

**Nao-Team HTWK**

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Team Description Paper

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## 1 About the Team

The Nao-Team HTWK is a RoboCup team that consists of graduate and undergraduate students of Leipzig University of Applied Science and was founded in February 2009.

The team participated in RoboCup German Open 2009 for the first time and immediately reached the second place as well as the first place in the Technical Challenge of RoboCup 2009. In 2010 the Nao-Team HTWK gained the Quarter finals and the first place in Open Challenge during the RoboCup in Singapore.

## 2 Team Supervisors

The Nao-Team HTWK is being supervised by Prof. Dr. rer. nat. habil. Karl-Udo Jahn and Prof. Dr. rer. nat. Klaus Bastian who are both Professors of Computer Science at the Leipzig University of Applied Sciences.

## 3 Team Member

Nao-Team HTWK 2011 includes 12 student members from one academic department:

**Rico Tilgner**, B. Sc., Student of Computer Science  
**Thomas Reinhardt**, B. Sc., Student of Computer Science  
**Daniel Borkmann**, B. Sc., Student of Computer Science  
**Stefan Seering**, B. Sc., Student of Computer Science  
**Tobias Kalbitz**, B. Sc., Student of Computer Science  
**Robert Fritzsche**, B.Sc., Student of Computer Science  
**Katja Zeißler**, Undergraduate, Student of Computer Science  
**Christoph Vitz**, Undergraduate, Student of Computer Science  
**Sandra Unger**, Undergraduate, Student of Computer Science  
**Manuel Bellersen**, Undergraduate, Student of Computer Science  
**Hannah Müller**, Undergraduate, Student of Computer Science  
**Samuel Eckermann**, Undergraduate, Student of Computer Science

## 4 Notable work and fields of interest

The Nao-Team HTWK contributes to research in different areas, which all play an important role in the field of robotics. These areas include image processing and segmentation, self-localization, biped-walking and motion generation as well as software architecture and optimization on resource-limited embedded systems. Some notable work done by us is mentioned in the following.

The *segmentation* of Nao's camera image and identification of the field and objects on it is an essential part of playing soccer. The biggest problem for most color-table based methods are the inability to cope with changing light conditions and the need to generate the color-table, which can be very time consuming. Changing lighting conditions (e.g. between daylight and artificial light which is common at the German Open) make it impossible to classify objects solely based on their color. Also, differing ball colors, like at RoboCup 2010, pose another problem for purely color based methods. Therefore, a real-time capable segmentation with no need for calibration would be advantageous. By applying the knowledge of the objects' shapes we developed a segmentation algorithm that can handle changing light conditions and colors robustly without the need for prior calibration. This method works reliably and in real-time. It has been used at German Open 2010 and RoboCup 2010 where it won the Open Challenge. The work will be available as a master thesis and is also planned to be published as a paper. Currently, we are working on a visual obstacle detection that will be integrated into the above algorithm.

Our current *localization* is based on a combination of RANSAC and particle filters. First, the line segments determined by the segmentation are projected onto the ground. For this, the body and head angles of the robot are used. Following, lines and the center circle can be detected and fed into a particle filter which generates a position estimate within a few milliseconds. However, as the method relies on correct body and head angles for the projection, it fails if the camera physically moves, which often happens when the robot falls. We currently develop a localization method that does not depend on any camera angles.

Until the beginning of 2010 we used closed-loop *walking* motions evolved through a genetic algorithm. These motions were fast but not omni-directional (eventhough walking along a curve was possible). This was a big disadvantage at the German Open 2010, so we decided to develop a completely different walking engine. As of RoboCup 2010, our walking engine is based on a parameterizable walking model similar to and is supported by a newly developed balancing algorithm. The big advantage of this system is full omni-directional capability and the ability to make fast direction changes whilst still being very stable. The new walking engine was tuned for stability and speed manually and achieved forward speeds in excess of 300 mm/s. We plan to combine the genetic algorithm and automatic evaluation system used in our old walking engine with the new one and hope to achieve both, more speed and even more stability until German Open 2011. Furthermore, we also plan on publishing the full system once we have finished the integration.

Also, on the software-architectural side, our Nao robots do not *communicate* via IP-based traffic. Statically assigning IP addresses and netmasks can lead to misconfigurations during immediate competition setups of Naos or reboots of robots due to system failures. Therefore, we implemented a zero-configuration

Layer 2 Ethernet protocol that runs within the Linux kernel by using the protocol hook *dev\_add\_pack* and Kernel FIFOs for queueing RX as well as TX packets. Communication happens via device files. A naonet communication manager within Userland controls the transmission and dispatch of messages. The receive path is therefore event-triggered.