B-Human

Team Description for RoboCup 2009

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1 Introduction

B-Human is a joint RoboCup team of the Universität Bremen and the German Research Center for Artificial Intelligence (DFKI). The team consists of numerous undergraduate students as well as two researchers from both institutes. The latter have already been active in a number of RoboCup teams such as the GermanTeam and the Bremen Byters (both Four-Legged League), B-Human and the BreDoBrothers (Humanoid Kid-Size League), and B-Smart (Small-Size League).

In RoboCup 2008, we participated as B-Human in the Humanoid League and as BreDoBrothers, a joint team of the Universität of Bremen and the Technische Universität Dortmund, in the Two-Legged Standard Platform League. Our main part in the joint team BreDoBrothers was to provide a software framework for the Naos. This has been a modified version of our Humanoid League software we have been developing over the last years. We also provided the state estimation modules as well as the getup and kick motions for the Nao (cf. `http://www.b-human.de/videos.php`). In RoboCup 2009, we want to concentrate our work exclusively on the Two-Legged SPL. By integrating all the students of the Humanoid League team B-Human, the BreDoBrothers would have more than thirty members. Therefore we decided to end the cooperation by mutual agreement to facilitate a better workflow and work-sharing.

The current team consists of the following persons, who are also shown in Figure 1:

Diploma Students. Oliver Bösche, Armin Burchardt, Erik Damrose, Katharina Gillmann, Colin Graf, Alexander Härtl, Thijs Jeffry de Haas, Judith Müller, Andrik Rieskamp, André Schreck, Andreas Seekircher, Ingo Sieverdingbeck, Thiemo Wiedemeyer, Jan-Hendrik Worch.

Researchers. Thomas Röfer (team leader), Tim Laue.

2 Relevant Achievements in RoboCup

The senior team members have already been part of a number of successes, such as winning the RoboCup World Championship triply with the GermanTeam (2004, 2005, and 2008),

Fig. 1. The current team at the RoboCup German Open 2009 awards ceremony.

winning the RoboCup German Open also triply (2007 and 2008 by the GermanTeam as well as 2008 by B-Smart), and winning the Four-Legged League Technical Challenge two times (2003 and 2007 by the GermanTeam). The activities also resulted in a vast number of publications [1]. In addition, the GermanTeam framework is the most used software basis in the real-robot leagues of RoboCup. In recent years, more than 30% of the teams in the Four-Legged League built their systems on top of it.

In parallel to these activities, B-Human started participating in the Humanoid League in RoboCup 2006. The software was as far as possible based on previous works of the GermanTeam [2]. In RoboCup 2007, B-Human reached the quarter finals and was undefeated during round robin. In RoboCup 2008, B-Human shot as many goals against superior teams as the best team of the SPL Two-Legged competition did. Figure 2 shows the robot models that have been developed so far.

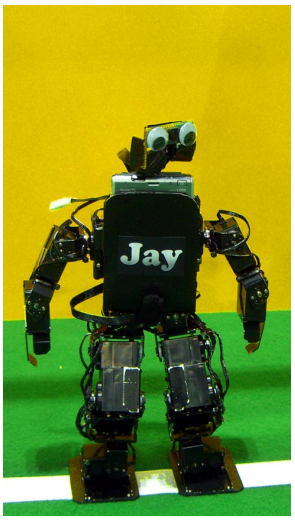
In 2009, B-Human participated in the RoboCup German Open Standard Platform League and won the competition. We scored 27 goals and received none in five matches against different teams.

3 Research Goals

The cooperative and competitive nature of robot soccer in the Standard Platform League provides a suitable test bed for a broad research area. The research of our team is mainly focused on probabilistic state estimation, robot simulation, and motion and behavior optimization.

3.1 Probabilistic State Estimation and Robot Vision

Our research regarding state estimation is mainly focused on Bayesian filters. For the AIBO platform, we have presented a vision-based Monte Carlo localization system [3,

a) 

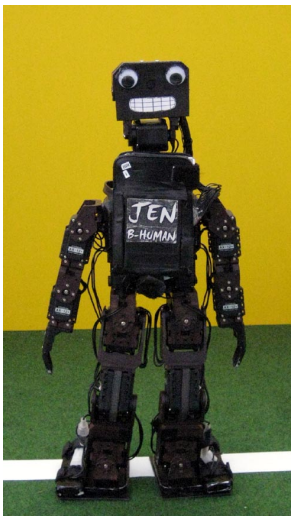
b) 

Fig. 2. Self-constructed humanoid robots: a) Jay from the 2006 BreDoBrothers team and b) Jen from the 2007 and 2008 B-Human team.

4] some time ago. The usage of particle filters for localization and tracking on humanoid robots has been also been shown in [5]. A Kalman filter-based approach for non-cooperative, egocentric tracking of multiple robots had been presented in [6].

To gain better results from state estimation, improvements in the field of robot vision, especially for color classification and motion compensation [7, 8], have also been achieved. Our current research is about minimizing calibration efforts as well as about an active vision component for the SPL.

