Osaka University "Trackies 2003"

Yasutake Takahashi[12], Kazuhiro Edazawa[1], Noriyuki Sakayanagi[1], Shinya Takamuku[1], Motohiro Yuba[1], and Minoru Asada[12]

[1] Dept. of Adaptive Machine Systems,
[2] Handai Frotier Research Center,
Graduate School of Engineering, Osaka University,
Yamadaoka 2-1, Suita, Osaka 565-0871, Japan,
{yasutake,asada}@ams.eng.osaka-u.ac.jp,
{eda,saka,yuba}@er.ams.eng.osaka-u.ac.jp
WWW home page: http:///www.er.ams.eng.osaka-u.ac.jp/robocup/trackies/

Abstract. This is the team description of Osaka University "Trackies" for RoboCup2003. 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 in 1997. We have been studying of applying a number of behavior learning/acquisition methods, (ex. reinforcement learning, genetic algorithm, multi-layered learning system, etc) to our robots [1–4]. We adopt an idea that the co-operative behaviors without any planning emerges in the highly dynamic, hostile environment [5]. This paper presents the employed hardware and a fundamental approach to control robots.

Fig. 1. A picture of our robot

2 Hardware

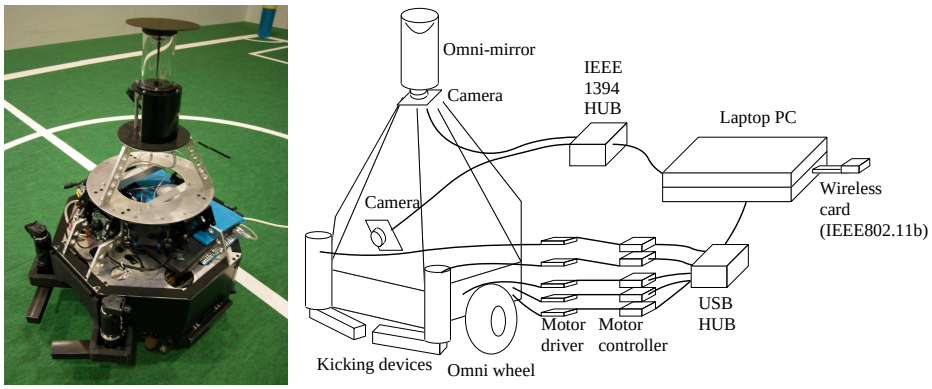


Fig. 2. A picture of our robots and an overview of the robot system

Figs.2 show a picture of our robots and an overview of the robot system that we designed and built. The system consists of a motor driving unit, a vision system, and a control unit.

2.1 Control Unit

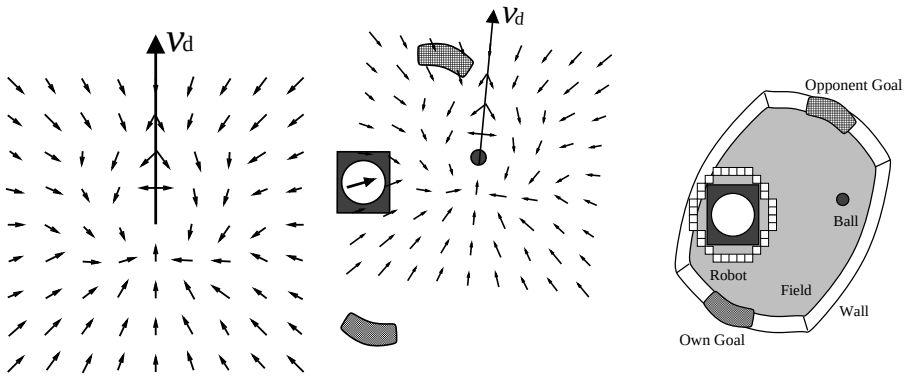
We use a standard laptop computer as a controller for the robot. The operating system is GNU/Linux. The software development of our mobile robot is done on the laptop computer. For the communication between a robot and an external server, wireless PCMCIA Ethernet cards (AT&A WaveLAN/IEEE) are used.

2.2 Vision System

The robot has an omni-directional camera system and a normal camera one. The color CCD camera has an interface of IEEE 1394, and the laptop computer captures the image directly. 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) on the laptop computer.

2.3 Motor Driving Unit

We adopt motor controllers based on Hitachi H8 micro-controller with USB interface. The driving mechanism is a omni-directional vehicle with three omni-wheels. The wheels are driven independently by separated DC motors. The kicking devices have sticks swinging horizontally, driven independently, and attached on the left and the right of the front of the body.



(a) Robot direction table (b) Ex. of applying the table (c) Obstacle detection area

Fig. 3. A typical strategy of our robot

3 Fundamental Approach to Control

4 Control Architecture

Our robot team consists of four identical robots. They all share almost same basic hardware, but they differ in their behavior programming. All robots of our team have a camera with an omni-directional mirror, and they decide their all behavior based on the information in the image plane. We describe a typical one here.

In order to carry the ball into the desired direction, we define a table that maps sections of the visual field to motion commands. Fig.3(a) shows the table; the center of the figure indicates the ball and the vertical axis indicate the desired ball direction. Arrows indicate the desired robot direction as response to the robot position in the segments of the visual field. Fig.3(b) shows an example. The obstacle avoidance behavior is implemented as follows: Fig.3(c) shows the obstacle detection areas. The robot recognizes that the area is free, if the green color occupies the area on the image. If the other colors (for example, black (the robots) and white (walls)) occupied the area and the desired robot direction crosses the area, the robot changes the desired direction next to the area.

4.1 Team strategy

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."[6]

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