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Matto: Towards a Pass-Based Tactics

Matto

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Abstract. *This paper describes our research interests and technical information of our team for RoboCup-99. Our robots have been developed to have a capability of a pass-based tactics. That is, the capability of receiving a ball from any direction and passing the ball to a desired robot. To achieve the capability, our robots have omnidirectional moving mechanisms and kicking devices.*

1 Introduction

Our research interests lies in interactions of tactics of teams and a mechanism of building tactics by reinforcement learning. In this paper a design concept and an architecture of our robot is described.

We study and analyze robots of the RoboCup-97, 98 to design our robots, and found that many robots lack the following things.

- Kicking device
- Agility

Considering the kicking device, only a few teams such as the CS Freiburg team [1] and the UTTORI United team [2] equipped it. Kicking device will change the tactics of the RoboCup dramatically in the middle size league. It will be a pass-based tactics like the modern soccer.

To accomplish the tactics, there are a lot of hard problems to be solved. Agility is a key point. The matches at RoboCup-97 and 98 show that most robots were like tortoises. It was caused by their mobile and vision systems.

To realize agility, the vision system can distinguish teammates and opponents and determine the location of its at the same time. Thus, we use wide-angle lenses. The mobile systems are desirable to move in all directions. Because a ball comes from in all directions, and a robot must receive the ball. An omnidirection mobile system is equipped in our robots.

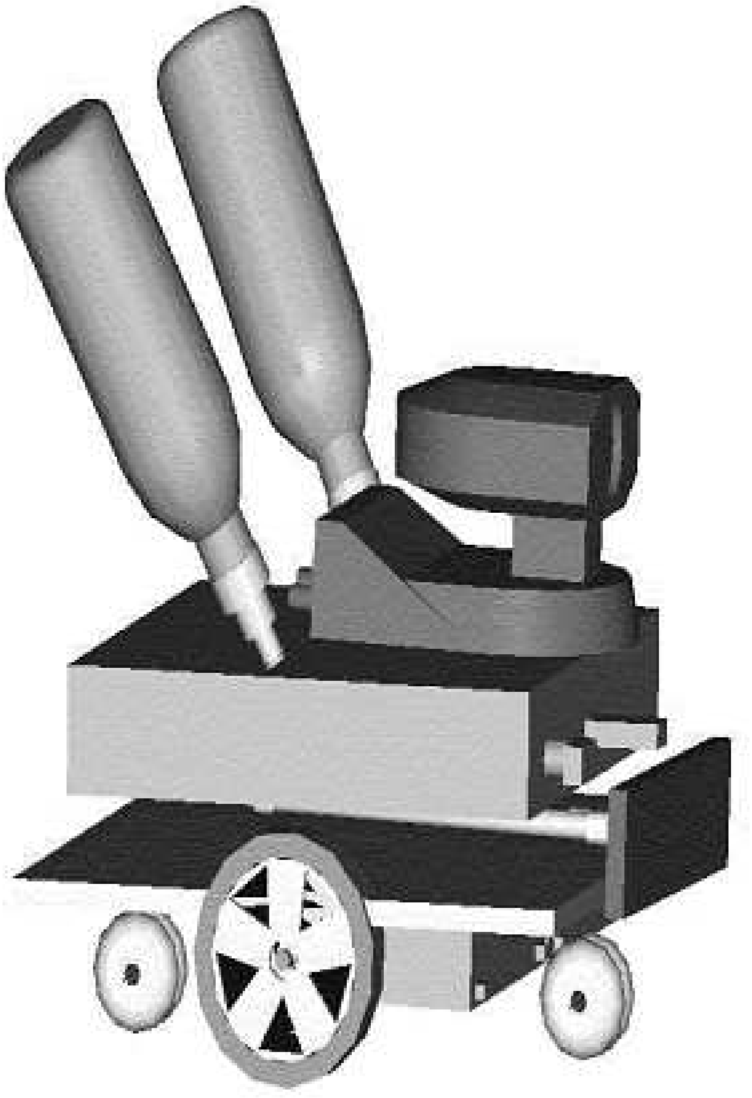

Figure 1: Prototype robot “Kese1”

2 Architecture

3 Hardware Architecture

3.1 Overview

We consider that robot is a computer system which can interact its physical environment. Thus, our robots are designed as basically PC/AT computers (small laptop computers, hereafter PC) with actuators and sensors.

