Team description for Robocup 2013 in Eindhoven, The Netherlands: [Dutch Nao Team]

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1 Introduction

The Dutch Nao Team consists of Artificial Intelligence (AI) Bachelor and Master students, supported by a senior staff member. The Dutch Nao Team debuted in the Standard Platform League (SPL) competition at the German Open 2010 [1]. Since their founding the Dutch Nao Team has beed qualified for the world-cup competitions in Istanbul [2], Mexico City [3] and Eindhoven [4].

The Intelligent Robotics Lab, a students initiative from the Universiteit van Amsterdam (UvA) and Technische Universiteit Delft (TU Delft), is an initiative to guarantee the continuation of the Dutch Nao Team. It will act as a governing body for the Dutch Nao Team and teams from these universities participating in other leagues, such as RoboCup@Work and the Rescue Simulation League. This will enable collaboration by the teams, as most state-of-the-art techniques in the field of Robotics can be applied in all RoboCup leagues.

2 Relevant Achievements and Publications

The Dutch Nao Team is a continuation of the Dutch AIBO Team, which participated at three competitions and published on several occasions[1].

he Dutch Nao Team participated in 2010 at the German Open. In 2011 The Dutch Nao Team participated at both the Mediterranean Open and the Iran Open. At the RoboCup Iran Open Symposium, the paper "An Experimental Comparison of Mapping Methods, the Gutmann dataset" was published [5]. A summary of this study was presented at the Research Challenge in Istanbul. In the 2011 World Championships, a top 16 position was achieved. 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 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.

2.1 Support

The Universiteit van Amsterdam has been active in the RoboCup since Paris 1998. The university has participated in several leagues (Windmill Wanderers, Clockwork Orange, UvA TriLearn, UvA

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

Rescue, Dutch AIBO Team, Amsterdam Oxford Joint Rescue Forces). The Informatics Institute and TU Delft support the team with a fully equipped robot lab and the usage of two H25 v3.2 Nao robots, five H21 v3.3 Nao robots equipped with v4.0 heads, four H21 v4.0 Nao robots and two H25 v4.0 Nao robots.

3 Research

The main focus of the Dutch Nao Team is the combination of Artificial Intelligence and Robotics. The RoboCup initiative provides the team the opportunity to work with various aspects within Robotics. Before this academic year, the teams code was based on own work [6]. The Python code has grown into a monolithic architecture, with lots of interwoven dependencies.

This year the Dutch Nao Team took Nao Team Humboldts (NaoTH) code[2], as framework for their code. NaoTH, which is designed in a modular fashion gives the Dutch Nao Team the opportunity to focus on high level programming by giving a more solid low level foundation. With the NaoTH Framework we can focus more on bringing the newest AI techniques to our code.

The code our team is using is forked right before NaoTH has joined the Berlin United research group. By being the first team to fork from this framework, we hope to bring diversity among the SPL teams. The Berlin United research group has different research goals from ours, and we expect to diverge considerably in the future.

3.1 Motion Control

Previously implemented keyframe motions will be ported to the NaoTH framework, such as different stand up motions, keeper movements and kicks. These open loop motions will be improved so that they are more robust to external disturbances.

A few of these innovations are demonstrated in the 2013 Qualification video[3]. Thanks to the development of a realistic Nao simulation, it is easier to develop new motions, either manually or by supervised learning.

3.2 Behaviour Design

XABSL[4] is used to define specific roles, which different agents can fulfill depending on the game situation. According to the 2013 rules, each team can now have up to five players in the field (one of which is the goalkeeper), which allows for more complex strategies than the ones used in previous years. Due to the deterministic nature of the underlying finite state machine(s), XABSL usually results in predictable behaviour. We will try to avoid this by creating sets of low level behaviours that can be used in one specific situation, rather than using a single behaviour.

3.3 Vision

Visual object recognition is a key ability for autonomous robotic agents, especially in dynamic and partially observable environments. A reliable landmark detection process is really crucial for

[2] See for more information http://www.naoteamhumboldt.de/en/publications/
[3] See for a larger overview http://www.dutchnaoteam.nl/index.php/media/movies
[4] For more information on XABSL see http://www.xabsl.de/

achieving self-localization, which can be considered as the stepping stone for having a functional robot soccer team.

We have developed a new vision framework for the standard platform league, focusing our research in line crossings detection and goal detection [7].

Both detection modules are based on detecting line segments by expanding groups of pixels, which are selected based on their color information. In Figure 1, we illustrate the process of line detection in three steps. The next step in our feature extraction procedure is to identify and extract information about how the line intersects another line. Each of such a crossing is indicated with a confidence measure, based on geometrical properties of the intersection. For detecting the projective variant of the middle circle, we use a line chaining method.

Fig. 1: Line Detection process, *left*: original RGB image, *middle*: points generated by the scanner, *right*: lines detected.

Our goal detection system is based on the image's color histogram, and provides information about top and bottom coordinates of the goal posts in the image, width of the post and, if possible, identify which of the three posts is seen. Figure 2 illustrates the results of the goalpost detection in three different cases.

3.4 Estimation of Trajectories through Visual Odometry

We implemented an experimental system for trajectory estimation using monocular visual odometry.

