RoboDragons 2011 Team Description

Taro Inagaki, Hajime Sawaguchi, Akeru Ishikawa, Kotaro Yasui, Tomomi Yasui, Yuji Nunome, Kazuhito Murakami and Tadashi Naruse

Aichi Prefectural University, Nagakute-cho, Aichi, 480-1198 JAPAN

Abstract. This paper describes a system configuration of RoboDragons, which is a team of Aichi-Prefectural University in Japan. Our hardware architecture has changed since last year. The use of components is almost the same as before, but this change helps to improve its performance greatly. Then from last year, our vision system has also changed to ssl-vision, so we want to show how our software relates to ssl-vision.

1 Introduction

In the team description paper (TDP) of RoboDragons2011, we want to describe how our hardware architecture consists and works in the game, and how our software relates to ssl-vision.

For the hardware, our current robots are the fifth generation ones in our Labs. Our teams have six robots at total, five for competitions and one for a reserve. Each robot mainly consists of control unit, voltage booster, motors and wheels, dribbling device, IR sensors, kicking devices, and communication device.

For the software, the base of our system is originated from the one at the time when we made a joint team with CMU in 2004 and 2005. Since 2005, many functions are added and improvements are accomplished. Then, last year, the vision system has changed to ssl-vision. Therefore, in order to run our system, a interface between ssl-vision and our system needs to be revised.

In the following sections, we describe more details about them.

Fig. 1. Our current robot

2 Hardware Architecture

In this section, we discuss a description of current robot in detail. The features of our robot are shown as below.

– a cylinder with dimensions of 145 mm height and 178 mm diameter
– the maximum percentage of ball coverage : about 18%   (Fig.2 at left)

Fig. 2. Current Robot
(Left: with cover and ball, Right: without cover)

To protect the internal circuit boards and mechanical devices, each robot is covered by a black cardboard (Fig.2 at left). To reinforce a strength of the robot, the cardboard we use is 1.5 mm thick plastic seet. Then in order to protect from entering trash at the back of our robot, there is no free space to expose the robot's parts at the back(Fig.3)
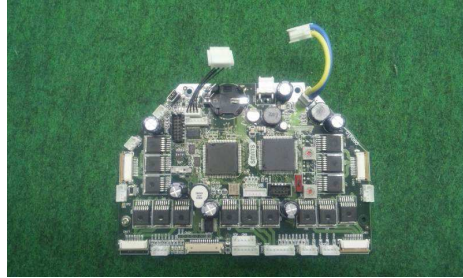

Fig. 3. Robot at Back   **Fig. 4.** 4-Cell Battery(example)

For a battery, we use a rechargeable 4-cell Lithium Polymer(Fig.4).

2.1 Control Unit

A control unit is a board computer, which is used to control the parts in a robot. It is mainly composed of CPU, memories, and IO boards.

- CPU : Hitachi's SH2A processor with FPGA

- Memories : Flash ROM(1MB) and SRAM(1MB)

Fig. 5. Control Unit

IO boards have power transistors which can drive motors. They also have interface circuits with the motors driving wheels and dribble roller, and IR sensor.

2.2 Voltage Booster

A voltage booster is used to increase the voltage in order to strengthen a power of kick devices(Kick Bar in Section2.7, Chip Kick Bar in Section2.8).

- a kind of DC-DC converter

- $15\ V$ DC $\longrightarrow 150\ V \sim 200\ V$ DC

- output voltage is adjustable

Fig. 6. Voltage Booster

The chopper circuit using a choke coil is a heart of the voltage booster. A PIC controls the chopper circuit. Large capacity condensers are used for keeping the high voltage output. Total capacity is $4500\ \mu F$. The voltage sensing circuit controls the output voltage. 2 solid state relays are used as the switches to drive the solenoids. These relays are controlled exclusively by the PIC. The charging time of the condensers is about $2\ sec$ when the output voltage is $200\ V$.

2.3 Motor

A DC brush-less motor is used to drive the omni-wheel. The description of the motor is shown as below.

– Maxon's "EC 45 flat 30 W"
– encoder unit is attached to control
– source voltage is 15 V

The motor has a pinion gear with 21 teeth and the omni-wheel has a gear with 64 teeth, so the reduction ratio is $21 : 64 = 1 : 3.047$.