Fig.1 shows one of our robots. It measures 38cm x 38cm x 32cm in length, width, and height (including the height of air tanks). The weight is about 7kg with a laptop PC and two 12VDC, 2.2Ah sealed lead-acid batteries.

3.2 Processing System

We learned from RoboCup Japan Open 99 that the complicated system is no use for the real robot soccer games. To make the robot system simple and reliable, a processing system of our robots is a standard PC/AT laptop PC with a Pentium MMX, a Mobile Cerelon or a Mobile Pentium II (266-300MHz) processor and 64 Mbytes or 32 Mbytes RAM.

3.3 Sensorial System

The vision system is the most important of all sensorial systems. Commercial video capture PCMCIA cards (IBM Smart Capture Card and Ratoc System REX-9590) are used for the vision system. These capture cards can capture 320x240 images at a frame-rate of 30 per second and have device drivers for Linux. Capturing performance is based on CPU power, therefore we need powerful CPUs such as Mobile Cerelons or Mobile Pentium IIs.

3.4 Actuator System

Kicking Device: The kicking device is composed of an air tank, an electric valve and an air cylinder as shown in Fig.2. The device has been developing now.

Omnidirectional Mobile System:

The omnidirectional mobile system has been developed for two of our robots (the rest of robots are conventional wheel system). This type of system has also adopted by several teams, e.g. RMIT (Andrew Price 1997), Uttori United (Yokota 1997). Those teams have developed a new system. Our system is conventional, however the reliability is very high and the max speed 2.0m/s is expected. There are 4 pairs of omniwheels as shown in Fig.3. and 4 DC gearmotors. Each pair of omniwheels is simply driven by the motor.

Motor Driver:

A small laptop PC is suitable for a mobile robot. But an interface between the PC and other devices is problem because there are few cheap commercial boards. Thus, we developed a motor driver board that is plugged into a parallel port or a serial port on the PC. Fig.4 shows the interface of the hardware architecture. The control unit of the motor driver board is composed of a micro-controller (SCNIX In-System Programmable Micro-controller). The board is programmable and easy to change the functions of the board and the cost is low.

4 Software Architecture

4.1 Overview

The software architecture is composed of an action module, sensor modules, and a motor module. Each module reads and writes the same shared

