Application from Hamburg Bit-Bots for Robocup 2013

Timon Giese, Maxim Holand, Robert Keßler, Maike Paetzel, Martin Poppinga, Nils Rokita, Robert Schmidt, Heye Vöcking

Department of Informatics, University of Hamburg info@bit-bots.de

Abstract. *Hamburg Bit-Bots* is a highly motivated team interested in the wide fields of robotics. Over the last two years we have developed our own software for the RoboCup tournament and gathered much experience. Our goal is not only to score, but to share this knowledge with like-minded people from all over the world.
Last year we were able to learn from the experiences gathered during that time and improved our software based on that. We are doing research in many different fields, among other things and globally unique topics as team communication based on natural language.

1 Our Team

The team *Hamburg Bit-Bots* consists of a group of students from the Department of Informatics at the University of Hamburg, Germany. The team is financially supported by the department and the university. Apart from that Hamburg Bit-Bots are an independent work group lead and organised by students.

We are using the *Darwin OP* robots produced by *Robotics and Mechanisms Laboratory*. All team members are currently studying computer science or Computing in Science and are working on their bachelor's or master's degrees.

2 Research

2.1 Research until now

We will give a short draft of the published work by some of our group members. Due to the fact that our team consists only of students, the published works so far are mostly bachelor theses.

Evolving Locomotion for the DARwIn-OP Is a bachelor thesis work-in-progress where walking with neural networks is learned using evolution on a Darwin model in Webots. In the future we consider to transfer a successful and stable walk to the real Darwin.

Team coordination in RoboCup soccer based on natural language Maike Paetzel is currently writing her Bachelor thesis about a new strategy for robot to robot communication during RoboCup games. In the last years the

coordination based on the wireless network was error-prone because of the unstable network hardware during the championships. Particularly with regard to the aim in 2050 the solution is a new communication protocol that is adapted to natural language. Robots should exchange their most important information via speech production and language processing.

Ball recognition based on probability distribution of shapes Sandra Schröder developed a process to determine whether a given shape would match the soccer ball or not. She uses an elaborate edge detection algorithm in combination with the probability distribution of the position of edges to calculate the possibility of a given shape in the presented image.

Behaviour based coordination of a multi robot scenario realized by BDI-agents Group member Anja Richter wrote her Bachelor thesis on the modelling of a behaviour for a logistic scenario. The behaviour is realized by software agents according to the believe-intention-desire model and then transferred to a multi robot system.

Estimation of optical-flow fields in multispectral images is a finished bachelor thesis written by Oliver Bestmann in the field of cognitive science. The developed algorithm is able to robustly estimate the optical-flow in an image sequence using additional information provided by color gradients. It can be used for better tracking of the ball once it is located.

Ball verification The group members Lasse Einig and Anja Richter wrote an article about the ball verification they developed for the object recognition tool for the NAO robot in the Standard Platform League 2011.

2.2 Current research

We will give you are short overview of our current research topics.

Construction design of new feet and heads for the new cameras As the DarwinOP has some problems with parts of its hardware we are working on our hardware, too. We tried to build our behaviour in parts on the distance to the ball. This distance was calculated with the angle of the head and the size of the ball on the picture. The camera in the Darwins head is fixed on the plastic and this is fixed to the body with a connector. That means the camera is very shaky and for that the angle is useless for calculating. That was the reason for us to design new heads and plot it with a 3D plotter. In this new heads will be enough space for our new cameras with higher resolution.
The second building area are the feet of the Darwins. Because humans are not walking with flat feet but doing a roll motion we try to design feet that make this roll motion possible, too. By now we have a prototype made of wood and try to make our new walk stable.

Evolving Locomotion for the DARwIn-OP The purpose of the bachelor thesis is the evolution of artificial neural networks to develop locomotion for the Darwin robot. The main problem in robot soccer is a robust and fast locomotion.

Since a humanoid robot is a very complex system, it is difficult to hand craft a robust walking algorithm. Furthermore it needs to be adjusted by hand if the floor or the weight distribution of the robot itself is changed. An approach to automatically develop a walking algorithm is the biologically inspired evolution in which a gradual improvement of individual solutions can be achieved over many generations. Advantage of the evolution is that the problem itself doesn't need to be solved, but one only needs a so-called fitness function, which rates the quality of a solution. But evolution has also certain difficulties which have to be overcome. The fitness function has to be designed very carefully in order to get good results. We are using a realistic model of the DARwIn-OP in the Webots simulator for the experiments so the final solution can eventually be transferred to the real Darwin. Because of the promising results we had so far we are now trying to optimize the evolution to develop a more robust solution.

