UvA@Work
Team Description Paper
RoCKIn@Work Camps 2014 - Rome, Italy

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I. Introduction

The UvA@Work team consists of bachelor students in Artificial Intelligence (AI) and Computer Science (CS) supported by a senior staff member. The team was founded at the beginning of the current academic year as part of the Intelligent Robotics Lab[1]. This initiative strives to involve students from the Universiteit van Amsterdam (UvA) with robotics. It also acts as a governing body for the UvA@Work team and other teams such as The Dutch NAO Team [1] (RoboCup Standard Platform League), the Amsterdam Oxford Joint Rescue Forces [2] (RoboCup Rescue Simulation League) and Maneki-Neko [3] (Micro Air Vehicle competition) to guarantee continuation of research, education and competition experience. This will also enable knowledge sharing between the teams.

II. Relevant Achievements and Publications

A. KUKA Innovation in Mobile Manipulation Award

The UvA@Work team is participating in the sponsored track of the KUKA Innovation in Mobile Manipulation Award. Inside this challenge the team will demonstrate that the KUKA youBot platform is capable of performing the Professional Task as defined in the Field Robot event 2012. The task starts with a customer, which likes to have a specific plant (say a yellow rose), which could be found in a field full of plants (mainly consisting of other types of plants or roses with a different color. First the robot has to find the ordered plant in a field with plants placed in irregular patterns. Once found, the robot has to show that the ordered plant has been found. Second, the ordered plant has to be taken and third, the ordered plant should be delivered at the starting point.

The Universiteit van Amsterdam is one of the four universities which has been provided with a KUKA youBot to participate in the KUKA challenge. The full details of the application can be read in the application paper [4].

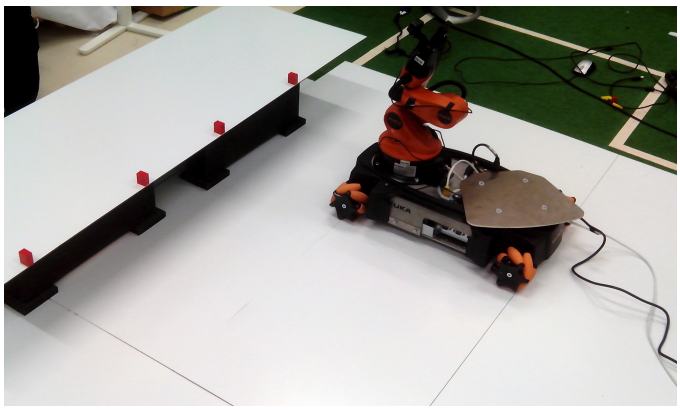

Figure 1. The setup used for the project 'Order picking with the KUKA youBot'.

B. Order picking with the KUKA youBot

With the arrival of the KUKA youBot a team of students started to investigate the possibilities of order picking. This was done over a 3 week period as part of a first year AI bachelor course 'Search, Navigate, and Actuate'. During this period the gripper of the robot was fitted with a color camera. This camera was then used to locate cubes or items of a specific color by using a blob detector. A graphical user interface (GUI) was created in which an end user could specify which item was to be returned. On each run a maximum amount of cubes would be picked up and returned to the operator in order to simulate an actual warehouse robot that has a certain amount of space in which it has to fit objects. Two of the students that have worked on this project are now part of what has become the UvA@Work team. A picture of the setup that was used during this period can be seen in Figure 1. A short demonstration of the progress of this project can be viewed in a video[2].

The full details of this project can be read in the project

[1] http://www.dutchnaoteam.nl/index.php/irobolab/

[2] http://www.youtube.com/watch?v=XheQRnMvB4o

report [5].

C. Path planning through a rose field

When a map of the environment is known, path planning could give the directions to steer the KUKA omni-directional robot through the field, as illustrated in Fig. 2. Several path-planning algorithms could be applied, but A* proves to be efficient enough to navigate maps with the complexity which could be expected for the agriculture order picking application.

Figure 2. The setup used for the project 'Navigating YouBot through a rose field with A*'.

The full details of this project can be read in the project report [6].

