous) Multi-robot team coordination to increase performance in the basic transportation test (BTT).

5 Applicability and relevance to industrial tasks

There is a wide range of industrial, health-care and domestic applications of autonomous mobile manipulation in domains such as manufacturing, logistics, remote repair, surgery, and support of elder and disabled people. Currently available approaches, e.g., in the area of robot-robot object manipulation, are typically fully pre-programmed and thus are too inflexible and fragile even against relatively small changes in the manipulation setting. Our research aims to contribute adaptive multi-robot systems that are able to autonomously operate in these complex and diverse environments.

References

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