NomadZ Team Description Paper for RoboCup 2017

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Abstract. This report summarizes the activities of the RoboCup SPL team *NomadZ*. In 2014, we participated at our first open tournament and our main focus has been perception and behavior programming. At the 2016 RoboCup, we competed in the indoor tournament, the drop-in player event as well as the technical challenges. For 2017, we are qualified for the team competition and aim to improve previous results. This paper provides an overview of our activities, detailed reports of the students' works are available on our website http://www.robocup.ethz.ch.

1 The Team

The *NomadZ* started in 2012 at ETH Zurich and are a joint effort of the Computer Vision Lab (CVL) and the Automatic Control Lab (IfA, Institut fr Automatik) at the Department for Information Technology and Electrical Engineering.

The team consists mainly of students working on semester or master projects to earn credits to their respective degrees. They are supervised by Alex Locher, Louis Lettry and Prof. Luc Van Gool from the Computer Vision Lab as well as Georgios Darivianakis, Benjamin Flamm and Prof. John Lygeros from the Automatic Control Lab. Furthermore, the students are directly supported by four teaching assistants, who guide the projects. In the spring term 2017, six students will be working together on semester projects. Their topics cover the fields of perception, motor control and behavior. Figure **??** shows the team at the European Open 2016.

Team members Besides the supervisors, these students joined us for the 2016-2017 season: Florian Amstutz, David Hug, Noyan Evirgen, Martin Kälin, Simon Flückiger, Silvan Plüss, Michael Walter, Maximilian Wulf, Yupeng Zhao.

2 Robot Hardware

We have currently four V5, one V4, and three V3.3 NAOs (all H21). All robots are used for developing, testing, competition and exhibition (e. g., public relations events). We will use the V4 and V5 robots at the RoboCup 2017, but are aiming to buy one or two more NAOs until summer.

Fig. 1. The NomadZ team at the RoboCup 2016 in Leipzig.

3 Robot Software and 2016 SPL contributions

We have based our code on the 2013 code release of B-Human and have focused our activities on perception, behavior programming and to a limited extent also motor control.

3.1 Perception

Two main tracks of research have been followed with the help of nine students over the last year.

The first one meant to adapt the different algorithms to fit the new rules: white goals on both sides of the pitch and a white soccer ball. Both challenges proved to be difficult as the elements of interest on the field have seen their difference in color reduced to become white. The goal detection has been improved to a robust version of the yellow goal detection to account for situations where "ghost" goals appear (i. e., two robots standing under a white line). The ball detection uses the main geometric, color and motion constraint present on the ball, respectively, its spherical shape, the black dots and the planar motion. A sliding window approach looks for spherical objects of a certain size and containing a certain percentage of dark pixels has proven to be reliable for the ball detection. We are still working on rendering this method more robust to reduce the number of false positives (e. g., robot feet, shoulders, goals with black nets).

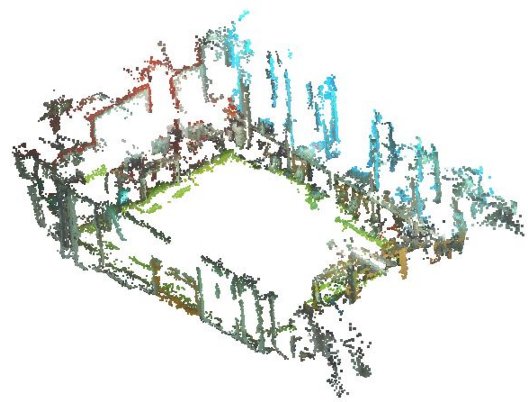

Fig. 2. Example of background reconstruction shared across the different robots which is used for self-localization.

The second track's objective is to improve the self-localization of the robots as landmarks (i. e., goals) get harder to detect reliably. Simultaneous Localization And Mapping (SLAM) methods have proven in the past to perform well even given high constraint such as low computational power. In this regard, we allocated a lot of energy to producing a localization system based on state-of-the-art techniques applied to our particular situation. We mainly incorporated the reduced dimensionality of the robot motion in the pose estimation and the relative constant background as a map shared across robots (example Fig 2). The students' report will be released by the end of summer 2016.

3.2 Behavior Programming

Over the year 2016, we were unfortunately not able to properly integrate our passing framework into the functioning code. Now we are closer than ever in getting it to work with a running kicking engine to tune kick strength, as well as new tactics for directed passing. Our hope is that this will work by the German Open in May this year. A pass tutorial for our students can be found on our YouTube channel (link on our website). Briefly, the pitch is divided into a grid. A robot on the grid will make grid points passable (set by a flag). Other points will be not passable because of another robots passing shadow. Passable points will be evaluated depending on the robots and the balls position. For instance, a pass from a defender is more likely than a striker who might score a goal with a shot.

Role assignment, diamond positioning and proper obstacle detection with path planning are effective in the simulator. However, we have been struggling with performance on the robots. Team members are working on systematic tests and integration of these modules with the help of former members.

3.3 Motor Control and Improved Walking Engine

Silvan Plüss has been working on analyzing and improving the current walking engine, with an initial goal of increasing the speed and robustness of straight-line walking. Although our walking has become more stable compared to the German Open in 2014, there is still ample space for improvement both on planning and tracking of a reference walking trajectory. The inverted pendulum model, currently in use in the B-Human 2013 release, is kept, but the control scheme was considerably improved. Instead of relying on an iterative algorithm which solves a set of nonlinear motion equations to compute the motor commands, Silvan has devised a control scheme based on a linear quadratic regulator (LQR) which uses a hybrid discrete-time state-space representation. This method exhibits improved trajectory tracking capabilities compared to the previous implementation.

Based on this work David Hug is working further on stabilizing walking using the theory of an inverted pendulum aiming to solve our problems of walking on the artifical turf.

4 Conclusions

The NomadZ are participating for the second time at the team event of the RoboCup. We are advancing steadily and our long-term objective is to leverage our labs' solid expertise in control and computer vision for action planning, decision making and self-localization, respectively.

5 Acknowledgments

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