Fusion

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Abstract. This paper introduces team "Fusion" and its soccer robots for RoboCup-2001. The team is organized by Kyushu University, Fukuoka University, Hitachi Information & Control Systems Inc.. considering technical requirements of RoboCup F2000 league. The soccer robots have been originally designed and made for the league. It is first attempt to join RoboCup for the robots and the team.

1 Introduction

Team "Fusion" is organized by Kyushu University, Fukuoka University, Hitachi Information & Control Systems, Inc. [1], and it is named intending unification of multiple technical fields and people of each organizations. The RoboCup is a standard problem for robotics and artificial intelligence and it needs overall technical abilities for various fields. That's also a challenging research theme. Therefore we decided to participate in RoboCup, especially F2000 league [2], because the league involves most extensive technical problems such as mechanism of mobile robot, image processing, cooperative motion control, etc.

By participating RoboCup, we mainly study a problem of "Optimal Planning in Dynamic Environment". This research topic contains important problems for intelligent mobile robots such as motion planning and control, collision avoidance of dynamical or static obstacles, and self-localization to apply the robots for every day environment. This paper describes a hardware and software architecture of developed intelligent mobile robots to study the research topic and to join RoboCup F2000 league.

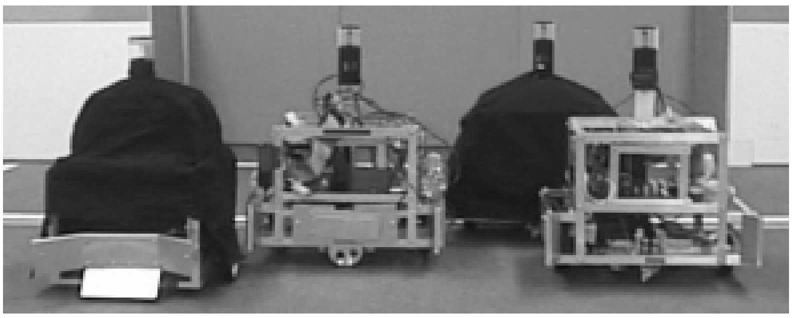

Fig. 1. Our Robots

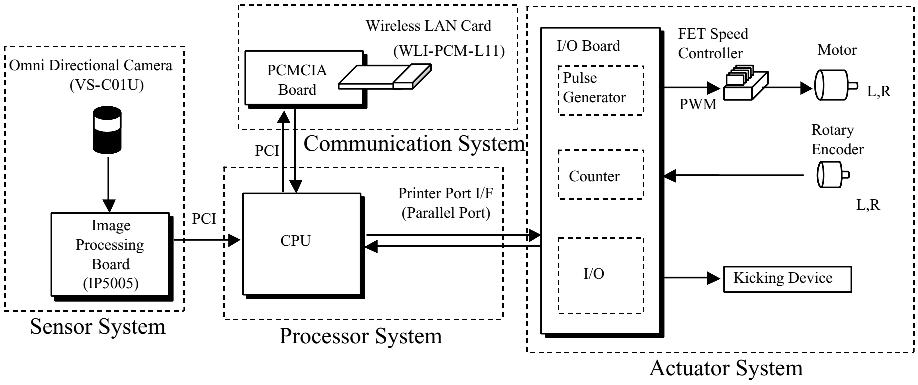

Fig. 2. Hardware architecture

2 Hardware Architecture

We have newly developed soccer robots for RoboCup F2000 league. The robots are shown in Fig.1, one is goal keeper robot (second robot from the left one in the figure) and the others are field player robots. For quick motion, the robots are made with powered wheel type (two independently driven wheels type), and are made with light weight as much as possible. (See bellow specification.) Each robot has an omni-directional camera system, a kicking device and a communication system. The overall hardware architecture of the robot is shown in Fig.2. To reduce the cost of the robot, an I/O card including pulse generator for motor amplifier, counter for encoder, parallel interface (8255 PPI) is originally developed. The I/O card is connected with CPU board by printer port.

- Dimension: 30cm×40cm×50cm
- Weight: 8 kg
- Maximum Speed: 2 m/s

2.1 Processing System

Considering extension of function such as sensors and actuators, we select a standard industrial CPU board with K6-2 300MHz or celeron 700MHz processor and 128Mbyte RAM as a robot controller having 5 PCI slots. The standard short-size PCI back plane unit containing the CPU board and other interface boards makes the control module compact and light.

