RMIT Raiders

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1 Introduction

The RMIT Raiders team is composed of three custom-made robots and one Pioneer[1] robot. The most significant feature of the custom platform is a powerful kicking device, which proved itself in the first game by kicking a goal from the centre of the field. Compared with previous competitions, our custom robots were much more reliable and the batteries lasted much longer.

The strategic component of the system is based on a commercial agent development system, JACK[2] [4]. Due to the difficulties of testing with physical robots, we developed a simulator for testing and debugging of plans.

We kept our existing vision mechanism but made some improvements in terms of robustness of recognition under varying lighting and improved distance estimation.

Our competition results were: 1-0, 0-1, 0-3, 0-6, 1-2.

2 Team Development

Team Leader: Lin Padgham, Associate Professor
Team Members:

- Daniel Bradby, Undergraduate student, did attend competition
- James Brusey, Graduate student, did attend competition
- Andrew Jennings, Professor, did attend competition
- Mark Makies, Design and Development Engineer, did attend competition
- Chris Keen, Senior Technical Officer, did not attend competition
- Anthony Kendall, Honours student, did not attend competition
- Dhirendra Singh, Undergraduate student, did attend competition

Web page: http://www.robocup.rmit.edu.au

* Lin Padgham is currently on secondment to CSIRO, though still fully involved in the RMIT RoboCup project.
1 Pioneer robots are produced by ActivMedia Inc., http://www.activrobots.com
2 JACK is a java based agent programming system developed by Agent Oriented Software, http://www.agent-software.com.au

M. Veloso, E. Pagello, and H. Kitano (Eds.): RoboCup-99, LNAI 1856, pp. 741–744, 2000.

3 Robots

We use two types of robot bases: a Pioneer Model 1 for the goalie, and a custom-made robot (called a Socbot) for the three other players. All robots use the same vision sensor, a Logitech QuickCam VC camera, and all have wheel encoder based odometry [1, 2]. The Socbots also have an electronic compass. The Socbots have a special kicker described below, while the Pioneer uses a less powerful, solenoid actuated kicker. We use Pentium II laptops for the majority of the computation, including vision processing. Each robot has a Lucent WaveLAN PCMCIA card for communication with other robots. Figure 1 summarizes the system architecture.

The Socbot uses two 6W MAXON motors controlled by a PID (Proportional Integral Derivative) controller. The controller makes use of wheel encoders that give 1800 counts per wheel revolution. It runs on a Motorola M68HC11 microprocessor and makes use of a Xilinx XC3090 Field Programmable Gate Array for some functions.

The Socbot's kicking device is spring loaded (using a bungee cord). It is wound up using a worm drive motor, and then held in a loaded position by a custom-made clutch. The clutch is released by a solenoid. A microswitch is used as a trigger to ensure that the kicker is not fired until the ball is close to the optimum position. The kicker is quite powerful. In testing we found that, at full setting, it could kick the ball over 20 metres, and then take only about 5 seconds before being ready to kick again.

