OWARI-BITO

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1 Introduction

OWARI-BITO team consists of 5 small robots, each of which is sized in 10 cm wide, 10 cm deep and 17 cm high (except an antenna). The purposes of the research project are the study on the cooperation among robots, the advanced local vision system and the robust communication environment, in addition to be able to win the game.

The competition results in RoboCup 99 was 0 - 3 in the round robin group C.

2 Team Development

Team Leader: Tomoichi Takahashi
Team Members: Team members are listed in the above title field.
Web page http://kiyosu.isc.chubu.ac.jp/robocup

3 Hardware

3.1 Robot

The features of robot hardware are the followings.

– Two processors are in the robot, named a main processor and a vision processor, respectively. The main processor controls the robot and communicates with the host computer. The vision processor processes the images captured

M. Veloso, E. Pagello, and H. Kitano (Eds.): RoboCup-99, LNAI 1856, pp. 675–678, 2000.

by the camera on robot. These processors are connected through the parallel ports.
- Two motors drive the robot. Each motor is a DC brush motor with an encoder.
- There are twelve proximity sensors and two acceleration sensors. The proximity sensors are composed of an infrared LED and a photo diode. Sensing range is about 20 cm. Each robot has four sensors both in front and back side, and two both in left and right side. The acceleration sensors measure the accelerations in x-direction and y-direction.
- A radio system uses a spectrum spread method with 2.4 GHz band that is in accordance with the RCR STD-33A. The maximal communication speed is 38.4 kbps, however, we use 19.2 kbps communication for ensuring the reliability. Our radio system has four communication modes. We use one (host) to many (robots) packet communication mode.
- The video capturing hardware can capture 30 images (size 323×267 pixels/image) per second in maximum.

3.2 Host system

A host processor is a typical AT-compatible computer. The host processor computes the team strategy and processes the images captured by the global vision camera set at the ceiling. A radio communication system is connected to the processor through a serial line. The operating system for this processor is the LINUX.

4 Sensing

We employ a global vision system and a local vision system. The global vision system, which is implemented on the host processor, senses the field and calculates the positions of the current robots and ball. The local vision system, which is implemented on each robot, is employed to track the ball. These vision systems work exclusively. The timing that the local vision system is invoked is determined by the strategy process. In this section, we describe a summary of the global vision process. (See section 8 for local vision system.)

Initial positions of robots and ball are given by human. Once they are given, the global vision sistem tracks these positions as follows.

- The world image (size:640×480pixels) is captured.
- A local window (size: 71×71 pixels) is extracted for each robot and ball. Its position is determined by the previous image of the center positions of robots and ball.
- A new position of robot is determined in the local window. If it misses, the whole image has to be searched.

The position data are sent to the strategy process.

5 Communication

In the packet communication mode, each radio system has its own identification number(ID). We use the master-slave communication, where the host is a master and the robot is a slave. The host establishes the connection line to a robot by designating the ID of the robot. The broadcasting communication is also available, using special ID.

To reduce the communication overhead, five move-commands (one for each robot) are put together into one packet and broadcasted to all the robots. Each robot gets the packet and extracts his own command. When the robot gets his move-command, current executing move-command is canceled. Approximately, a half of the total communication time is reduced, compared with the case of one packet for each command.

A host processor makes an above packet and sends it to all robots at the time when the strategy process have determined the motion of each robot. In our system, this communication is able to occur 15 times per second.

6 Skills

All actions of the robots are planned by the predicted future ball position which is calculated from the current ball position, moving direction and speed. If none of our robots keep the ball, two robots which are close to the ball move to the place where is the ball to get it. In the attacking circumstance, attacking robots move to the place where they can kick to the opponent goal. In the defending circumstance, defending robots move to the position between the ball and our goal to disturb the shoot of the opponent robot. To kick the ball, the robot moves along the shortest path between the ball and the robot itself. We don't have special dribble skill now. When the dribble is necessary, the robot repeats a small kick.

7 Strategy

A strategy of OWARI-BITO is based on the simplified strategy of human soccer. Distinctive features are the following three points.

- Each robot is having a basic role such as Forward or Midfielder. However, it flexibly changes its role depending on the game situation.
- When our team is not having a ball, two robots which are close to the ball approach to the ball and try to get it. We call this action "Press".
- When our robot attacks the opponent goal, if the opponent robots surround it, it tries to put the ball out to the open space. It makes the other attackers to have the chance of free shoot.

The basic role of the five robots are a Forward (FW), two Midfielders (MF), a Defender (DF) and a Goalkeeper (GK). All robots other than GK can change their role dynamically in the game. For example, if three of our robots (other than GK) are in our side, two robots close to the ball change into MFs and try to press. The remaining robot changes into DF and defends the goal. The role of the robot is determined by the present position, not by the present role.

The basic strategy is as follows,

Attacking: FW and two MFs attend to the attack. DF and GK remain in our side to defend the opponent's counter attack. In the opponent side,if MF keeps the ball, it kicks the ball to the opponent goal direction. FW moves in front of the opponent goal and catches the ball which the MF passes. If FW can keep the ball, it shoots immediately. If all three attacking robots move to the ball, tere will be jammed. To avoid the jam, at least one attacking robot stands in an open space, away from the ball. The robots, in the jam area, try to pass the ball to the robot, in the open space. The robot, in the open space, tries the passing action, if it catches the ball.

Defending: Two MFs, DF and GK attempt the defense, and only FW remains in the opponent side to make counter attack. In the defense area, two MFs press the ball. DF moves to the place to disturb the opponent shooting.

8 Special Team Features

There are two kinds of local vision systems, a normal-vision and an omni-vision. The goal keeper robot and one of midfielder robots have the omni-vision systems and remaining robots have the normal vision systems. Each robot has the world model of the field. If he finds the ball but does not find the goal in his eye, he pushes the ball to the goal using the world model. In case of finding both the ball and the goal, he pushes the ball using real model. (Obstacle avoidance algorithm is not implemented yet.)

9 Conclusion

Main issues for future work are the followings.

- It is necessary to compensate the positional error caused by the slip. For example, a compensation using the acceleration sensors, or a compensation using a GPS-like positioning system should be considered.
- In a local vision mode, as the landmark such as goals and field corners are often occluded by the other robots, it may happen not to detect the landmark correctly. A robust algorithm to overcome such a case should be developed.
- To elaborate the strategy, a precise simulator of the robot motion should be developed.