Fig. 7. Current Robot
(Left: with cover and ball, Right: without cover)

2.4 Omni-Wheel

A omni-wheel is a large wheel, which consists of 15 small tires in circumference. Each robot has 4 omni-wheels to move the field, and each wheel is driven by a DC brush-less motor shown at the above section.

– a omni-wheel has 15 small tires in circumference
– a diameter of the omni-wheel is 56 mm
– a diameter of the small tire is 13 mm

Fig. 8. omni-wheel

2.5 Dribble Device

A dribble device gives a backspin and is used to keep a ball. It consists of a dribble roller, a motor with an encoder, and a planetary gear.

- Dimensions of the dribble roller : 20mm in diameter and 73mm in length
- The dribble roller is made of a alminum shaft with silicon rubber
- The motor is Maxon's "EC 16 15W"
- The reduction ratio of the gear is 1 : 5.4

Fig. 9. Dribbling Device

2.6 IR sensor

The IR sensor is used to detect a ball and attaches above the dribbling device.

- It consists of three infra-red light emission diode(LED) and photo diode pairs
- The irradiation angle of the LED : about 15 degree

When one of the three photo diodes gets the reflected infra-red ray more than a preset threshold value, the sensor outputs the signal.

Fig. 10. IR Sensor

2.7   Kick Bar

A kick bar is used to kick a ball straight forward, which is a direction perpendicular to the kick bar.

– The kick can be made for an accuracy of 5 degree
– The kicking speed can be 9.5 $msec$ under the ideal conditions.
– The kick bar is made of a large solenoids and 7075 aluminum alloy

A large solenoid is made by a coil winding the 0.6 mm^ϕ enameled wire on a bakelite cylinder in 7 layers.

– The dimensions of the cylinder : 13 mm in inner diameter, 26 mm in outer diameter, and 55 mm in length

– The stoke is 30 mm

A 7075 aluminum alloy, which is light and hard, is employed for the kick bar. Moreover, V-shaped ABS plastic is attached to the aluminum kick bar.

2.8   Chip Kick Bar

A chip kick bar is used to kick upward, which is flying over an opponent robot.
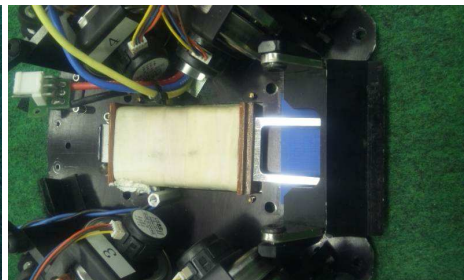
– A kick can fly a ball with a 2 m distance and 1 m height

A small solenoid is made from the same material with the large one.

– The dimension of the cylinder : 13 mm in inner diameter, 26 mm in outer diameter, and 27 mm in length.
– The stroke is 7 mm
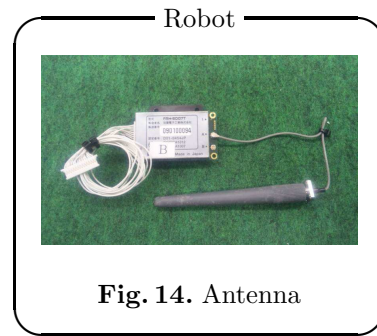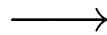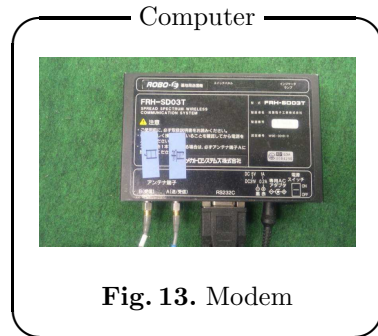

Fig. 11. Kick Bar   **Fig. 12.** Chip Kick Bar

2.9 Communication Device

A communication device is used to send a command to a robot from a computer.

Our wireless communication can be made by using a modem from the computer(Fig.13) and an antenna from the robot(Fig.14).


Fig. 13. Modem

Fig. 14. Antenna

We use a spectrum diffusion communication on the 2.4 GHz band.

– Modem name : "FRH-SD07T"
– Maker of the modem : Futaba

The modem has several communication modes. We use a "direct mode" which can send the messages with the least delay between modems. A pair of the FRH-SD03T and the FRH-SD07T realizes the communication between the host computer and the robot(s).

