Application from Hamburg Bit-Bots for Robocup Worldcup 2014

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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. Last year we were able to learn from the experiences and improved our software based on that. Among other topics, we are conducting research in many different fields, from team communication based on natural language to human-like shaped Darwin-feet

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 solely by students.

We are using modified *Darwin OP* robots produced by *Robotis*. All team members are currently computer science related students 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 consist only of students, the published work so far are mostly bachelor thesis.

Team coordination in RoboCup soccer based on natural language
Maike Paetzel has written 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 during the championships. Particularly with regard to "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
This finished bachelor thesisk was 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.

Improving the stability and durability of the Darwin Camera Hardware
The Darwin-OP head has some flaws in it's design. The camera is mounted directly in the front of the head and is only secured by the plastic peel of the head. We had several issues with defective contacts of the camera caused by falling forward. Our decision was to design a new head for our robots to protect the camera from damage. Now we are using a new camera protected by a new head, made of aluminium, developed by us.

2.2 Current research

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

Construction design of new feet The Darwin-OPs feet are flat and mounted in their center to the leg. 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 aluminium with a hinge-joint and springs might render our robots walking more stable.

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 in some areas of the image. 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 is the field recognition. We implemented a self-calibrating model to recognize the field colour even under changing lighting conditions. Also, we implemented autocalbration for Ball-colors. This also enables us to play with multi colored balls. This allows us a fast set-up in a new environment.

Localisation on the field We had rewritten our localisation in 2012 to be based on the Kalman Filter and line tracking to localise the robot. However the results did not satisfy us, so another rewrite is scheduled. This time we want to try some artificial learning algorithm.

Robot/Team Communication based on natural language The goal of the RoboCup is playing soccer as similar to humans as possible. To get a step closer to this 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 communicate to the other robots via speech synthesis and gets information 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 our source code in a virtual environment on nightly basis. Currently we are at adapting the simspark simulation framework for our needs. With this set-up we would like to raise our software quality and give it a measurement.

Complex behaviour The behaviour is currently 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 the future we want to improve our model and possibly 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.

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 heuristic algorithm to segment a binary image really fast ($O(n)$) into a graph structure, and check objects for their "limbs" in order to classify an object on the field as a robot. This is going to be a bachelor thesis in the future.

Sound Source Localisation To check the player's position 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 localising 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 participating as *RFC St. Ellingen* in the SPL league. The new team was founded with the goal to integrate knowledge from different fields of our studies in a more practical approach. It was explicitly created for the participation in the humanoid league and thus started from scratch with new robots and a newly developed codebase.

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

In 2012 we participated at the German Open and were placed third. Furthermore, we took part at the WorldCup in Mexico City and were dropped out in the 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 took part in a research exchange.

Last year we participated at the German Open and placed second and hostet a Mini RoBow. At the WorldCup we missed the quarter finals.

4 Further dedication in RoboCup

Apart from the participation during championships we have many projects to make robotics and RoboCup accessible to people. For example we participated in "Robots on Tour" in Zurich 2013, in the "Hamburg Night of Knowledge" and "Berlin Night of Knowledge".

In cooperation with a school we created a course in robotics for high school students which was a great success last year.

5 Code from other Teams

Right now all of our codebase is written by members or former members of our team. Our Walking is heavily influenced by the *Team-Darwin*.

6 Statements

6.1 Participate

We assure to participate in the RoboCup 2014 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 gained a lot of experience in last two RoboCup seasons and are working hard to improve our software for the coming years. We managed to improve our software in many aspects, for example we are now able to walk reliably stable and have a partly self-adapting vision.

We are looking forward to see how our robots acquit themself on the *Worldcup* with the new software. We see the *Worldcup* 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 become part of this great event.

8 Video

http://data.bit-bots.de/application2014.mp4 or
http://youtu.be/umnWFyavx6s

9 Website

http://bit-bots.de