The theory and implementation is described in detail in [8]. The trajectory of the robot is estimated by using a frame-to-frame method, which uses displacement of features between two subsequent frames to find a rotation matrix and translation vector that indicate displacement of the camera. In this process, the essential matrix is computed, which is then decomposed into candidate rotation matrices and translation vectors. Alongside, 3D positions of corresponding keypoints in both frames are approximated using iterative triangulation. Based on the found points, the correct candidate rotation and translation are chosen. Several different methods are employed for decomposition of the essential matrix and triangulation. The provided theory in this report gives ground for a system for trajectory estimation for the robot. Although the performance could not be evaluated, we argue that the provided system can be used as a basis for a real-time application, that could perform fairly well on both trajectory estimation and in later stages, even 3D reconstruction.

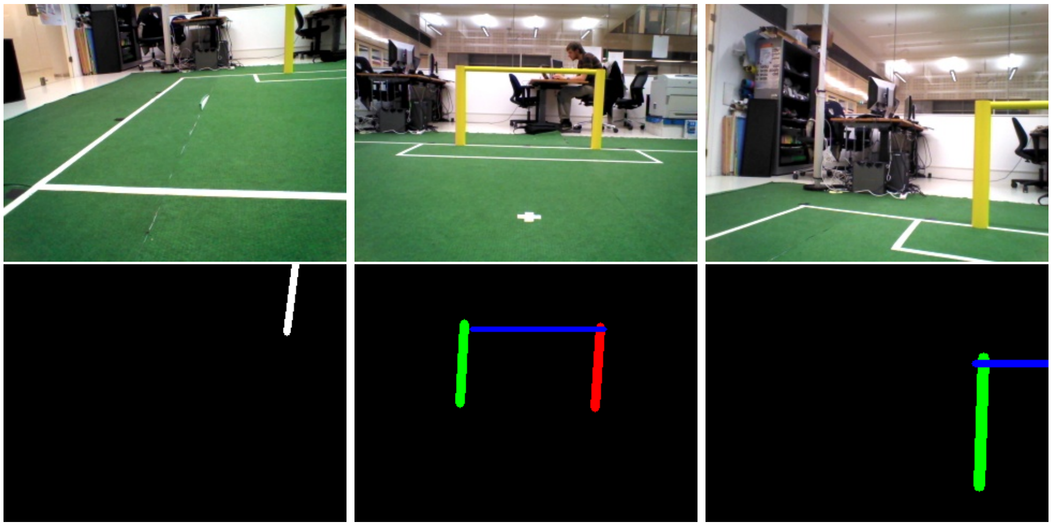

Fig. 2: Goal detection example results (green: left goalpost, red: right goalpost, white: undefined vertical goalpost, blue: horizontal goalpost.

3.5 Visual Compass

The rules introduced in 2012 make the field completely symmetrical and thus complicate localization. The current code uses team communication to compare the current robot pose with help of the ball location estimate to other robots' position estimates to increase their confidence. An extension to this is to build a visual compass, searching for salient features in the background (i.e. not in the playing field) and comparing them with an a priori learnt map, to determine which direction the robot is facing, thus trying to evade to score an own goal.

To realize this we plan to use a similar vision based approach as described and implemented for localization in the AIBO league [9]. We hope to implement and test this system until this year's world cup in Eindhoven.

3.6 Fisheye Camera

Localizing a humanoid robot, such as a Nao, with the use of external cameras is often done with multiple overhead cameras. In most cases, one camera is not sufficient to capture the entire field, but this can be done through use of a fisheye camera. A single fisheye camera creates the wide, panoramic images that enable view of the whole soccer field. When Naos are localized using the overhead fisheye camera in our developed system [10], quite accurate coordinates will be available. These coordinates can be used as ground truth to verify localization of Naos. Such a ground truth is useful for computing confidence boundaries for our localization algorithms.

4 Activities

Besides research in robot soccer, the Dutch Nao Team is also involved in other related activities.

4.1 Demonstrations

The last year, Dutch Nao Team has focused on promoting the RoboCup and Artificial Intelligence throughout the Netherlands. This was accomplished by giving demonstrations at relevant events and trough the use of media.

4.2 Summerschool

Experience, gained by research and participation is also used to inspire young students. During the summer of 2012, the Dutch Nao Team organised its first Robotics-Summerschool: an one week during event in which students gain experience and knowledge of Robotics and its associated fields of research. The students received lectures from active researchers within the fields of Computer Vision, Autonomous Decision-making and Robotics, and applied AI and Software Engineering knowledge to solve a given task using landmarks, to navigate through a maze. Students were guided by the Dutch Nao Team and had to implement their own algorithms. This event was highly successful and will therefore from now on be organised once or twice a year to promote Robotics and technology and foster research in Artificial Intelligence.

4.3 Teaching

Besides the summerschool, the team has organized a programming course to educate future members and other interested students. This has encouraged freshmen to join the Dutch Nao Team or other teams encompassed by the Intelligent Roboics Lab. By offering projects and organizing or attending interesting workshops, students are able to conduct research relevant to the RoboCup for course credits.

5 Conclusion

The Dutch Nao Team has participated in several competitions around the globe. It will continue its research, especially in the field of probabilistic robotics and autonomy. By joining forces with TU Delft and cooperation with other teams encompassed by the Intelligent s Lab, it will become possible to apply state-of-the-art techniques in a much broader field than before. It will also continue to educate students interested in Robotics, as well as promotion of Artificial Intelligence research in general.

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