UvA@Home 2017 Standard Platform Proposal

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Abstract. This proposal describes the approaches that will be taken by the UvA@Home team to compete in Standard Platform League with the Softbank Robotics Pepper. The research challenges concern person recognition, object recognition, object manipulation and navigation using the previous research and achievements of the UvA teams in the RoboCup.

1 Introduction

The UvA@Home team consists of two bachelor Artificial Intelligence students supported by a senior university staff member. The team was founded as a part of the Intelligent Robotics Lab at the beginning of the 2016-2017 academic year. The IRL acts as a governing body for all the University of Amsterdam's robotics teams, including the Dutch NAO Team and the UvA@Home team (both active in a RoboCup Standard Platform League). It encourages the sharing of experience between these teams to be successful in both leagues, which is possible because the Nao and the Pepper robot share the same NaoQi basis (although a slightly different version).

2 Background

The Universiteit van Amsterdam has a very long history in RoboCup [1]. The university has been active in the Soccer Simulation League [2], the MidSize League [3], the Rescue League [4], the 4-Legged League [5], the Rescue Simulation League [6] and the Standard Platform League [7]. The teams have won several prices[1], both in the competition as with the technical challenges.

The focus of the research of the university is on perception, world modeling and decision making. The @Home competition nicely fits in our research; the lack of a standard platform withheld us from entering the competition. Instead, we have initiated studies towards the simulation of the @Home competition [8, 9].

When qualified, the Intelligent Robotics Lab has the intention to buy a Pepper robot under the conditions of Softbank Robotics [2], if the investment budget

[1] http://www.robocup.nl/achievements.html
[2] http://www.robocupathome.org/athome-spl/pepper

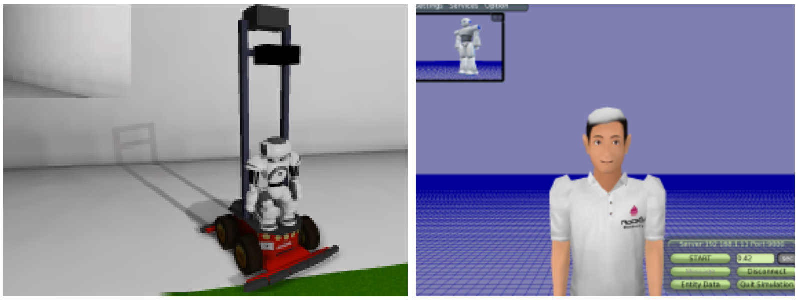

Fig. 1. An @Home robot in the UsarSim [10] and an @Home scenario in the SigVerse [11] simulation environment [8, 9].

of 2017 is approved. Otherwise, the university has good contact with two Dutch companies in the possession of a Pepper robot.

3 Person Recognition

Earlier work in the Dutch Nao Team [12] has focused on Nao recognition using the Viola-Jones Algorithm [13], an algorithm originally meant for facial recognition. It utilizes the cascading of weak classifiers technique to create a new algorithm with performance comparable to a strong classifier. While other algorithms may have a higher accuracy, the goal of the Viola-Jones Algorithm is to perform well on low CPU systems. The paper [12] applies this algorithm for Nao detection and runs on the 1.6 GHz Atom CPU of the Nao [3]. The approach is to extract Haar-like features from the upper and lower body to train weak classifiers using a dataset consisting of images taken of other Nao's during a RoboCup SPL match. The weak classifiers have a set of features of which the important ones are boosted according to the following equation.

$$w(x) = \begin{cases} 1 & \textbf{if } \ pf(x) < p\theta \\ 0 & \end{cases} \tag{1}$$

Where $w(x)$ is the weak classifier, $f(x)$ is the list of features for a sub-window x of the image, p is the parity which indicate the direction of the inequality sign and θ indicates a threshold.

