HULKs Team Description Paper 2017

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1 Introduction

The RoboCup SPL team HULKs formed in April 2013 and thus is one of the newer teams in the league. The team is organized as the association RobotING@TUHH e.V. and currently consists of about 25 members, most of which are graduate students. We have participated in the RoboCup 2014, 2015 and 2016, the RoboCup German Open 2014, 2015, 2017, the RoboCup European Open 2016 and the RoboCup Iran Open 2017.

This document is structured as follows: In section 2 we will briefly describe the research that has been done since the end of last season. Section 3 describes our efforts regarding the mixed team competition. Finally in section 4 acknowledgments are being made, announcing code usage for the RoboCup season of 2017.

2 Current Research

2.1 Behavior

After RoboCup 2016 we observed that improving the behavior is the key part for playing more competitive games. Our behavior in 2016 was not considering any team information and each robot had a preconfigured role. From a software-technical point of view this has been realized with `boost::msm`. This impeded development due to slow compilation times and unnecessary hard implementation of hierarchy. Therefore the goals were getting rid of `boost::msm` and implementing a team strategy in the new behavior engine.

The behavior consists of a decision tree that is implemented as a set of functions that return a command for specific body parts or the complete body. Hierarchy is realized through functions calling other functions. The resulting command of a function can be adjusted by the calling function or combined with another command, e. g., a walk command can be combined with a head command. Each function gets a data set which forms a world model that can be used by the behavior. Functions can also reference the last command that was output by the root function. Some complex behavior tasks are put into their own modules which produce data that is part of the data set.

Our actual behavior is role-based and contains implementations for a keeper, striker, defender and supporter.

The striker is the robot which is nearest to the ball and, apart from the keeper, the only role who manipulates the ball. It decides whether it wants to kick directly into the goal, dribble, or pass to a teammate, depending on the distance and angle to the goal and the positions of teammates.

Defending and supporting robots both walk to certain positions on the field where they are strategically useful. A keeper stands in its penalty area and, depending on the ball position, turns to the ball or clears it.

2.2 Robot Detection

Being able to detect teammates and opponents is a crucial ability in a soccer game. On the one hand it allows to avoid collisions with opponents and on the other hand it opens possibilities for a more refined strategy.

The task was approached using machine learning techniques for object classification and was split into two basic steps:

First the image is scanned for large chunks of non-field color areas which are then stripped of their color information and reduced in size. In a second step, the corresponding parts of the image are fed into a neural network to classify whether they contain a robot or not. One main objective of this research was to compare a large variety of neural network setups. For this purpose the parameter space was explored by varying input size, activation function and topology in combination with both convolutional and feature-based approaches.

A detailed evaluation showed that convolutional networks promise the best results, achieving a false positive rate of about 4 % while being able to maintain a true positive rate of about 86 % and a runtime of about 0.9 ms to 1 ms per robot candidate on the NAO hardware [2]. Providing a broad basis for future work in the field of machine learning, these efforts showed that convolutional neural networks are the tool of choice when it comes to object classification on the NAO.

With these results at hand our future research will focus on differentiating between robots of the own and the opponents team. These insights are also going to be helpful for training future artificial neural networks for the purpose of further object classifications like ball or field mark detection.

2.3 Dynamic Kick

Currently, the kick is based on a static motion file that consists of key-frames. While this proved to be sufficient for scoring our first goals, more sophisticated kick engines are conceivable. In a recent endeavor to improve the kick, a motion that is adaptable to different circumstances was implemented. To achieve the desired adaptability the kick engine is designed around the Dynamic Movement Primities (DMPs) approach according to Böckmann and Laue [1]. Essentially, a DMP imitates a given motion and can be scaled in position, direction and

duration while largely maintaining the shape of the imitated trajectory. This can be used to adapt to different ball positions and kick targets. With the kick motion being more flexible much time can be saved when positioning relative to the ball. Furthermore, the kick strength can be adjusted by scaling the duration to improve the capability of passing the ball to teammates [3].

3 Mixed Team Competition

In 2016 B-Human and HULKs decided to form the B-HULKs team to participate in the Mixed Team Competition of the RoboCup World Championship 2017. For this purpose a first meeting was held to discuss a common team strategy. Upon that objectives were defined that are necessary to allow for a good team play.

Furthermore the `BHULKsStandardMessage` was introduced as an addition to the `SPLStandardMessage`, sharing information such as pass targets, assigned roles and detected obstacles.

4 Acknowledgments

Although the C++ code that runs on the NAO has been written completely by our team, we use motion files from other teams. Specifically, we use the genuflect motion by B-Human and the stand up motions by the Nao Devils Dortmund. The motion files have been converted to our own format. We would like to thank both teams for their contributions.

References

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2. Kahlefendt, C.: A Comparison and Evaluation of Neural Network-based Classification Approaches for the Purpose of a Robot Detection on the Nao Robotic System (2017), http://www.hulks.de/_files/PA_Chris-Kahlefendt.pdf
3. Wege, F.: Developement and Implementation of a Dynamic Kick for the NAO Robotic System (2017), http://www.hulks.de/_files/BA_Felix_Wege.pdf

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