Pointcloud-based self-calibrating vision Our vision is based on point clouds. These point clouds are pre-generated sets of points that we use for image processing. The point clouds are generated at start-up. Generating means creating and sorting random points and reference to each of them an array of their nearest neighbours including the distances. Using this point clouds enables us to gain higher resolution on certain areas of the image. So in particular we use three different point clouds according to our input and the resolution we want to achieve in a particular area of the input image. Another topic on vision is the field recognition. We implemented a self-calibrating model to recognize the field colour even if it is different under changing lightning conditions. This helps us in achieving a fast set-up in a new environment which is certainly necessary for future robotics research.

Localisation on the field At the moment we are using no complete localisation. The robot just knows where the ball is and where the goals are. But we are going to rewrite the localisation started in October 2012. The new localisation will be based on Kalman Filter line tracking to localise the robot. To support the visual localisation process, we aim at a motion tracking system. This system will record the movement of the robot and figure out the rough position and direction of the robot. This can be used to reduce the computing time and increase the precision of the localisation .

Robot/Team Communication based on natural language The goal of RoboCup is playing soccer as similar to humans as possible. To get a step closer to that goal we try to convert our robot to robot communication from wireless communication to natural language. We are currently developing a new communication protocol that is optimized to the requirements of natural language. Every robot can transport their own data to the other robots via speech synthesis and gets data from them via language processing.

Continuous simulation and evaluation of tryouts To test our robot behaviour we plan to set-up a continuous integration system which is simulating nightly our source code in a virtual environment. Therefore we are just evaluating simulation frameworks which can be used. With this set-up we would like to raise our software quality and give it a measurement.

Complex behaviour The behaviour is modelled with finite automata. This means that every abstract state like "Search for Ball" is capsuled in such a state executing the piece of code that is particular assigned to this situation. In each such a state there are conditions which when met make a transition to another state happen. In future we want to improve that model and maybe add a state machine in which a state could be a state machine itself. Furthermore we want to improve testability of the behaviour software part due to it complexity. This means finding a way to make it at least a bit more possible to design such a complex behavioural system.

Robot recognition One of the common problems in our field is to recognise the shape of a robot, regardless of the robot type. This has to be done in a very time and space efficient way. We are testing a new kind of algorithm to segment a binary image really fast ($O(n)$) , and check objects for their "limbs" in order to classify an object on the field as a robot.

Sound Source Localisation To check where a player is we plan to use sound source localisation. This is useful at least from the point where the robots are talking to each other with natural language. Different voice types can be used to identify different robots. This would give a major benefit in localizing in a multidimensional way.

3 Prior performance in RoboCup

The *Hamburg Bit-Bots* team was founded in 2011 as a group of former participants of the official robocup bachelor project. The aim of the team was to enlarge the experience won during the project time. Cooperation with the SPL team *RFC St. Ellingen* is limited to the sharing of the laboratory. The current team was explicitly founded for the participation in the humanoid league and thus started from the beginning with new robots and a newly developed codebase.

In 2011 we started our working group and were busy recruiting students and setting up our robots.

Last year we participated in RoboCup German Open and were placed third. Furthermore, we took part in the world championship in Mexico City and were dropped out in second round robin, but successfully finished the Throw-In challenge. Apart from that we joined the Robow 12.1, 12.2 and 12.3 in Berlin to push the interconnectedness between the european robocup teams and take part in a research exchange.

4 Further dedication in RoboCup

Beyond the participation in the championship we do have many projects to make robotics and RoboCup accessible to people. For example we are going to participate in "Robots on tour" in Zurich 2013 and in the German Protestant Kirchentag.

5 Code from other Teams

Right now all of our codebase is written by members or former members of our team. We do not use any code from other teams.

6 Statements

6.1 Participate

We assure to participate in the RoboCup 2013 Humanoid League.

6.2 Referee

We assure that we have a person with sufficient knowledge of the rules. We assure that this person will be available as referee during the competition.

7 Conclusion

We achieved a lot experience in last years RoboCup season and are working much to improve our software for next year. We managed to correct our software in many aspects, for example we are now able to walk stable and do localisation on the field.

We are looking forward to see how our robots acquit themselves on the championships with the new software. We see the *RoboCup World Championships* as an opportunity to exchange our experiences with other students and researchers from all over the world and to improve and communicate our knowledge.

We sincerely hope to get the chance to be part of this great event.