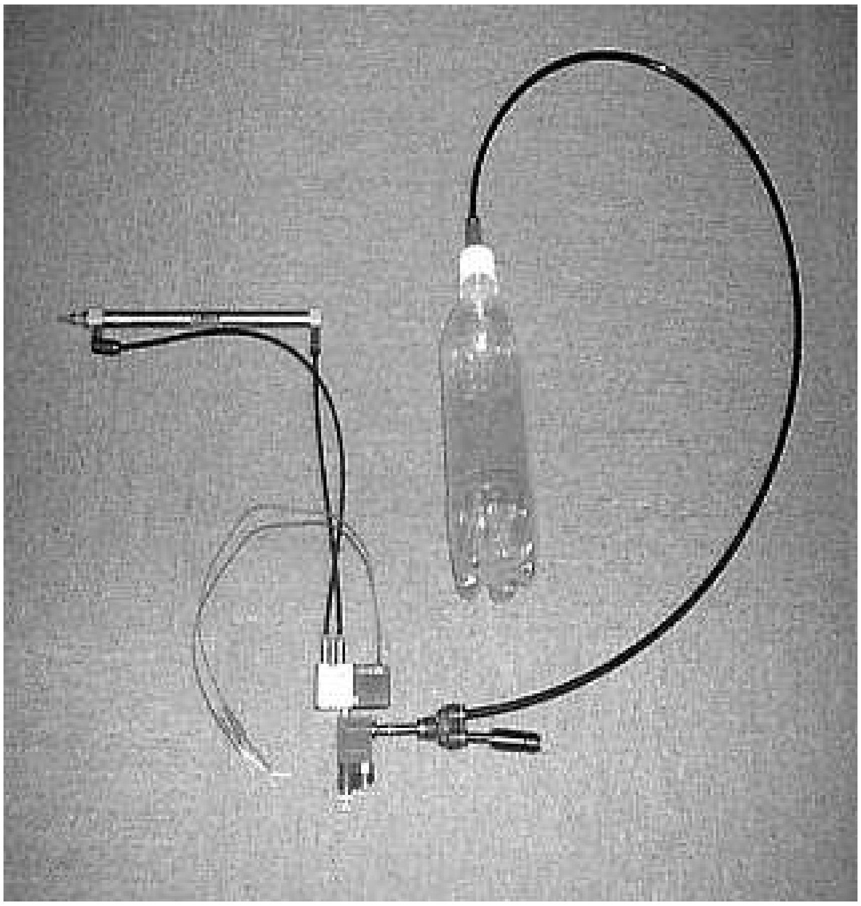

Figure 2: Kicking device

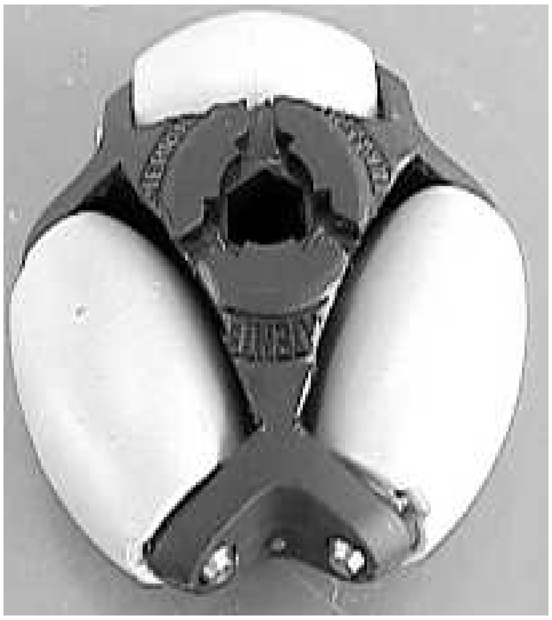

Figure 3: Omniwheel

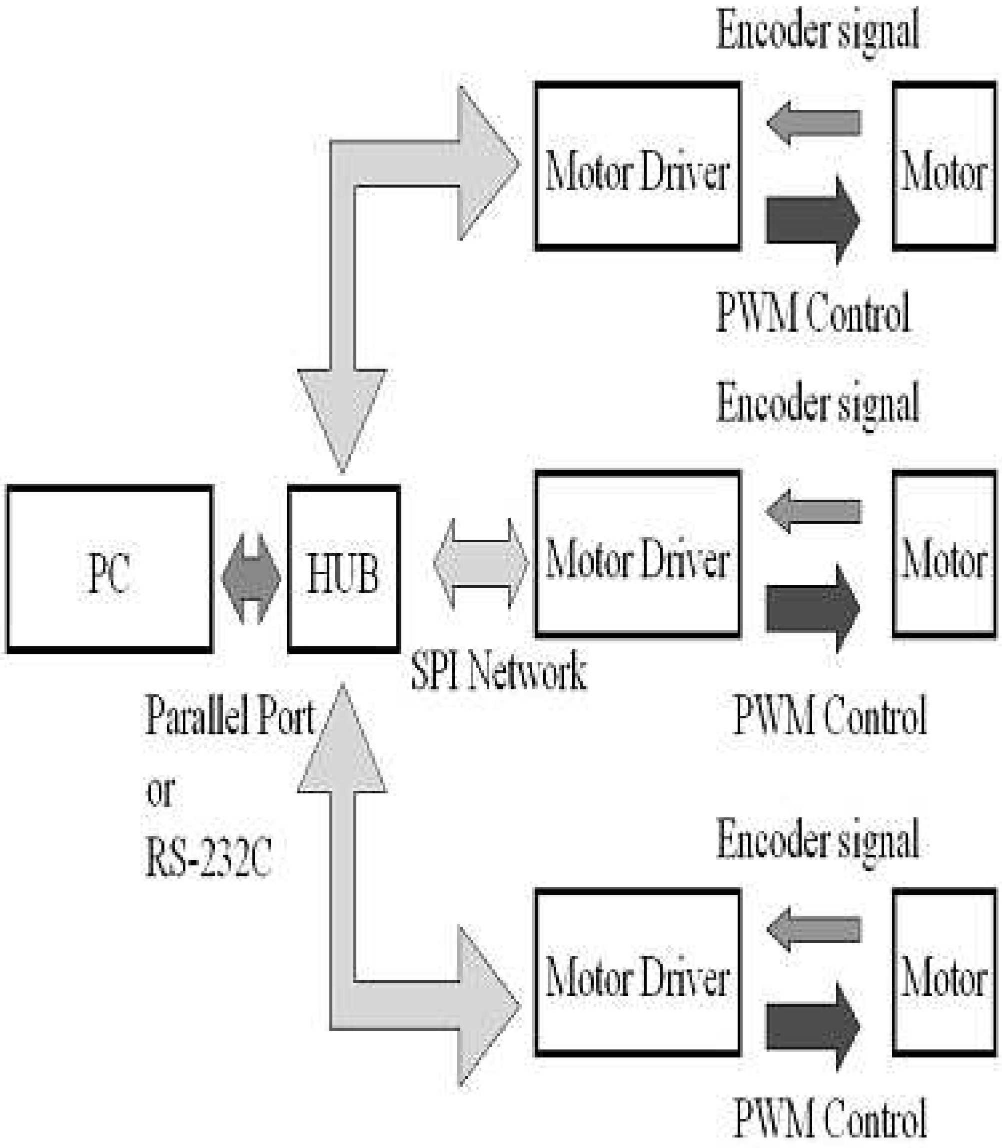

Figure 4: Interface between PC and motor drivers

Table 1: Table 1. State and action table

State							Action	
Ball			Enemy Goal			...	Prob.	Command
Find	Lost	Dist.	Find	Lost	Dist.	...	?@	?@
1	0	100cm	0	0	—	...	1.0	goto_ball()
1	0	10cm	1	0	200cm	...	0.8	shoot()
1	0	10cm	1	0	200cm	...	0.2	pass()
...	...	...	?@	?@	?@	?@	?@	?@

memory asynchronously. And we use semaphores to avoid a race condition of synchronizing parallel processes.

4.2 Action Module

We assume that a Markov decision process determines our robots behavior. Therefore if a state is determined then an action is determined deterministically or non-deterministically. Table 1 shows a simple example.

Table 1. State and action table

4.3 Sensor Modules

Sensor modules read information from each sensor and write information in the shared memory. A vision module receives visual input from an on-board CCD camera. The vision module distinguishes objects (a ball, goals, teammates and opponents) using colors information and calculates the position.

4.4 Motor Module

The motor module reads information from rotary encoders and writes the shared memory. The module also reads a motor command from a parallel port. The command is composed of 2 bytes. 1 byte is used for the speed control and the other is used for communication between PC and the motor driver boards.

5 Conclusions

This article presents the details of our team. RoboCup-99 is our first challenge. We have been spent a lot of time to build our robots. However, to accomplish the pass-based tactics, the omnidirection system and the kicking device are indispensable. To make the kicking device reliable takes top priority for our team.

6 References

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[2] K. Yokota, K. Ozaki, A. Matsumoto, K. Kawabata, H. Kaetsu and H. Asama: Omni-directional Autonomous Robots Cooperating for Team Play, pp. 333-347, RoboCup-97: Robot Soccer World Cup I, Lecture Notes in Artificial Intelligence, Springer, 1997.