The RoboCup-NAIST

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1 Introduction

Through robotic soccer issue, we focus on **"perception"** and **"situation and behavior"** problem among RoboCup physical agent challenges [1]. So far, we have implemented some behaviors for playing soccer by combining four primitve processes (motor control, camera control, vision, and behavior generation processes)[2]. Such behaviors were not sophisticated very much because they were fully implemented by the human programmer. In order to improve the performance of such behaviors, we have applied a kind of learning algorithm during off/on-line skill development phase. For example, to acquire purposive behavior for a goalie, we have developed a robot learning method based on system identification approach. We also have developed the vision system with on-line visual learning function [3]. This vision system can adapt to the change of lighting condition in realtime.

This year, we constructed a new robot equipped with an omnidirectional camera in addition to an active vision system so as to enlarge view of our soccer robot. Using this omnidirectional camera, our robot could estimate its location in the soccer field. However, such result is not used for accomplishing cooperative tasks between robots.

In the RoboCup00 competition, our team had 7 games in roundrobin. We won 2 games and lost 5 games. Finally, our team could not reach the quaterfinals.

2 Team Development

Team Leader: Takayuki Nakamura
Team Members:

- Hideaki Takeda, Aossicate Professor, who attended the RoboCup since 1998.
- Kazunori Terada, Ph.D candidate student, who attended it since 1998.
- Masamichi Oohara, Master course student, who attended it for the first time.
- Tetsuya Yamamoto, Master course student, who attended it for the first time.
- Masanori Takeda, Master course student, who attended it for the first time.

Web page http://robotics.aist-nara.ac.jp

P. Stone, T. Balch, and G. Kraetzschmar (Eds.): RoboCup 2000, LNAI 2019, pp. 591-594, 2001.

3 Robots

We have developed a compact multi-sensor based mobile robot for robotic soccer as shown in **Fig.**1. As a controller of the robot, we have chosen to use a Libretto 100 (Toshiba) which is small and light-weight PC. We utilize a wireless LAN PC card (WaveLAN(AT&T)) for communication on our soccer robot.

Motor control system

A motor control system is used for driving two DC motors and is actually an interface board between a portable PC and motors on the chassis of our soccer robot. This control board is plugged into a parallel port on the portable PC. The motor speed is controlled by PWM. To generate PWM pulses, we use a PIC16C87 microcontroller. The motor control command is actually 8 bits binary commands for one motor. This board can receive control commands from the portable PC and generate PWM signals to right and left motors.

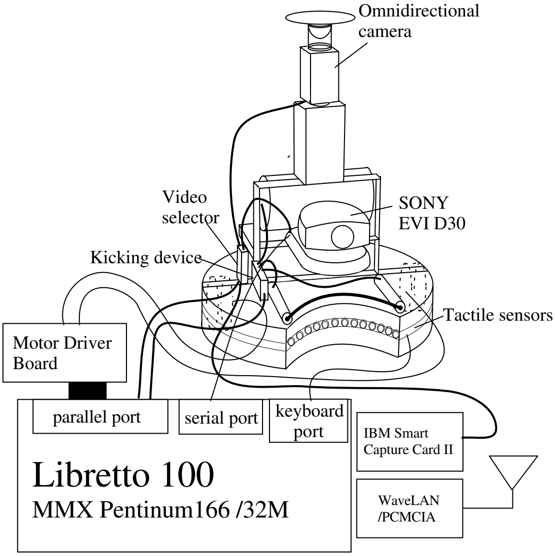


Fig. 1. Our soccer robot.

Kicking device control system

Our kicking device consists of an air tank, an air cylinder and a solenoid valve. We make an interface board between a portable PC and a relay for controlling this solenoid valve. The control command is actually 1 bit binary command. This control board is also plugged into a parallel port on the portable PC.

4 Perception

Tactile sensing system

We constructed a cheap tactile sensing system [2] by remodeling a keyboard which is usually used as an input device for PC. A keyboard consists of a set of tactile sensors each of which is a ON/OFF switch called a key. If a key is pressed, the switch is ON. If not, the switch is OFF. By using these sensors which are set around the body of soccer robot, a tactile sensing system can detect contact with the other objects such as a ball, teammates, opponents and a wall.

