Osaka University "Trackies 2001"

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Abstract. This is the team description of Osaka University "Trackies" for RoboCup2001. The hardware and software architecture are presented.

1 Introduction

The Robot World Cup Soccer Games and Conferences (RoboCup) are a series of competitions and events designed to promote the full integration of AI and robotics research. The robotic soccer provides a good test-bed for evaluation of various research, e.g. artificial intelligence, robotics, image processing, system engineerings, multi agent systems.

Osaka University "Trackies" has participated the RoboCup since the first one 1997. We have changed our robot system from a remote controlled vehicle to a self-contained robot because the remote brain system often suffered from much noise of camera image and motor command transmissions. On the other hand, we adopt an idea that the cooperative behaviors without any planning to emerge cooperation in the dynamic environment caused by multi robots in a hostile environment.

This paper presents the employed hardware, namely robots and computers, and a fundamental approach to control robots.

2 Hardware

Fig.1 show pictures of our mobile robots we designed and built. Fig.2 shows an overview of the robot system. The system consists of a motor driving unit, a vision system, and a control unit.

2.1 Control Unit

We use an on-board computer as a controller for the robot. It is a standard PC parts, and commercially available. Each PC has a 233 MHz Intel Pentium MMX CPU, 128 MB RAM and 160MB Silicon Disk Drive (as a hard disk drive). The operating system is Debian GNU/Linux, and we install the minimum system in the hard disk drive in order to communicate with external file server. The

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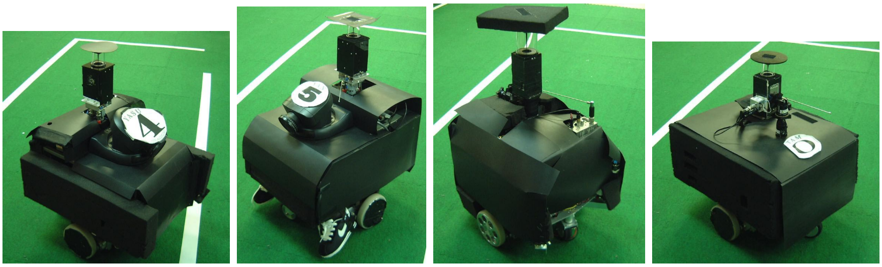

Fig. 1. Our mobile robots

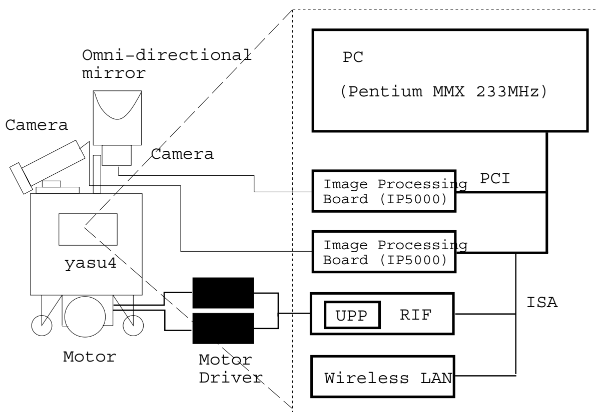

Fig. 2. An overview of the robot system

software development of our mobile robot is done on the external file server. For the communication between a robot and an external file server, wireless PCMCIA Ethernet cards (AT&A WaveLAN/IEEE) in PCMCIA to ISA adaptors are used. Each computer has one or two image processing board (Hitachi IP5005) or frame grabber for vision system, and one Robot Interface Board which has an Universal Pulse Processor for motor control.

2.2 Vision System

The robot has an omni-directional camera system with or without a normal camera system. Two robots have SONY EVI-D30 which has a motorized pan-tilt unit. An omni-directional camera system consists of a color CCD camera and a omni-directional mirror and is mounted on the robot as the camera optical axis is aligned with the vertical axis of the mirror. A simple color image processing is applied to detect the ball, goals, field, and obstacle areas in the image in real-time (every 33ms).

2.3 Motor Driving Unit

The driving mechanism, which is originally designed at Tsukuba University and now commercially available as a vehicle unit with motor, wheels, and control drivers, is a PWS (Power Wheeled System); the vehicle is fitted with two differential wheels. The wheels are driven independently by separated DC motors, and two extra free wheels ensure the static stability. Robot Interface Board generates PWM pulses, which controls the speed of the wheel. The pulses are sent to the motor drivers which drive the wheels.

3 Software

Our robot team consists of four robots. They all share almost the same basic hardware, but they differ in their behavior programming. The basic idea for cooperative behaviors among the teammates is that cooperative behaviors without any planning or intention of cooperation emerges in the highly dynamic, hostile environment provided by RoboCup. We design each robots' behaviors such as "use the environment directly," "replace computation with rapid feedback," and "tolerate uncertainty before trying to reduce it."[1]

3.1 Strategy Learning for a Team

Team strategy acquisition is one of the most important issues of multiagent systems, especially in an adversary environment. RoboCup has been providing such an environment for AI and robotics researchers. A deliberative approach to the team strategy acquisition seems useless in such a dynamic and hostile environment. We have presented a learning method to acquire team strategy from a viewpoint of coach who can change a combination of players each of which has a fixed policy at RoboCup Symposium 2001[2]. Assuming that the opponent has the same choice for the team strategy but keeps the fixed strategy during one match, the coach estimates the opponent team strategy (player's combination) based on game progress (obtained and lost goals) and notification of the opponent strategy just after each match. The trade-off between exploration and exploitation is handled by considering how correct the expectation in each mode is.

3.2 Evolutionary Behavior Selection

We have presented a behavior selection mechanism with activation/termination constraints at RoboCup Symposium 2001[3]. In this method, each behavior has three components: policy, activation constraints, and termination constrains. A policy is a function mapping the sensor information to motor commands. Activation constraints reduce the number of situations where corresponding policy is executable, and termination constrains contribute to extract meaningful behavior sequences, each of which can be regarded as one action regardless of its duration. We apply the genetic algorithm to obtain the switching function to select the appropriate behavior according to the situation. As an example, a simplified soccer game is given to show the validity of the proposed method. Simulation results and real robots experiments are shown, and discussion is given.

References

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