3.2 Simulation

Our central development tool is the simulator SimRobot. This application is in use and under continuous development since the 1990s [9]. Figure 3 shows the current version [10] simulating the B-Human robots. Recent research issues concerned the realism of the simulation regarding the sensors [11] as well as the actuators [12].

The current version of SimRobot is included in B-Human's code release (cf. Sect. 4). This is also the first version based on the *Qt* framework and thus being able to run on different operating systems.

3.3 Motion and Behavior Optimization

In RoboCup competitions, one major task is the robot locomotion on a flat field and its optimization in terms of quickness, flexibility, and stability. Especially in the leagues with legged robots, good omni-directional walking skills are essential for winning games. Controlling the robots' legs in order to walk for example is typically done by defining trajectories for the foot movement. The parameters (e.g. step height, step length, timings etc.) of the trajectories affect the stability and speed of the walking gait. Our team has

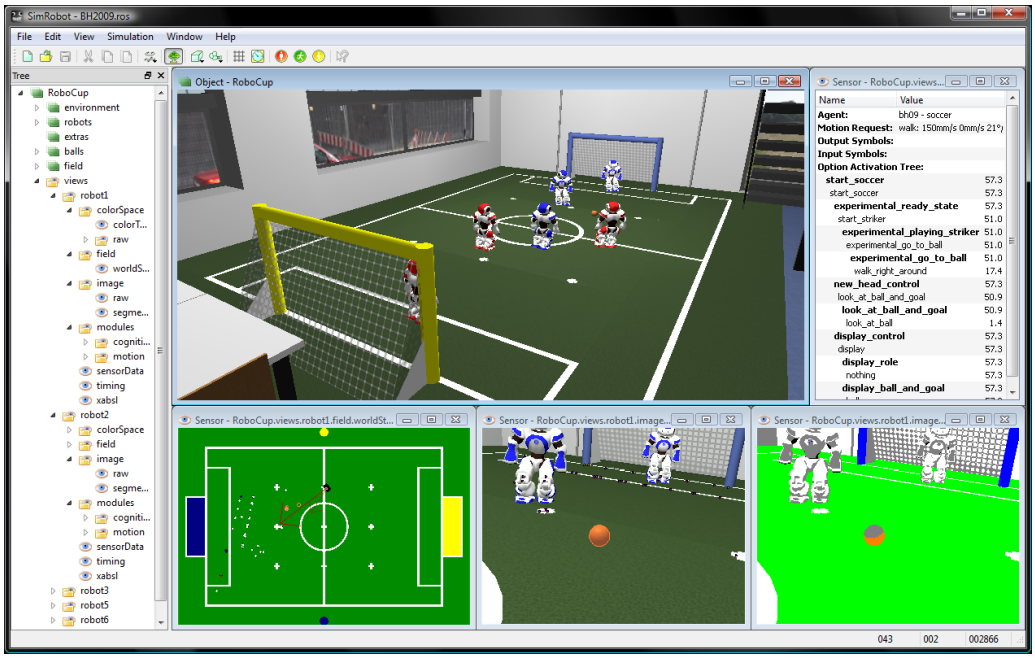


Fig. 3. Our simulator SimRobot simulating Nao robots playing soccer in our lab. The application displays (from left to right, top to bottom) the scene graph, the simulated lab environment, the behavior activation paths, the world state estimate, and the raw as well as the segmented camera image of a red Nao.

published different autonomous learning techniques for the gait optimization on an AIBO [13] as well as on a humanoid robot [14]. These approaches will also become applied to the Nao robot.

Our current work is about balancing in combination with dynamic kicking motions. In addition, we intend to extend the parameter optimization approaches to the low-level skills of the robot's behavior.

4 Source Code Release

We decided to tie up to the lost traditions of the Four-Legged League to release code after a competition. We think that code releases are an important part of sharing scientific works with others and that it is sorrowful that this tradition of code releases seems to be slowly abating. Sharing of code gives the great opportunity to learn from each other and to bring the robotic research forward with bigger steps.

We released our code – together with a comprehensive documentation – to the public on our website: `http://www.b-human.de/publications.php`. We hope this act motivates other teams to release their code too or to use our code as a basis, as the code of the GermanTeam has been used as a basis by other AIBO teams.

5 Summary

Our software has been fully ported from our Humanoid League robots. Hence, we already had an almost complete set of components needed for playing soccer with a Nao robot, inter alia including a stable walk, kicking and getup motions, vision, and localization. This state of our software is completely included in our code release which has been made to accelerate development within the Standard Platform League.

Amongst some remaining minor adaptations, e. g. to take advantage of some specific Nao sensors (ultrasonic sensors in the chest, pressure sensors under the feet) we continue our research described in Sect. 3. For RoboCup 2009, especially a further optimization of the gait and the kicking motions appear to be crucially important. Furthermore, the plus of processing power the Nao provides compared to the B-Human robots enables us to apply more advanced algorithms, primarily for vision and state estimation.

The current state of the system, as of May 2009, has already proven to be competitive by winning the RoboCup German Open.

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