Humboldt Hereos in RoboCup-99 (Team description)*

Hans-Dieter Burkhard, Matthias Werner, Michael Ritzschke, Frank Winkler, Jan Wendler**, Andrej Georgi, Uwe Düffert, and Helmut Myritz

Humboldt University Berlin, Department of Computer Science,
D-10099 Berlin, Germany
email: hdb/mwerner/ritzschk/fwinkler/wendler/georgi/dueffert/myritz@informatik.hu-berlin.de,
WWW: http://www.ki.informatik.hu-berlin.de

1 Introduction

The team members include students as well as members of the teaching stuff from the Department of Computer Science at the Humboldt University. They represent the groups of Artificial Intelligence, Responsive Computing, and Signal Processing, respectively. It was the aim of the project to combine the skills of these disciplines to program soccer playing legged robots.

An underlying idea was to use the experiences from the simulation league for the general structure of the robot software. We still think that this concept is realistic. But the restricted time forced us to use a very simple reactive approach for the RoboCup 1999 world championship.

Our general research interests can be described as follows: We are interested in the development of skills on higher level decision protocols using methods from Machine Learning, especially from Case Based Reasoning. For knowledge processing and deliberation we are using mental models from Artificial Intelligence. We are specifically interested in developing normal consensus protocols, collision avoidance protocols and would like to develop new models of faults, e.g., the opposing soccer team would be considered as a new type of a fault. Furthermore we are interested in novel algorithms for image processing and their implementation in embedded systems. We would like to apply parallel computing structures for image processing using the pixel-bit parallelism principles of distributed arithmetic. Scalable resolution allows simultaneous suppression of noise, sharpening of discontinuities and labelling of important data.

2 Team Development

Team Leader: Prof. Hans-Dieter Burkhard

* This work was partly sponsored by TecInno GmbH Kaiserslautern, Daimler Chrysler AG Research & Technology Berlin and PSI AG Berlin

** This work has been supported by the German Research Society, Berlin-Brandenburg Graduate School in Distributed Information Systems (DFG grant no. GRK 316).

M. Veloso, E. Pagello, and H. Kitano (Eds.): RoboCup-99, LNAI 1856, pp. 770–773, 2000.

Team Members:

Prof. Hans-Dieter Burkhard
- leader of the AI group
- did lead the design and did consulting
- did attend the competition

Dr. Matthias Werner and Dr. Michael Ritzschke
- research assistent at the responsive computing / signal processing group
- did lead Aperios and OPEN-R integration / did lead design of vision and did consulting
- did attend the competition

Dr. Frank Winkler and Peter Tröger
- research assistent at the signal processing group / undergraduate student
- did lead development of vision and acoustic tools and did consulting / did implementation of acoustic communication
- did not attend the competition

Jan Wendler
- PhD student at the AI group
- did design and implementation of the world model
- did attend the competition

Helmut Myritz, Uwe Düffert and Andrej Georgi
- undergraduate students
- did the implementation and debugging
- did attend the competition

Web page http://
www.ki.informatik.hu-berlin.de/RoboCup/RoboCup99/index_e.html

3 Complete Robot Architecture

We have distinguished four main parts which we call Cortex, Brain, Body, and Communication. Messages are passed between these modules according to the underlying control structure.

The general idea is to transmit the plans computed by the Brain to the Body and perform it by the available skills. The Body controls the movement of the legs in order to turn, move, kick etc. Additionally, there exists a direct information flow between Cortex and Body for immediate actions, e.g., for keeping track of the ball. This imposes some rudimentary layered architecture.

4 Vision

The Cortex uses the Color Detection Engine (CDT) to identify the objects in the image by common procedures of image-processing to find the object parameters, e.g. position, width, center-point.

