rUNSWift 2003

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Abstract. In domains as complex as robotics, rather than aiming for perception, we try to build systems that are less likely to fail. Robot soccer is an excellent example of a task in which robustness is much more important than clever behaviour. The rUNSWift team has tried to keep this principal in mind during its development. However, as the competition has progresses from year to year, we try to add new capabilities which add to the complexity of the system. The greatest challenge for the team is manage that complexity so that the overall behaviour of the robots improves significantly.

1 Introduction

As in past years, the core of the rUNSWift team is comprised mainly of students in their fourth year of undergraduate study in the School of Computer Science and Engineering at the University of New South Wales. This year, the team is also supported by the newly formed research centre, National ICT Australia.

2 The Team

The undergraduate team members in 2003 are:

- Ricky Chen
- Eric Chung
- Ross Edwards
- Eileen Mak
- Raymond Sheh
- Nathan Wong

The team leaders are Bernhard Hengst (UNSW/NICTA), Claude Sammut (UNSW) and Will Uther (NICTA).

3 Team organization

The organisation of the 2003 team began during Summer of 2002 (i.e. beginning in December in Australia). Nine undergraduates students were recruited to begin work on restructuring the code and developing new techniques. The students are supervised by UNSW and NICTA staff. Over the Summer some of the students began to specialise in longer term research projects related to Machine Learning and developing high-level languages for robot control. The remaining six began specialising on competition code.

Over the past four previous years of our participation in RoboCup, the code had been patched so many times that it became difficult to extend and lacked modularity. This is a particular problem since our team consists of final year undergraduate students who change each year. So each year, they must learn from scratch how to program the robots to play RoboCup. Thus, understanding the accumulated code was becoming more difficult each competition.

A large part of the initial effort, was directed towards cleaning up and rewriting past code. Although this delayed the development of new techniques, a cleaner code base has made extensions easier to implement. All the code is maintained by Subversion, a revision control system that is similar to CVS but extends it in various ways.

The 2003 code has been broken into several Aperios objects with an aim to correcting some of the problems we had last year with communication. Much of the previous code has been revised, correcting errors and improving efficiency.

4 Vision

The vision system consists of a blob formation component, which is the initial stage in object recognition. Because the camera has a relatively resolution and the images are noisy, many spurious blobs are formed. These are filtered out by heuristics that are derived from knowledge of the domain. Like any knowledge-based approach, it is important that the heuristic rules fire when they should and don't fire for the wrong cases. To assist us in debugging the heuristics, we have substantially improved our logging capabilities so that we run the vision system off-line and can test the heuristics on sample cases.

For colour classification, as in previous year, we record sample images and paint them by hand with the correct colours. These provide training data for learning algorithms that generate a colour look up table. The algorithms being used this year are Nearest Neighbour and a decision tree classifier.

One of the challenges in this year's competition is to be able to localise without the use of the coloured beacons. To do this, we have introduced an edge detection system that finds the field lines and boundaries. This method depends on knowledge of the soccer field to disambiguate line candidates.

5 Localisation and Strategy

The introduction of wireless communication between the robots in 2002 allowed us to begin experimenting with distributed sensor fusion. This has continued in 2003. Since 2000 we have used a method based on the Kalman filter. However, many of the *ad hoc* methods used int the past have been replaced by more a principled approach and extended. We have also improved the communication between the robots so that information is transmitted more reliably.

In 2002, the field was increased in size and the number of players increased from three to four. The addition of the extra player created surprising new complexities in the game. Much of our effort this year has gone into better positioning.

6 Background of Principal Investigators

Bernhard Hengst is completing his PhD in Hierarchical Reinforcement Learning at the University of New South Wales and is currently employed at the newly formed research institute, National ICT Australia (NICTA). He was a member of UNSW's championshiop team at RoboCup 2000 and was one of the supervisors for the 2001 and 2002 teams which were champions and runners up, respectively.

Claude Sammut is Professor of Computer Science and Engineering at the University of New South Wales and Head of the Artificial Intelligence Research Group. His early work in Machine Learning contributed to the foundations of the field of Inductive Logic Programming. With Donald Michie he also did fundamental research in Behavioural Cloning, i.e., learning control strategies by observing other agents. His current research interests include applications of Machine Learning to Robotics and building Conversational Agents that can be embodied in a robot.

Will Uther received his PhD from Carnegie Mellon University (CMU) in 2002. He was involved in the RoboCup legged league twice while at CMU. In the 1998 Paris RoboCup competition, Dr Uther, with his then advisor Professor Manuela Veloso, won the Demonstration Legged League competition. In the 2001 Seattle RoboCup competition, Dr Uther was a member of the CMU team that came second to University of New South Wales team in the Legged League Competition. He is continuing his research into abstraction in robot learning at NICTA and UNSW.

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