RoboDragons 2007 Team Description

Ryota Nakanishi, Kazutoki Otake, Ryota Narita, Motomu Tanaka, Shigehiro Ueno, Hiroki Achiwa, Junya Maeno, Kazuhito Murakami and Tadashi Naruse
Aichi Prefectural University, Nagakute-cho, Aichi, 480-1198 JAPAN

Abstract. In this paper, we describe the key features of our team, mainly the followings: (1) cooperative 3-robot passing and shooting, (2) camera layout system, and (3) high precision ball extraction method. The main feature of our system is the implementation of the cooperative play.

1 Introduction

RoboDragons team takes part for sixth time in the RoboCup Small Size League competition. This year, we introduce a new camera layout based on the risk criterion. We also introduce a robust ball extraction technique, i.e. a technique that can extract the ball even if it is partially occluded. Moreover, we try a cooperative 3 robot passing and shooting again.

2 Team Members

Team Leader:

- Ryota Nakanishi(cooperative control)

Team Members:

- Kazutoki Otake(vision and mechanics)
- Motomu Tanaka(system design)
- Ryota Narita(vision)
- Shigehiro Ueno(Kalman filtering application)
- Hiroki Achiwa(vision)
- Junya Maeno(strategy and tactics)
- Kazuhito Murakami(supervisor)
- Tadashi Naruse(supervisor)

3 Overview of the RoboDragons system

In this section, we describe the overview of our robots and software system.
3.1 Robots

Figure 1 shows a configuration of the RoboDragons robot platform. The features of the robots are shown below.

− Each robot has four omni-wheels that allow it to move in any direction.
− Each robot has a kicking device and a dribbling device. The kicking device is driven by a solenoid.
− For each robot, one Hitachi SH2 processor is employed as a control processor which operates at 24MHz.

![Fig. 1. RoboDragons robot; with external cover and with internal structure exposed](image)

3.2 Software system

Figure 2 shows the overview of the RoboDragons system. The features of the system are as follows:

1. Host computer is Athlon64 X2 4200+ with 512MB memory and Debian GNU/Linux OS.
2. Two or more SONY DXC-9000s cameras are used. Each camera grabs an image of size $640 \times 240$ pixels in every $1 / 60$ seconds.
3. Each module (shown in box) in Fig. 2 is implemented as a thread.
4. Two or more image processing modules process the grabbed images from multiple cameras to produce the locations of the robots and a ball. They are integrated by the coords integrator module.
5. The soccer module consists of a strategy, a tactics and a path generation submodules, and it produces an action command for each robot.
6. Finally, radio module sends the command to each robot through the radio system.
4 Camera layout system

In this section, we explain the camera layout system.

The camera layout in our system is decided by using the risk criterion. Here, the risk means how high the ball is occluded by the robot. (The global vision system loses a ball if the robot moves closer to or some robots close up the ball.) It depends on where the cameras are set and where the robot is.

The system calculates the area $S_{C}(X, Y, Z, x, y)$, the occluded area by the robot, where the camera is set at the position $(X, Y, Z)$ and the robot is put on the position $(x, y)$. Since the robot moves on the field according to the given strategy, we have to consider the weighting function that shows how often the robot stand on the position $(x, y)$ on the field. We give it by the probability density function $p_{R}(x, y)$. Then the system computes the risk function $E(X, Y, Z)$, which is a function of $S_{C}(X, Y, Z, x, y)$ and $p_{R}(x, y)$.

$$E(X, Y, Z) = \int g(p_{R}(x, y), S_{C}(X, Y, Z, x, y))dxdy$$

Optimal camera position is given by the position $(X_{min}, Y_{min}, Z_{min})$ which minimizes the function $E(X, Y, Z)$. (In case of multiple cameras, $E$ is a function of the cameras positions.) Figure 3 shows the examples of camera layout for 5 and 7 cameras.

5 High precision ball extraction

Our vision system has a high precision method which extracts partially occluded ball base on the statistical features of the pixels area of the color marker and
Fig. 3. Examples of cameras layout

its neighborhoods. More specifically, input image is labeled by using color information, then each small candidate region of the ball, if there exist, is classified into a partially occluded ball (shown in figure 4 (a)) or a noise (shown in figure 4 (b)) by using HLAC and SVM.

Fig. 4. Examples of orange objects

6 Cooperative play

The main tactics of our team is a cooperation between robots. A primary form of the cooperation is what we call a **direct play** (Fig. 5(a)) [3], i.e. the robot A kicks a ball toward the robot B, and then the robot B directly kicks the ball toward the goal without holding or dribbling when the ball arrives in front of the robot B.

The direct play makes it possible to achieve continuous passing among teammate robots without stopping the ball’s motion. This makes the opponent robot difficult to intercept the ball and defend the goal from shooting. Moreover, in a real game, since the opponent robots are likely to move in the direction of preventing the teammate robot holding the ball from shooting on the goal, the second teammate robot (receiving robot) can get the ball from the first robot and achieve the goal relatively easily.

Another cooperation is a **1-2-3 shoot** (Fig. 5(b)) [3], which we define as a play where three robots (A, B, C) cooperate, i.e. the robot A which is holding a
ball kicks it toward the robot B, and the robot B kicks it toward the robot C by a direct play and finally robot C shoots on the goal. This play makes it possible to achieve a goal with high probability, since the fast handling of the ball makes it difficult for the opponent robots to follow the ball.

References