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http://www.ep.liu.se/ea/cis/1999/006/10/

OWARI-BITO — Team description

Owari-bito

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Abstract. *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. Two robots move autonoumously when their local vision is valid, and other robots are controlled by center host comupters.*

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) as shown in Fig. 1. 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.

2 Hardware Configuration

2.1 Robot configuration

The feature of robot hardware is that it has local facilities such as a local vision and proximity sensors, and a robust communication system using spectrum spread method. Fig.2.1 shows a hardware configuration of the robot.

- A processor block consists of two one-board computers, named a main board and a vision board, respectively. The main board controls the robot and communicates with the host computer. The vision board processes the images captured by the local vision camera. Each

Figure 1: Team OWARI-BITO — A whole view

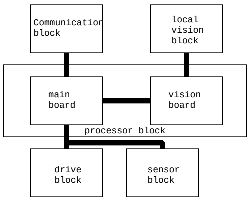

Figure 2: Block configuration of the robot

board has a processor SH7040 of Hitachi, Ltd. These two boards are connected through the parallel ports.

- A drive block drives two motors. Each motor is a DC brush motor with an encoder.
- A sensor block consists of proximity sensors and acceleration sensors. The proximity sensor is composed of an infrared LED and a photo diode. Sensing range is about 20 cm. Each robot has four in front and back side, and two in left and right side, respectively as shown in Fig. 1. The acceleration sensor is a 2 dimensional sensor, i.e. it measures x-direction and y-direction accelerations.
- A communication block is a radio system, which uses a spectrum spread method with 2.4 GHz band that is in accordance with the RCR STD-33A. Though the maximal communication speed is 38.4 kbps, we communicate in the speed of 19.2 kbps because of keeping the reliability. Our radio system has four communication modes. We use one (host) to many (robots) packet communication mode. (In the future, we will use many to many communication mode.) This radio system is a product of Futaba Corporation.
- A local vision block consists of a small size color camera of Panasonic and a video capturing hardware. The video capturing hardware can capture 30 images (size 323x267 pixels/image) per second in maximum.

2.2 Host system configuration

A host processor is a typical AT-compatible computer. Many processors can communicate with each other through LAN, and realize load balancing. Our host computer system consists of two processors, one for computing the team strategy and another for processing the images captured by the global vision camera set at the ceiling. These are called strategy processor and image processor, respectively. A radio communication system is connected to the strategy processor through a serial line. The operating system for these processors is LINUX or FreeBSD, depending on the programmers.

3 Software configuration

3.1 Robot control software

In the current environments, as both main board and vision board do not support the multitask environments, we adopt the time sharing environments based on the timer interrupts. (In the future, we will support the multitask environments such as VxWorks (Tornado).) Motor control, proximity sensor processing, acceleration sensor processing and communication are processed in time-sharing on the main board. Image processing is basically a single task processing on the vision board.

Each robot has its own position and pose data. These are calibrated by the calibration command issued by the strategy processor. The command is issued when the robot is standing.

Two robots are assigned as MF(midfielder)s, other three robots are assigned each to FW(forward), DF(defender) and GK(goalie). One of MF, FW and DK are controlled by host computer. The other MF and GK are robots with local vision and move semi-autonomously. We say semi-autonomous control is

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if data_from_vision_board is ok then move_autonomouly,
                                else follow_host_command.
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3.2 Host computer software

The vision processor discriminates opponent robots and friend robots and it computes the position of each robot and the ball. For the friend robots, the pose (direction) is also computed. These data stamped with time are sent to the strategy processor.

The strategy processor first computes movement vectors of each robot and ball by using the current and past global data from the vision processor and the local data from each robot, then makes commands according to strategies. The key issues of our team strategies are

- FW moves to make open space when we are defending our goal. The defending robots will kick the ball to the sapce and FW will counterattack the opponent goal,

- for the opponent's ball, two defending robots near the opponent robot try to grab it,
- MFs take the role of the FWs when the ball is in the oponent side, otherwise they take the role of the DFs.

4 Communication protocols and commands

In the packet communication mode, each radio system has its own identification number(ID). The master-slave communication is adopted, where the host side radio system is a master and the robot side one is a slave. The host side radio system establishes the connection line with a robot by designating the ID of the robot side radio system. After communicating with the robot, the host side disconnects the line, and connects to other suitable robot. In this way, the strategy processor communicates with all robots. The radio system has many commands to realize the flexible communications.

Next, we describe a configuration of the communication packets between the host and robots in the following. (Only packet bodies are shown.)

Form 1 : STX | CMD | PARA_1 | ... | PARA_n | BCC | ETX

Form 2 : STX | DAT_1 | ... | DAT_n | BCC | ETX

Form 3 : ACK

Form 4 : NAC

Form 1 is a packet from the strategy processor to the robot. STX and ETX are start and end of text code, respectively. CMD is an operation code and PARA_1 ... PARA_n are parameters. BCC is a check sum code. Each code is 1 byte in size. Each byte from STX to PARA_n is exclusive-ORed to make a BCC. In the current master-slave implementation, the commands are issued in one-way from the strategy processor to the robot. Form 2 through Form 4 are packets from the robot to the strategy processor. The Form 2 is a return packet when the strategy processor requests the local data which the robot has. The Form 3 is an acknowledgement message when the strategy processor sends the Form 1 packet but the robot does not need to send any local data. The Form 4 is a non-acknowledge message when the robot could not get a packet correctly. If the strategy processor gets the packet of Form 4, it re-sends the packet of Form 1.

The commands are grouped as follows.

- calibration commands group
- move commands group
- robot's local data request commands group
- parameter setup commands group
- local vision commands group
- goal keeper commands group
- cooperation commands group

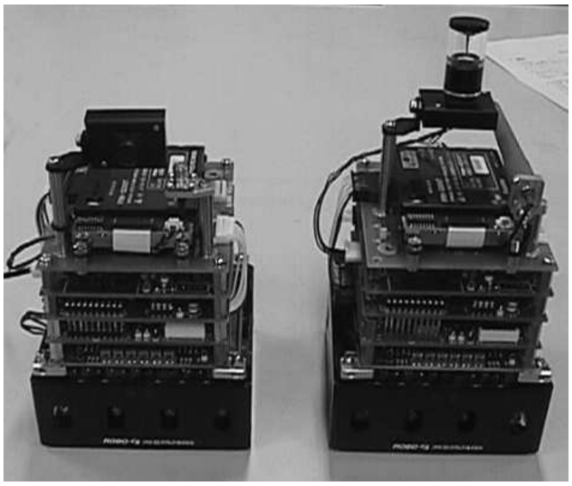

Figure 3: Local vision: (Left) normal camera, (Right) added Omni-directional vision.

Details of these commands are omitted for a shortage of paper, but in the move commands group, the following special commands are prepared,

- tracking command which tracks the ball using local vision,
- two pass move command which goes to the target position escaping the obstacles located on the line between current position and the target position.

5 Concluding Remarks

We have shown the configuration of OWARI-BITO team. OWARI-BITO is now under construction. The current status is that the robot hardware is completed, the basic control software and the basic commands are implemented. Local vision and cooperation commands are under development. Fig. 3 shows our semi-autonomous robots. Left one is GK, and right one is MF with micro ominidirectional vision sensor of ACCOWLE Co, LTD.