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Dutch Nao Team: team description for Robocup 2013, Eindhoven, The Netherlands

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Publication date

2012

Document Version

Submitted manuscript

[Link to publication](#)

Citation for published version (APA):

ten Velthuis, D., Verschoor, C., Wiggers, A., van der Molen, H., Blankenvoort, T., Cabot, M., Keune, A., Nugteren, S., van Egmond, H., Rozeboom, R., Becht, I., de Jonge, M., Pronk, T. E., Kooijman, C., Slaap, R., & Visser, A. (2012). *Dutch Nao Team: team description for Robocup 2013, Eindhoven, The Netherlands*. Universiteit Amsterdam & TU Delft. <http://www.science.uva.nl/~arnoud/publications/DutchNaoTeamQualification.pdf>

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Dutch Nao Team

TEAM DESCRIPTION FOR ROBOCUP 2013 - EINDHOVEN, THE NETHERLANDS
<http://www.dutchnaoteam.nl>

November 8, 2012



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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 [6]. In 2011 the Dutch Nao Team made its breakthrough by qualifying for the RoboCup in Istanbul [5], and qualified for last years RoboCup in Mexico [4].

The Intelligent Robotics Lab, a student initiative from the Universiteit van Amsterdam (UvA) and Technische Universiteit Delft (TU Delft), was founded this year, to guarantee the continuation of te 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 @Work and Search and Rescue. 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. This year the Dutch Nao Team is planning to participate in the competition of the following opens:

- RoboCup Berlin Open Workshop (RoBOW)
- German Open 2013
- Iran Open 2013

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 occasions¹. The Dutch Nao Team participated in 2011 at both the Mediterranean Open and the Iran Open. At the Mediterranean Open Workshop on RoboCup Research a presentation about “RoboTag with a humanoid robot” was given. At the RoboCup Iran Open Symposium, the paper ‘An Experimental Comparison of Mapping Methods, the Gutmann dataset’ was published [7]. 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.

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 Rescue, Dutch Aibo Team, Amsterdam Oxford Joint Rescue Forces). The Institute of Informatics and TU Delft support the team with a fully equipped robot lab (large enough for the Standard Platform League soccer field) and

¹See for an overview <http://www.dutchnaoteam.nl/index.php/publications/>

the usage of two academic H25 v3.2 Nao robots, five H21 v3.3 Nao robots equipped with v4.0 heads and four H21 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 acquire various abilities of many aspects within robotics. Having learned from past participations in the RoboCup, a new framework will be designed in a modular fashion. Recent developments with ROS are quite successful in combination with Nao. Although ROS is computationally intensive and may not be useful during a match, it will enable use of state-of-the-art techniques and fluent communication in individual projects. Redesigning the Dutch Nao Team's framework so it can cooperate with ROS will enable us to record data, play back, and adjust settings accordingly. It will also make the use of machine learning possible, by using the sent data as features. By using ROS we want to contribute to the effort of creating a standardized environment with available libraries for the NAO platform. This corresponds to our open source mindset.

3.1 Communication and Planning

The communication between Nao robots will be kept to a minimum: players will only act different from their original behaviour when a joint action is in the best interest of the team. For example, when two robots see the ball, only the closest robot will try to intercept it, while the behaviour of the other will be overridden. By rewarding joint actions, it will be possible to use reinforcement learning to find optimal strategies, using the outcome of a short sequence of joint actions as indication of their joint value. Together with localization and Nao robot recognition, a tactical behaviour can be implemented and optimized by learning. Examples of this include assisting other Nao robots in an attacking state or defensive state.

3.2 Localization

For localization the Dutch Nao Team researches multiple methods: Dynamic Tree Localization, an Extended Kalman Filter and a Particle Filter[2]. Dynamic Tree Localization [3] estimates a location using a recursive approach: it specifies a probability that a Nao is in a certain region. If the probability is high enough, this region is split into smaller sections, each with its own probability. If a probability decreases, regions are merged. With heuristics a (final) location can be estimated. This method, implemented in a simple form, has proven to be accurate. Further research is done to improve the accuracy and determine how the heuristics have to be chosen. The Particle Filter and Extended Kalman Filter are both efficient state-of-the-art methods for position estimation. The symmetry of the field, which increases the difficulty of the problem, will be handled by making smart use of prior knowledge and by goalkeeper detection (if it is present).

module it now is possible to find the position of a limp relative to one of the legs. This forward kinematics module also gives the possibility to locate the Center of Mass and is used in a Center of Mass based P-controller to keep the Center of Mass above the Support Polygon. A second balancer uses online data in the foot sensors to correct outside interference from other Naos during a competition. These modules can be used to further research robust closed- and open-loop motions.

3.5 Camera Calibration

The location and orientation of the camera is used when calculating the position of an object on the field relative to the Nao, by means of projection. Tests have shown that the camera-angles measured by the Nao's sensors are not reliable, especially the one measuring the camera's pitch. This can cause the Nao to believe that an object is much closer by or farther away than it truly is. Calibrating the camera-angles prior to a game can temporarily solve this problem by introducing an offset to the measured camera-angles. However, during a game the camera could be shifted; e.g. the Nao could fall over. In order to cope with the camera shifting during a game the camera angles must also be calibrated during the game. This can be done by comparing the true position of an object that can always be determined with its position calculated by the Nao. Such an object could be the Nao's feet. No matter what the location of the Nao on the field or the state of the game is, a Nao should always be able to locate the tips of its feet and know their true positions³. The error of the calculated foot positions can be propagated back towards the camera-angles, updating their offsets.

3.6 Fish Eye Camera

Localizing a humanoid robot (the 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 fisheye camera creates the wide, panoramic images that enable view of the whole room. The use of it is based on the same principles as normal overhead cameras: An image is mapped to real world coordinates using a predefined transformation matrix, background models, and prior knowledge about possible positions of the Nao. The difficulty here lies in the transformation of wide, distorted images obtained from the fisheye camera to its "flattened" variant, a problem is usually solved through camera calibration. When Naos are localized using the overhead fisheye camera, quite accurate coordinates will be available. These coordinates can be used as ground truth to verify localization of Naos⁴.

³It is of course possible to imagine situations in which a Nao is not able to locate its feet, for example, a foot could have fallen off.

⁴See for an overview <https://sites.google.com/site/2012robottracking/>

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 use of media through interviews.

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 fields of research. The students received lectures from active researchers within the fields of Computer Vision, Autonomous Decisionmaking and Robotics, and applied this knowledge to solve given tasks (e.g. how a camera detects landmarks, and can use these 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 Robotics 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 Robotics 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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