3 Software

In order to adapt a SSL-Vision system, the relations between our system and real world are shown as a diagram below.
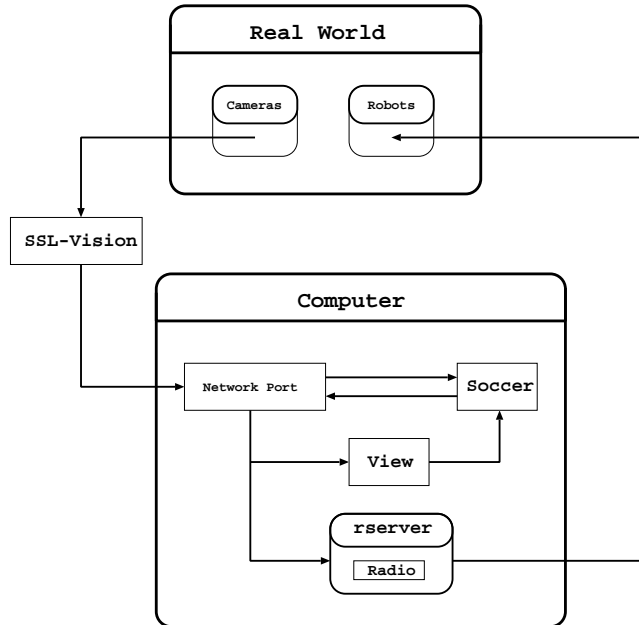
Fig. 15. Overview of Software System

The features of our host computer shown in Fig.15 are

- Athlon64 X2 4200+ with 512MB memory and Debian GNU/Linux OS.
- used for 3 main modules (rserver, view, and soccer).

(1) The *Rserver* module has a radio sub-module and it is used to send the command from soccer module to each robot through the radio system.

(2) The *View* module is used to see the simulated image of real world from SSL-Vision's information so that users are easy to understand the situation. To do so, users set the numbers of robots and our team color. These input information are transported to soccer module.

(3) The *Soccer* module is used to make an action command for each robot. This module consists of a strategy, a tactic, and a path generation sub-modules. This module is described in more detail at the next section.

3.1 Soccer Module

A soccer module is used to make an action command for each robot. In order to make a role, many patterns of strategies are needed to be compared from a field condition. Then a soccer module decides a best strategy matched in the game at the time. This is a movement of the soccer module to choose a best strategy.
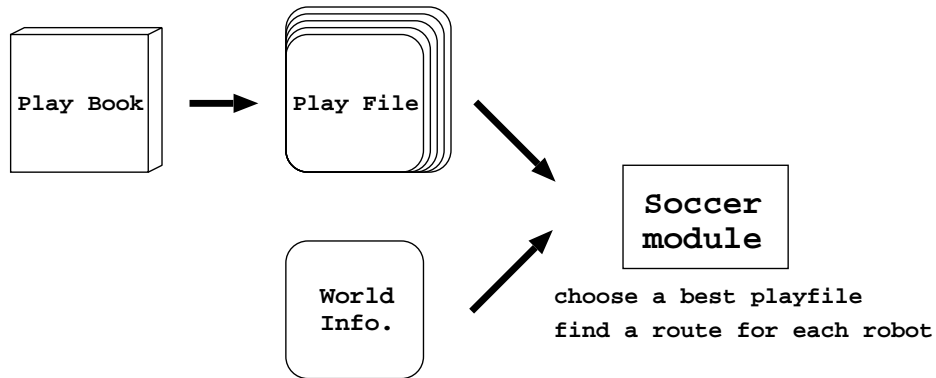
Fig. 16. Soccer Module

- A play book is a group of play files. All play files used in the game are congregated in this play book. By this information, all patters of strategies can be set and calculated by a soccer module.

- A play file, which is a strategy, indicates a role for each robot except a goal keeper. Each play file has to be written a requirement for choosing compared to a condition on the field.

- A world info. is given by a ssl-vision and contains a condition on the field.

- A soccer module compares a requirement for each play file with a field's condition by a world info. A strategy played in the game is chosen by this result, which is a best match to the field's condition.

After a role of each robot is chosen, the soccer module also decides a route for each robot. This result is reflected to the command and sent to a robot by using the modem(Fig.13).

4   Conclusion

In this paper, we described our hardware architecture and software related to a ssl-vision. Our robot raises its performance by such a change of hardware. Then last year, a ssl-vision is used as a common vision system to all teams in the game. Therefore, a interface between our system and ssl-vision needed to be revised in order to participate the game.

5   acknowledgement