Visual sensing system

We use an active vision system and an omnidirectional camera system. As an active vision system, we have chosen a color CCD camera (SONY EVI D30, hereafter EVI-D30) which has a motorized pan-tilt unit. An omnidirectional camera system consists of a hyperbolic mirror and a color CCD camera of which optical axis is aligned with the vertical axis of the mirror. In order to capture two images from both vision systems by one video capture PCMCIA cards (IBM Smart Capture Card II, hereafter SCCII), we make an video selector device which can be controlled through the parallel port from a portable PC.

Vision Module

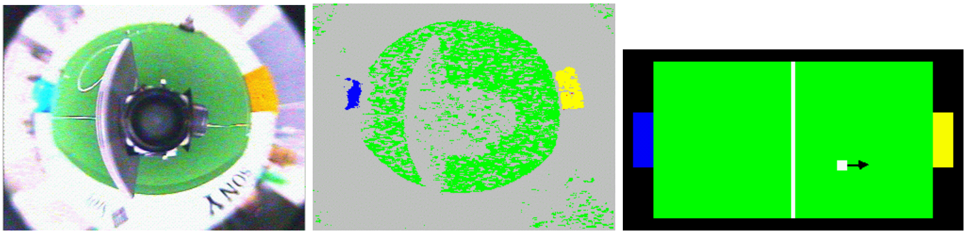
The vision module provides some information about the ball, goal and teammates in the image. The teammate is recognized by a colored marker on each robot. The vision module provides the area of the targets(ball, goal and a colored marker), the coordinates of their center and the both maximum and minimum horizontal coordinates of the goal and so on.

In the omnidirectional image (hereafter, ODI), the vision module also provides observed directions of the targets. Based on such observed direction of the targets (goals) whose location is known in advance, the vision module also estimates the location of the robot in the soccer field.

5 World Model

In order to control our hardware systems, we use a shared memory and 5 software components which are the motor controller, camera controller, tactile sensor module, vision module and behavior generator. All software components read and write the same shared memory in order to acquire and give the states of our hardware systems. Using this shared memory, they can communicates each other asynchronously. For example, the behavior generator takes the state of camera, vision, tactile and motor in the shared memory as input vectors. Then, it combines these information with programmer's knowledge and decides the robot's action at next time step. Finally, it writes the motor command for the motor controller on the shared memory.

Using the ODI and prior knowledges of the landmarks, our robot can estimate its location and orientation. **Fig.2** (a), (b) and (c) shows the input ODI, the processed ODI and the result of self-localization, respectively. In this case, own and opponent goals are treated as two landmarks. The distance between these two goals are known in advance. In **Fig.2** (c), a white rectangle and a black arrow shows the robot's position and its orientation, respectively. As shown in this figure, the result of self-localization is almost correct. In this experiment, the average error of positions and orientations is $(\bar{\Delta X}, \bar{\Delta Y}, \bar{\Delta\theta}) = (174(mm), 208(mm), 4(°))$, where $(\bar{\Delta X}, \bar{\Delta Y})$ and $\bar{\Delta\theta}$ shows the average error of estimated positions and orientation with respect to 21 locations. In our current system, it takes 66 ms to do this processing for one frame. Due to this long processing time, our robot do not estimate its location and orientation in the competition.



(a) Input ODI (b) Processed image (c) Result of self-localization

Fig. 2. Experimental result

6 Communication

There is no communication between our robots in the competition.

7 Strategy

The behavior generator decides the robot's behavior such as avoiding a wall (called avoiding behavior), shooting a ball into a goal (called shooting behavior) and defending own goal (called goalie behavior). We make a simple strategy for shooting the ball into the goal. To shoot the ball to the goal, it is important that the robot can see both ball and goal. Therefore, the robot must round the ball until the robot can see both ball and goal with the camera toward the ball. Finally, the robot kicks the ball strongly. Avoiding behavior is implemented in a reflex way based on the tactile information.

For preventing a ball from entering a goal, our goalie moves left/right with the center of robot body toward a ball, when a ball is approaching to our goal. The home position of the goalie is the center of a line close to our goal. The goalie only moves along that line.

8 Conclusion

An accurate localization method is a key technology for successful accomplishment of tasks in cooperative way. Next year, we will develop a method for estimating position and orientation of multiple robots using multiple ODIs based on geometrical constraints.

References

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