Owaribito-CU

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1 Introduction

The Owaribito robot soccer team has competed in RoboCup at Stockholm (1999) and Seattle (2001) as a joint team of Aichi Prefectural University and Chubu University. In Fukuoka (2002), Chubu University participated as an individual team. This paper describes features of Owaribito-CU robot soccer team.

The features are

- use of the low cost robot for education,
- a vision system with two unsynchronized cameras.

2 Use of a robot for education

2.1 Education Program using RoboCup small robots

We think creating a soccer robot team over several semesters provides an excellent teaching material for students in engineering courses. It not only covers themes from hardware to software, but also topics in system engineering materials. RoboCup small robots can be used as undergraduate educational materials. It is low cost and manufacture of the robot for education is possible [1]. We investigate an education program for half year using RoboCup small robots as shown in Table 1. The program was designed for students at department of electronic and computer science.

Table 1. Education Program

Process	Contents	Time (hour)
Experiment of logic circuit	It is performed using motor and H8 circuit	4
How to use an oscilloscope	Motor circuit and power supply circuit is measured	2
Computer interface	A robot is operated from PC with RS-232C	2
Assembler programing	Soccer robot control	2
Image processing	Recognition of robot ID	2

2.2 Low cost Robot for Education

Our basic robot for educational use can be manufactured for about 350 US dollars per set as shown in Fig. 1. Table 2 shows details of the parts and cost for the robot which has two wheels. Compared with Palm Pilot Robot Kit by CMU [2], the cost is almost same and cheap. We think this is an important factor as an educational material. The robot can be made easily with 14 hours by an undergraduate student who does not have any knowledge of robot design. Students who made the basic robot by themselves had a sense of achievement through the making process. The basic robot moves at velocity of 35 [cm/s] is not enough speed for a match in RoboCup. However, we think the robot is effective for learning the robotics such as a controlling motor etc.

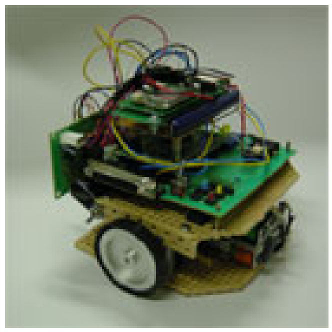

Fig. 1. Basic robot

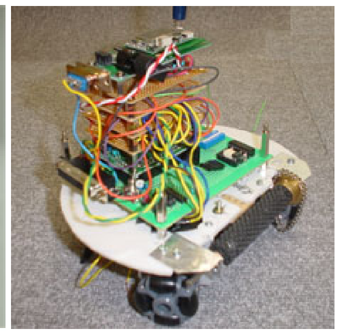

Fig. 2. omni-directional robot

Table 2. Required Parts for the basic robot

part	Qty	cost
radio	1	$ 80
H8 system board	1	$ 90
motor circuit parts	2	$ 30
stepping motor	2	$ 60
frame parts	1	$ 20
tire and wheel	2	$ 50
other circuit parts	1	$ 20
total		$ 350

Fig. 2 shows an omni-directional robot with kicking and dribbling devices based on the basic robot. It is not difficult to develop omni-directional mechanism into the basic robot. It costs about 400 US dollars per set even though it has 3 motors. The omni-directional robot would be able to move at a sufficient velocity for the competition. In RoboCup 2003, we use the omni-directional robot.

3 Vision System with Two Unsynchronized Cameras

We present a vision system with two normal unsynchronized cameras, which has lesser occlusion of objects.

3.1 Vision system with two cameras

Fig. 3 shows our vision system that uses two cameras, camera1 and camera2. The two cameras are mounted on either side of the field and each camera views the entire field. Fig. 4 shows the images captured by each camera.

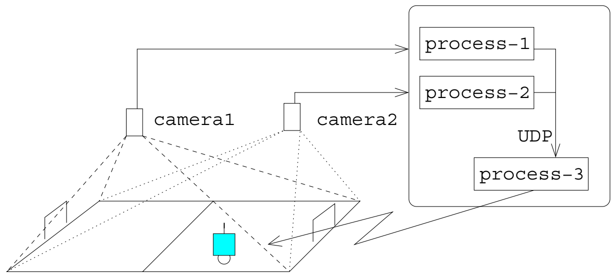

Fig. 3. Overview of our vision system

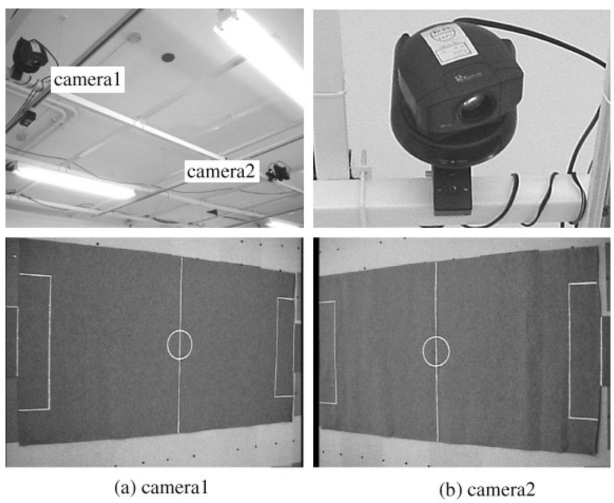

Fig. 4. Camera images

3.2 Camera calibration and error estimation

Each camera is calibrated separately. The camera calibration maps camera_image_coordinates to the_field_coordinates [3]. The middle circles in Fig. 5 show a trajectory of an orange golf ball that runs from one goal to the other goal. X-axis and Y-axis(left labels) in Fig. 5 are the side lines of the small-sized soccer field .

The errors in calibration become larger as they are far from the camera position. The errors can be estimated at the calibration stage. Triangles in Fig. 5 show the calibration errors plotted against x-position. Y-axis (right label) values indicate the magnitude of errors that vary from 3.5mm to 5mm.

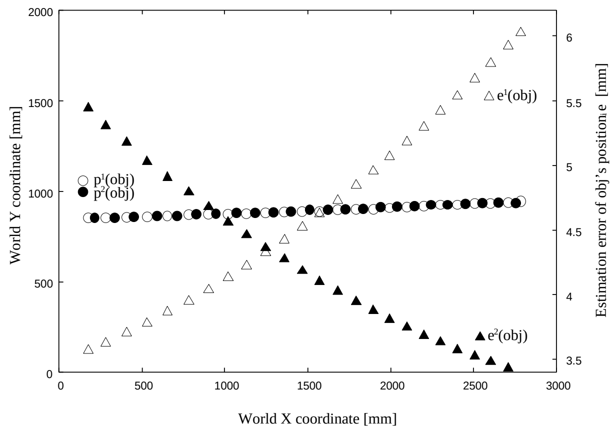

Fig. 5. A trajectory of an orange ball (left label) and calibration errors (right label)

3.3 Features of the two camera system

Using two cameras gives us three features; (a) lesser occlusion of objects as we get views from two cameras, (b) lower composite error of measurement of a two camera system compared to either camera used alone and (c) higher sensing speed with no camera synchronization detailed in [4].

In the case of defense and offense at the competition, a vision system has to get precise positions of the ball and robots especially around each goal area. The placement of two cameras as shown in Fig. 4 has two advantages. One of them is better accuracy of the positions when the camera close to the ball is selected as shown in Fig.5. The other one is that occlusion area occur only near the center line of the field and the occlusion area by our two camera system is less than that of single camera vision system.

4 Conclusion

We present that our robot was designed for a material of education program for robotics. And also we described a vision system with two unsynchronized cameras which has lesser occlusion of objects.

References

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