UvA@Work Customer Agriculture Order

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Abstract

The goal of the UvA@Work is to 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 (Identify). Second, the ordered plant has to be taken and third, the ordered plant should be delivered at the starting point.

1 Team description

The Intelligent Robotics Lab (IRL) is an initiative of the University of Amsterdam (UvA) to guarantee the coordinate the efforts of the robotic teams of the university. It acts as a governing body for all the robotic teams of the university, which participate in various leagues of the RoboCup and the International Micro Aerial Vehicle Competitions. This initiative will enable collaboration between the teams, as most state-of-the-art techniques in the field of Robotics can be applied in many applications, although every time in a slightly different manor.

The IRL arose in 2012 from the Dutch Nao Team, when students wanted to apply their experience into socially more relevant applications.

Experience

The University of Amsterdam has been active in the RoboCup since 1998. It have been active in the Windmill Wanderers, Clockwork Orange, Dutch Aibo Team, the Amsterdam Oxford Joint Rescue Forces [1] and the UvA Rescue Team [9].

Currently the Intelligent Robotics Lab (IRL) is active in two competitions. The Dutch Nao Team is active in the RoboCup Standard Platform League and Maneki-Neko is active in the International Micro Aerial Vehicle competitions (IMAV). This section shortly describes the origin of these teams and in their achievements. The main focus of both robotics teams is to write intelligent software to create smart applications.

Dutch Nao Team The Dutch Nao Team was founded in 2010 by several Artificial Intelligence students in order to participate in the RoboCup. RoboCup is an international research and education initiative, attempting to foster Artificial Intelligence and Robotics research by providing a standard problem where a wide range of technologies can be integrated and examined, as well as being used for integrated project-oriented education. The Dutch Nao Team competes in the Standard Platform League, which is a RoboCup robot soccer league, in which all teams compete with identical robots. The robots operate fully autonomously, i.e. there is no external control, neither by humans nor by computers. The current standard platform used is the humanoid NAO by Aldebaran Robotics.

The team consists of Artificial Intelligence Bachelor and Master students, supported by senior staff-member Arnoud Visser. The Dutch Nao Team participated in several competitions and published on several occasions[1]. The Dutch Nao Team participated in 2010 at the German Open [10]. In 2011, the Dutch Nao Team participated at both the Mediterranean Open and the Iran Open. In the 2011 World Championships, a top 16 position was achieved [5]. In 2012 the Dutch Nao Team participated in the Iran Open, achieving a shared third place, and partook in the RoBOW, organised by Berlin United. At the 2012 World Championships in Mexico the team [6] was eliminated during the intermediate round. Also in 2013 the RoBOW was visited, which resulted in dancing the Harlem Shake in Dortmund. During a more serious session the Dutch Nao Team won a third prize at the Iran Open 2013 competition.

Maneki-Neko The team Maneki-Neko was founded in 2013 in collaboration with the National Aerospace Laboratory, NHL University of Applied Sciences and Delft University of Technology. The goal of the team is to collaboratively participate in the International Micro Aerial

[1] See for an overview: `http://www.dutchnaoteam.nl/index.php/publications/`

Vehicle competitions (IMAV). The IMAV is an initiative that attempts to share and demonstrate new micro aerial vehicle technology. The competitions emphasize on flight dynamics and autonomous flight. The IMAV consists of an indoor and outdoor competition, where these aspects are extensively tested in the various challenges. The high level of autonomy is stimulated in this competition as the rules give signi?cantly more points to teams that operate autonomous flights. Maneki-Neko focuses on the intelligent applications that are onboard of the flying systems. The current platform used by the UvA is the standard platform AR.Drone 2.0 by Parrot.

The UvA part of the team consists of Artificial Intelligence Bachelor and Master students supported by senior staff-member Arnoud Visser. The UvA participated previously at 2011 competition [4]. The team participated in the Iran Open 2013 [8], where it won the technical challenge for autonomy and published a paper [7].

2 Motivation and Objectives

The international FieldRobotEvent was founded in order to motivate students to develop autonomous field robots. Since the start in 2003 the FieldRobotEvent has become a platform for innovations and interdisciplinary co-operation in field robotics. The competition has evolved since the initiation in more and more challenging tasks: in 2012 the challenge consisted of navigating through straight, curved and partly fragmented rows of plants (so called container fields), recognition and detection of different types of plants, as well as localisation ad orientating in the field.