This approach performed best for the detection of limbs, especially those in the upper body and showed a lower recall but higher precision compared to the method implemented by another team in the SPL that used the same dataset [14]. Using the Pepper robot it will be possible to improve upon this

[3] `http://doc.aldebaran.com/2-1/family/robots/motherboard_robot.html#nao-v5-v4`

algorithm utilizing the more powerful CPU [4] and apply it to a more complex dataset consisting of humans.

4 Object Recognition

Recognizing and localizing object is difficult to execute on robots who generally have low-end CPUs. Some of the previous approaches done by the Intelligent Robotics Lab and its members/collaborators include:

- The ROS object detector which relies on the OpenCV2 library used for the UvA@Home league [15].
- A series of color, contour, size and blob detection based approaches used for the Roasted Tomato Challenge [16].

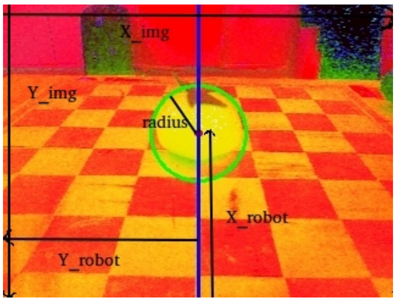

Fig. 2. Detecting of a tomato with a Nao robot using combined contour and color detection[16].

- A color invariant cognitive image pro-cessing module (CIP-module) based on the Recognition-By-Components (RBC) [17] used for ball and goal recognition in the Robocup SPL soccer competition.
- Optimizing the amount of perspectives that are required to correctly identify an object from the RoCKIn@Work competitions [18].
- In [19] categorization was accomplished by a Bag of Key-points approach, inspired by the method of Csurka et al. [20], to distinguish 10 different objects from the RoCKIn@Work competitions.
- In [21] categorization was accomplished using a decision tree approach based on shape and color, inspired by Alers et al. [22], to distinguish 10 different objects from the Ikea Duktig fruit and vegetable set.

The later two approaches make use of datasets recorded with an ASUS Xtion 3D sensor, which make their algorithms direct applicable to the Pepper robot.

[4] `http://doc.aldebaran.com/2-4/family/pepper_technical/motherboard_pep.html`

5 Object Manipulation

In most cases the goal of object recognition in the setting of the @Home league is the manipulation of said objects. Earlier work on the UvA@Work League [15] and the Roasted Tomato Challenge [16] have required the manipulation of objects. In both cases the MoveIt library [23] from the ROS framework was used. In this approach the MoveIt ROS Node receives a 3D world position from the object detection Node, the MoveIt Node contains a representation of the limbs and joints of the robot and uses those to solve the inverse kinematics. The joints are then moved to position the grabbing actuator to the object location.

[16] [24] [25] [23]

6 Localisation

The Pepper robot has an extensive set of sensors, but only the HR cameras provide long range measurements, which will mean that for localisation we have to rely on visual SLAM (or adjust our navigation strategy).

Although for long range measurements the baseline between the two HR cameras is too short, much can be learned from the motion of the robot. To verify the applicability of visual SLAM, tests with the available ros-packages[5] will be made.

7 Navigation

The Intelligent Robotics Lab has extensive experience with the application of laser-based simultaneous localisation and mapping algorithms for robots in a natural environment[6], yet the point-clouds of the 6 laser scanners with their limited range of 5 meters will force us to fall back to the coastal navigation algorithms developed for the Minerva museum tour-guide robot [26].

8 Conclusions and future work

We are looking forward to explore the possibilities of the Softbank Robotics Pepper and the challenges imposed by the RoboCup@Home competition. A large benefit is that progress in this league is directly applicable to social relevant scenarios, something that can directly be communicated and disseminated to interested companies and the community.

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[5] `http://wiki.ros.org/vslam_system/Tutorials/RunningVslamOnStereoData`

[6] the Care-O-Bot of the European ACCOMPANY project, the Giraff robot of the European TERESA project, the MBot robot of the European MOnarCH project

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