III. Scientific Background

The UvA@Work team has the obligation to innovate from the level which was demonstrated by the Swarmlab@Work team [7]. Their approach will be used here to describe the current state-of-the art.

A. Mapping and Localization

The Swarmlab uses gmapping [8], available as ros-package, to build a map in advance. An alternative mapping algorithm, developed inside the Rescue league, is hector-slam [9].

B. Navigation

The Swarmlab also uses an A* algorithm for global navigation. An probabilistic alternative for A* could be real-time randomized path planning [10].

The found path is executed by Swarmlab using a dynamic window approach [11] trajectory rollout. This local planner samples different velocities and ranks them according to the distance to the goal and the distance to the path, while velocities that collide with the environment are excluded. An alternative could be to implement classical wall- and corridor-following behaviors.

C. Fine-Positioning

The grasp objects, a higher accuracy is needed than can be provided by the global slam-algorithm. The Swarmlab implemented ICP based scan registration [12] for fine grain positioning. Inside the Rescue Simulation League, better performance could be achieved with weighted scan matches [13].

Figure 3. An overview of the variety of sensors available to the Uva@Work team.

D. Object Recognition

The Swarmlab uses decision trees from a data-mining toolkit [14] for the recognition of the objects. This recognition is performed on black and white images; an alternative could be to use color descriptors [15].

E. Inverse Kinematics of the Arm

To control the joints of the arm the Swarmlab implemented a simple inverse kinematics [16] module to calculate the joint values for any top-down gripping point that is in the reach of the robot. An alternative would be to use geometric algebra [17].

IV. Research Objectives

The goal for the RoCKIn Camp 2014 is to reproduce the work of the Swarmlab, based on the source code graciously published by this team[3] and to start to design experiments where alternatives, as mentioned in Section III, could be tested.

V. Hardware Specification

Inside the Intelligent Robotics Lab, there is access to two KUKA youBot robots. The robots can be equipped with a rich sensor suite as can be seen in Fig. 3. Available sensors are Asus Xtion Pro Live, several Microsoft Kinects, an Xsens MTi-G-700 motion tracker and Hokuyo UTM-30LX & URG-04LX laser scanners. A new sensor, which to our knowledge, has not been used on a KUKA youBot is the Ricoh Theta, a spherical panorama camera with 360° field of view.

VI. Team Members

Sébastien Negrijn - Bachelor AI student

Sébastien Negrijn is currently a second year AI student at the Universiteit van Amsterdam. He has participated in the Standard Platform League in both the Iran Open 2013 and the RoboCup 2013 at Eindhoven after which he was elected as member of the 2014 Organizing Committee of Standard

[3] https://github.com/swarmlab/swarmlabatwork

Platform League. His interest in the KUKA youBot has grown after seeing it in action at the RoboCup. He will function as the teamleader during the upcoming events.

Stephan van Schaik - Bachelor CS student

At the moment, Stephan van Schaik is a third year student of the BSc. Computer Science programme at the University of Amsterdam. In his spare time he is mostly fascinated by embedded systems, low-level system programming, and thinking not only about how to solve rather complex problems, but how to structure the solution in the most effective and elegant manner. Therefore he has taken the role of software architect upon him, investigating and realizing a dedicated framework for the team to use.

Janosch Haber - Bachelor AI student

Janosch Haber currently is enrolled a second year Artificial Intelligence Bachelor student at Universiteit van Amsterdam. Joining the UvA@Work team in mid-October he has taken the task of developing and implementing the path-planning modules for the team's KUKA youBot. As this being his first time working with real-life robots he is looking forward to gain more programming-, project- and team experience in the course of the competition and its appertaining events.

Arnoud Visser - Lecturer AI

Arnoud Visser originally studied physics at the University of Leiden. At the University of Amsterdam since 1991, he participated in several national and international robotics projects. Inside the RoboCup initiative, he participated in several soccer and rescue leagues. Last year he was associate chair of the competition in Eindhoven. Currently he is chairman of the Dutch National Committee and Executive for the Rescue Simulation League.

VII. Knowledge improvement

The learning goal for the RoCKIn Camp 2014 is to get familarized with the ROS-framework and the state-of-the-art packages and methods applicable for the KUKA youBot.

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