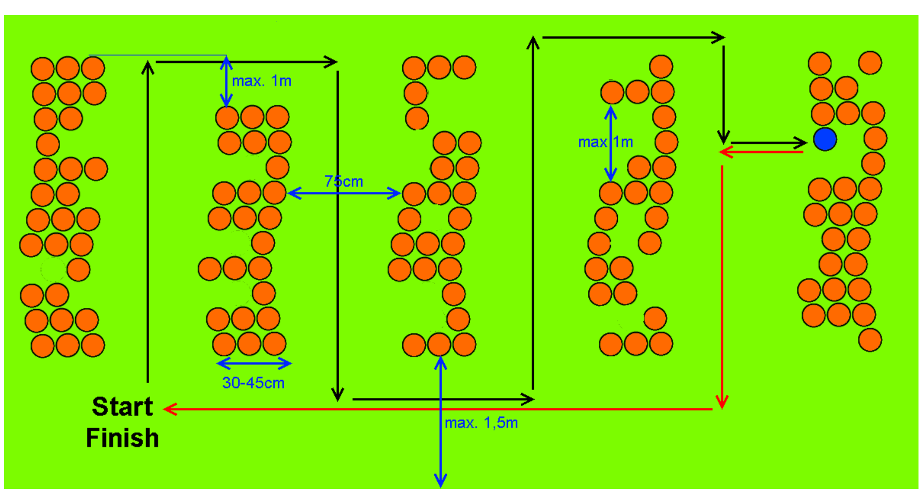

Figure 1: The customer order task - find the ordered plant (blue) in a container field full with other plants (orange) and bring it back to the Finish.

Plants are not the easiest obstacles to avoid, due to their complex and irregular form. The rows of plant could start neatly organized, but as customers buy plants, effect will be that the rows contain gaps, moved plants, etc. Navigation through such irregular container field is already a challenge. In the customer order task, where we will focus on, it is the task to find one specific plant in this irregular container field. As in the regular rose business, the plants will be indicated with tags. For the tag, one can think of barcode identification (stickers on the pot). The tag will placed on a random plant in the field. Once found, the plant has to be picked up and placed on the platform of the KUKA youBot (manupulation task) and the robot has to return along the shortest route back to the finish (navigation task)

This challenge contains both navigation, perception and manipulation elements, under circumstances typical for the Agriculture business. Yet, the algorithms develeped for this task could also be applied in other applications, as warehouse or service applications.

3 Approach and Realization

Our KUKU youBot will equiped with a sensor suite consisting of an Asus Xtion Pro Live to create disparity map, a Hokuyo LX30 laserscanner for a occupancy grid map, an Xsens MTi-G-700 motion tracker. The perception will be based on the image processing (opencv based) and point cloud (pcl based) stacks integrated in the Robot Operating System ROS.

The workplan will start with a literature study on how a successfull approach on this task [2] could be combined with algorithms applied in the RoboCup@Work and the RoboCup@Home, as combined in the European RoCKIn program. The actual experimentation will start with navigating through regular rows of plants (task 1), followed by navigating to irregular container fields (task 2), before the customer pick up is attempted (task 3).

4 Results and measures of success

The FieldRobotEvent 2012 has clear measure for success:

1. The robot has 3 minutes to show the identification of a plant. Finding (and signaling) the ordered plant within a radius of 0.5 m results in 10 points, within a radius of 1.0 m results in 9 points, within 1.5 m in 8 points etc (points = 11-2*radius). Navigating to the right row will give a bonus multiplication of 1.5 to the gathered points in this subtask.

2. Picking the ordered plant within 2 minutes. Picking the ordered plant WITHOUT any manual intervention gives a bonus of 20 points. Picking the ordered plant with manual intervention (put robot in right row and in front of ordered plant) gives 10 points.

3. Last, the robot delivers the plant, for this task a maximum of 2 minutes is allowed. Delivering the ordered plant gives a bonus of 10 points. Penalty of 1 point per 0.5 meter distance from starting point is subtracted.

Most important are the clear boundaries for success. The points are not directly of opportance, although registrating them will allow a direct comparison with the top teams in the FieldRobotEvent 2012 (47,5 points for the winner).

5 Economic analysis of proposed solution

The Dutch platform for Robotics RoboNED has recently made an analysis of the application areas where robotics could have the biggest economic impact [3]. The Netherlands holds a leading position in agriculture in terms of productivity and efficiency. In horticulture important drivers for agro-robotics are increasing labor costs, the limited availability of sufficiently trained labor, and the poor image of the sector due to the employment of (illegal) foreign workers who are not familiar with Dutch labor regulations. Agro-robotics might also support quality improvement of the harvested product. The potential is high, because currently there are only a few commercially available robotic systems. In horticulture, robots are currently available for producing cuttings, planting in trays, plant protection, sorting and packing. No commercial examples are known for harvesting and crop maintenance. As result of this analysis, agriculture has been identified as an application area where the Netherlands has a good position to have create robotic systems which will have an impact on a world scale.

Robots in agriculture need to fulfill two main functions: mobility on the farm and manipulation of objects. Robotics is defined as the intelligent transformation of sensing into mechanical action. Research is generally focused on sensing, mobility (e.g. autonomous vehicles), manipulation, and end-effectors. However, not much attention is paid to intelligence, navigation and manipulation in unstructured environments. This project tries to have impact precisely focused on the latter three aspects.

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