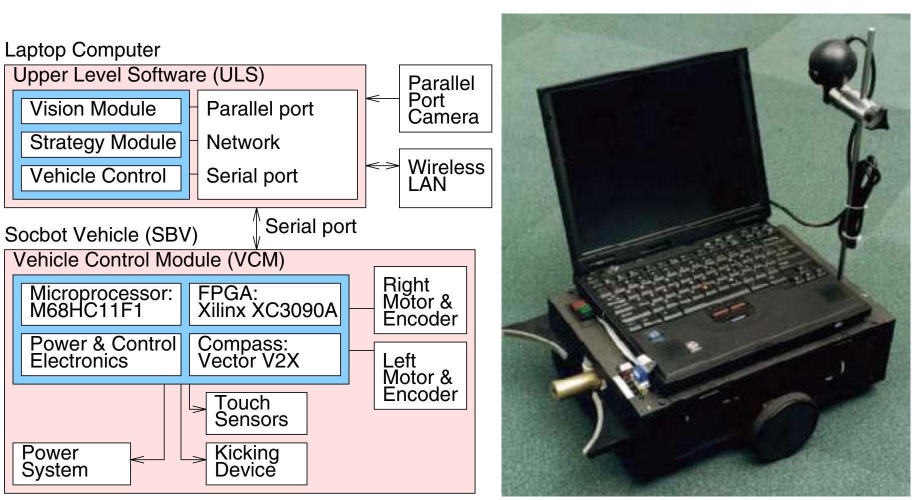

Fig. 1. Architecture of soccer robot and a picture of the Socbot. For the goalie, a Pioneer substitutes for the Socbot but uses the same software

4 Perception

The robots attempt to perceive the ball position, the position of other robots, and the position of the walls, through the vision system. Also, some information is broadcast to other robots to assist them building a world model.

The vision system is based on an inexpensive, parallel port camera: Logitech's QuickCam VC. The vision system outputs distance and angle information for each object that it finds. Although we had used the QuickCam in the previous tournament, we made some significant improvements in colour recognition using techniques described elsewhere [3]. Also, we changed from using the size of the image segment as the determinant of distance and used the vertical angle to the base of the object instead. We still check the size of the image segment, however, to see if it roughly matches the distance obtained from the vertical angle.

We use information about wall segments, together with information from the compass, in order to correct for errors in odometry.

5 World Model

We used an allocentric (i.e. non-egocentric) view of the field, so that objects were represented in terms of field coordinates rather than relative to the robot. The robots keep information about own position and heading, the ball position and velocity, and other robots' position and velocity. Own position and heading is determined through wheel encoders with correction from the compass and wall sightings. The vision gives relative position to other objects and this is translated into an absolute position. The world model is updated from this using a simplified Kalman filtering approach.

In addition, there are interpreted state variables, such as flags for whether the robot is lined up for a shot at goal.

6 Communication

The robots communicate via a radio ethernet LAN using multi-cast packets. All robots transmit where they think they are and where they think the ball is. This information is sent from each robot about ten times per second. We noticed that the communication was specifically helpful to the goalie in tracking the ball when the ball was far away, however we had some problems with wrong information being transmitted back and forth between robots.

7 Skills

To get to the ball, our robots used a series of waypoints to avoid bumping into the ball when trying to get to the other side of it. Due to the explicit modeling of the ball in the world model, they were able to do this without seeing the ball for much of the manœuver. When the ball is close to the front of the robot, the kicking mechanism is "armed", which means that the kicker will fire automatically when a microswitch triggers on the front of the robot. If the kicker doesn't fire for some reason, we will still try to dribble the ball by constantly trying to move towards it, as long as it is still roughly in line with the goal.

The goalie robot has special code for blocking the goal. Since our goalie is quite slow, we use some of the prediction mechanism available from the world model to try to predict the path of the ball.

8 Strategy

The robot's basic strategy is straightforward: Find the ball by spinning; line up the ball and the goal; approach the ball and kick it. While doing all of this, it avoids collision with other robots and uses a modified approach for when the ball is near the wall. Much of the sophistication of the software is in building a model of the field.

9 Conclusions

Although the game scores do not reveal it, we believe that the team has greatly improved over previous years and is beginning to look competitive. Our main failing was to rely heavily on the compass, which behaved unpredictably in the electromagnetically noisy environment. The robots turned out to be slower than expected, largely due to the software limitation of only being able to turn when stopped. The defence was poor mainly because no defensive plans had been written. Our kicker worked excellently however, and in general the systems were robust and reliable.

Next year's competition will be held in Melbourne, Australia and so we want to field a much more competitive team. The main areas that we will attempt to improve are the vision system, where we plan to use a digital signal processor (DSP) to perform much of the computation, and the strategy component, which will be rewritten to make more use of the JACK agent architecture. Part of this rewrite will include improvements in cooperation.

References

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4. P. Busetta, R. Rönnquist, A. Hodgson, and A. Lucas. JACK intelligent agents – components for intelligent agents in Java. *AgentLink Newsletter*, January 1999.