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The Humboldt Heroes: Controlling Sony Legged Robots using BDI

Humboldt-Heroes

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Abstract. *The paper describes the architecture and the scientific goals of the Sony Legged Robots team "Humboldt Heroes". Scientific goals are the study of techniques for autonomous agents under real life conditions.*

1 The team

The team members include students as well as members of the teaching stuff from the Institute of Informatics of Humboldt University. They represent the groups of Artificial Intelligence, Responsive Computing, and Signal Processing, respectively. It is the aim of the project to combine the skills of these disciplines to program football playing legged robots. We have to remark that most of the ideas are still under development while writing this description.

2 General Research Interests

We are using methods from Distributed AI for knowledge processing and control, based on mental models of deliberation. We are interested in the development of Skills on higher level decision protocols using methods from Machine Learning, especially from Case Based Reasoning.

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.

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.

3 Proposed Approach to address the RoboCup Challenge

We have experience in the design of agent architectures for the simulation league, where we have used belief-desire-intention approaches. There we have developed a couple of basic skills (e.g. for kicking, dribbling, ball interception). The choice of desires and intentions is based on utility calculations, which lead to individual plans on the base of the available skills. Cooperation is performed using the known behaviors of team mates.

We already have some experience with robots where robots need to cooperate to execute a specific task. Our approach is based on CORE (COnsensus for REsponsiveness) middleware which was developed by our group for a cluster of workstations. In this project we will add an extra level of difficulty by modeling hostile faults. We also plan to use sophisticated search techniques such as Tabu Search and Simulated Annealing to develop a strategy and decide on particular moves.

Furthermore, we have some experience in hardware/software co-design and implementing low level signal processing procedures for recognition tasks both in hardware and in software.

We got some experience in implementation of effective control methods from experiments with the minirobot system KHEPERA. So we could make comparisons between decision- rules-controller and fuzzy-logic-controller. To get practical experience with the leg motion coordination we used the industrial robot RV-M1 (from Mitsubishi Electric Europe).

4 Recent developments

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 Cortex uses the Color Detection Engine to identify the objects in the image by common procedures of image-processing to find the object parameters, e.g. position, width, center-point. The control of head motions is subject of the Cortex.

The software architecture of the Brain is oriented on mental modelling of agents (BDI), which is used by AT Humboldt in the virtual RoboCup. It transforms the received data into an internal world representation ("belief"). It identifies possible options ("desire") and commits for useful plans ("intention"). The basic structure permits various refinements in the future. The Brain can ask the Cortex for certain information.

Plans computed by the Brain are transmitted to the Body and performed by the available skills. The Body controls the movement of the legs in order to turn, move, kick etc. There exists a direct information flow between Cortex and Body e.g. for keeping track of the ball. This implements some rudimentary layered architecture.

Encryption codes are used for a multi-channel point-to-point communication via microphone and speaker. It includes common methods of signal

processing like digital coding, fault tolerance coding, convolution and correlation. It is to be used for scene information and cooperative planning.

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