2.2 Sensor System

Sensor system, especially a vision system is a significant element for intelligent mobile robots. For wide scope sensing, we use an omni-directional camera system. The omni-directional camera is composed of a CCD camera and a hyperboloidal omni-directional mirror, in which the camera optical axis is in line with the vertical axis of the mirror. This camera system is used for self-localization and recognition of ball, goal and other robots. For the recognition, we use IP5005

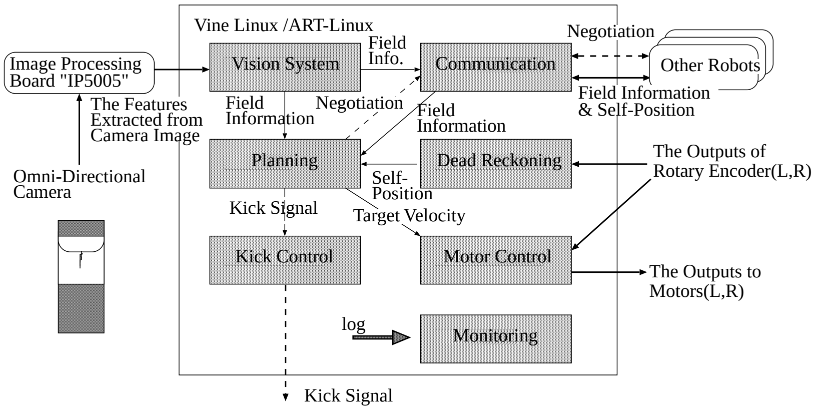

Fig. 3. Software architecture

(Hitachi) as an image processing board. This board has features of fast transaction speed and versatile image processing ability. All of our robots have this vision system.

2.3 Actuator System

In our robot, two wheels are independently driven by two DC motors with reduction gears. The DC motors are controlled by an originally designed I/O board and FET speed controller which is for R/C car (Keyence A-07RZ). The robot has a kicking device which is consists of an air cylinder, an electro-magnetic valve, and an air tank. This enables powerful action of shooting and passing.

2.4 Communication System

Communication among field-player robots is important for cooperation movement such as passing, post-playing and positioning. To communicate with other robots, all robots of our team are equipped with wireless LAN cards.

3 Software Architecture

Software architecture of our robots is illustrated in Fig.3. It is composed of 6 basic tasks running in parallel. We use ART-Linux which is an extension of Linux as a real-time OS, developed by Youichi Ishiwata at ETL[3]. Our robots recognize situations (ball and other robots) by vision system and local sensors installed on the robot, and then communicate with other robots about the information. Each robot determines its action according to the information of the field, and negotiate with other robots. During the game, the robot memorizes the data of self-position, the position of the ball, the positions of other robots, the output to I/O board and communication. After the game, we analyze these data for optimal motion planning of the robot.

3.1 Image processing

Each robot is equipped with an omni-directional camera. The vision task extracts colors of the ball, other robots, and the goals in the image from the camera by a simple image processing in real time. Then the task calculates the robot's self-position, the location of the ball, and the location of other robots from the location of the extracted colors in the image. If it is difficult to estimate the robot's self-position with the vision system by the influence of the error of image processing, the robot estimates its self-position with dead reckoning.

3.2 Communication

Our robots share the information of the field by using communication: i.e., each location of the robots on their side, the location of the ball, and the location of the opponent robots. Each robot can use the information which may be difficult to get by local sensors of the robot. In addition, our robots may negotiate each other to achieve more appropriate positioning or passing.

3.3 Planning

Using the most reliable information from all information of the field, the robot decide one action based on if-then rules and negotiation with other robots. The actions are "move to position", "move to ball", "dribble", "pass", and "shoot". Each robot has different if-then rules corresponding to its role: i.e., goal keeper, center forward, left wing, and right wing. For example, if a robot is in the neighborhood of the ball, it will move to the ball in order to keep or clear the ball. Simultaneously, the other robots will move to the appropriate position to support the robot.

4 Conclusions

In this paper, the team "Fusion" and the architecture of our robots was introduced. We have developed original robots and studied a motion planning problem based on reliable information of the field and negotiations with other robots. Key feature of our robot is lightweight which enables quick motion and low damage when collision. By participating in this RoboCup, we want to evolve our research on intelligent mobile robots.

References

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   http://www.robocup.org/
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