It is well known, there are some possibilities to describe the colour in a picture. Common colour spaces are for instance RGB, YUV (the PAL/European standard for colour television broadcasting) and HLS, where H is for the Hue

(the H value is a degree value through colour families), L for Lightness (1 = white, 0 = black) and S fore Saturation (that is the degree of strength of a colour - greater is S, the purest is the colour).

The robot-eye use the YUV space and so we can analyze the YUV-values in a robot-image. But we want to create CDTs for a wide range of lightness/darkness and of saturation, because the robot sees different colours in the pictures if he looks from different viewpoint to the same objects. On the other side we found in our testing-period, that every robot had from the same viewpoint under the same light conditions little different YUV-values. Therefore we realize a way to develop our CDT's with four steps:

- Shooting session to get some images from all relevant objects (ball, goals, playerdress, landmarks), we use different viewpoints and - if enough time, all our robots.
- Analyzing of the YUV values and transformation via RGB in the HLS space. Our tool allows us to use the mouse for moving a reticule over the object. With the help of the statistical componente we get for H,L,S the mean value and the standard deviation.
- Now we use a second tool to simulate possible combinations of HLS around the mean values of H,L,S - with the help of random numbers of the constant distribution like radio noise. Every generated HLS-point (we use more then 1000 points) will be transformated in the YUV space and the resulting borderlines of YU and YV plane built our CDTs, which we can save in a file.
- We check the quality of our CDTs with a further program using originally robot-images. This tool allows - if it is necessary - manually corrections of the CDTs.

5 Control

We did not develop our own skills. This was a real drawback since the usage of the available skills caused several problems, e.g. the main disadvantage was a missed possibility to interrupt a movement in process. Another disadvantage was a lack of movements' precision.
We tried to overcome these disadvantages by several means:

- To interrupt a movement, we insert an interception function between the skill module and the robot module. Its task was to catch outgoing commands and to report success to the skill module.
- To improve the real-time behavior, we used a priority queue to transmit commands to the body. Sent but not yet executed commands that became superfluous are thrown away.
- Critical parts of a movement are executed in the step-wise mode. That shall increase the movement's accuracy.

However, the creation of a real-time walking and posture control is a mayor objective to become an appropriate competitor in the next competition.

6 Localization

The robot has to stop each time he tries to localize himself on the field. Then he turns his head to scan the full area around him all seen flags and goals are stored. The dog can now calculate his own position and body direction with these informations. The calculations are most of the times correct, only if the number of seen flags is very low or the distance to a flag or a goal is quite wrong, than the calculation can went wrong very hard. Usually we have to wait a small amount of time until the next localization is of advantage.

7 Strategy

The software architecture of the Brain is oriented on our simulation league agents, the AT Humboldt team, which is using a BDI architecture for the mental modelling. According to the BDI architecture the Brain transforms the received data into an internal world representation ("belief"). It identifies possible options ("desire") and commits for useful plans ("intention").

Actually, we did not finish the work on this concept for RoboCup. Instead, we used a simple reactive approach:

- Look for the ball
- Run to the ball
- Search and positioning for the opponent goal
- Go with the ball to the opponent goal
- Kick if you are near the opponent goal

8 Special Team Features

Because of the hearing and speaking possibilites of the sony legged robot, we decided to implement an acoustic communication. The speaking ability was a big advantage for debugging, the robot could tell us what he had seen by playing a predefined wave-file.

Unfortunately SONY did not supported the hearing capacity this year, therefore an acoustic communication between the robots was not possible.

9 Conclusion

We are very thankful to SONY for giving us the opportunity to work with such an exciting device. We are full of plans for the next year.

In future we will continue to develop in a close cooperation of all groups (Artificial Intelligence, Responsive Computing and Signal Processing). We will try to optimize coordination of all movements of the robot. Additionaly the problem of localization is another major point of interest in next years work.

During this year all three groups together are organizing one lecture "Intelligent Robotics", where motivated students are able to work with the Humboldt Heroes team. Certainly we don't forget the simulation league, the AT Humboldt 2000 is already in preparation.