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The Crimson Small Robot Team

Crimson

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Abstract. *This paper shall summarize the hardware and sofrware description of the overall system in short terms. Our robot was designed move as fast as possible keeping correctness. So, DSP CPU, high pulse encoder and Adaptive Control algorithm was used at the robot system. From the information of global vision system, centralized computer excutes overall game strategy and decides each robot's movement. Then broadcast these commands to each robot. In planning robot's path, we used simple but powerful algorithm.*

1 Introduction

As a background of trends for multiagent system, it is first noted that the performance of computers has been improved rapidly as well as the network capability, providing us with convenient developing environment. On the other hand, higher flexibility and robustness are required for manufacturing system, which is motivated by large-variety small-lot production, improvement with new technology transfer, and high fault tolerance and maintenance. Such needs are suggested in multiagent system as well as bionic manufacturing system and self-organizing manufacturing system[1]. In multiagent system, wide technologies such as an operating algorithm for distributed autonomous robots, several electrical and mechanical technologies, image processing and communication should be combined with.

Because the ROBOCUP is a proper system to which we can apply many technologies for multiagent system, those may have an influence on various area in relation to multiagent system.

In the path-planning of soccer robot system, many existing methods that are used in developing the autonomous mobile robot are being applied. For examples, there are voronoi graph method, that it first draws the loop which envelopes objects, adds paths which connect from start-point or goal point to that loop and then achieves wanted path[2][3][4]. Secondly, visibility graph method, that it regards objects as polygons in 2D space, draws lines with which are connected a start-point and a goal-point through edge points of that polygon and then selects a set of which length is the shortest in several sets[5][6][7][8]. Finally, cell decomposition method, that it decomposes a 2D space into a set of simple cells, and then using relations with those, gets a path[9]. We investigated those methods. As a result, we concluded those not to be effective with robot soccer system. So, we applied the concentric circle algorithm.

The robots used in soccer system must be able to move rapidly and accurately operated by the master. Because DC motor is used as an actuator, mechanical and electrical components should have a good performance, and an effective control algorithm is needed.

This paper describes the overall architecture of our robotic soccer system.

2 Overall Architecture

A vision camera over-looking the playing field connected to a vision system. From the global vision algorithm, vision system processes the images, giving the positions of each objects. This system connected to a centralized computer. From the information of vision system, centralized computer perceives the positions and directions of each robot and the ball. This centralized computer also excutes the game algorithm of each agent. Game algorithm evaluates the state of overall circumstances and users its strategic knowledge to decide what to do next. After deciding the command of each agent, centralized computer sends the command packages to the each robot through radio communication module(Radio Frequency off-board controller). This command packages broadcasted and each robot selects it's own information from it's identification binary code. So, each robot can behave independently by it's on-board controller. This sequence occurs in real-time from the syncronization of a vision camera (30 frames/sec).

3 Hardware Description

3.1 Robot

Each robot is an actuater of robot soccer system. It can be move as fast as possible from the command of centralized computer and also as correct as possible. So, our robot system consists of DSP CPU and DC Motor. For the above goal, we used Model-based Adaptive Control Algorithm. The wireless communication module added for the purpose of receiving data from the centralized computer at speeds of up to 1.2Kbytes/sec. Our system entirely centralized, robot isn't communicate each other. Then, robot specification follows :

-CPU	TMS320c32(50MHz) DSP
-Speed	0 - 1.5 [m/sec]
-Actuator	DC Motor (7.2, 5W)
-Battery	1.2V X 6(7.2V)(Ni-MH)
-Motor Control Algorithm	Model-based Adaptive Control
-Communication	RF(418 or 433MHz)

3.2 Vision System(KeysCT)

For the purpose of color tracking, we use this vision system developed by ROBOTIS Inc. This system can detect the positions and the sizes of the object by the on-board color based algorithm. It processes this sequence at the full speed(30 frames/sec). This system performs following procedures:

- Grab of an image data received from camcoder or CCD.
- Analyzation of the received image data; identifying the object, detecting the Center of Mess Coordination, calculating the area of each object.
- Transmition of a result to host-PC.

Then, Hardware specfication of the vision system follows :

-Image processing speed	60fields/sec
-Resolution	320pixel * 200pixel (Flexible)
-Color	2^{19} colors
-Communication	Serial 115200, 57600bps
-Transfer information	position, size, color
-Maximum trackable objects	35objects in 60Hz
-Signal	NTSC, S-Video
-Power	DC6V, 400mA
-OS	Windows98

3.3 Centralized Computer System

This system detects each robot's information from the vision system data. And also excutes overall game strategy and decides each robot's movement. Then broadcast these commands. The following is specfication of our computer system : strategy

-PC	Pentium MMX233 Notebook PC
-Language	Visual C++
-OS	Windows98

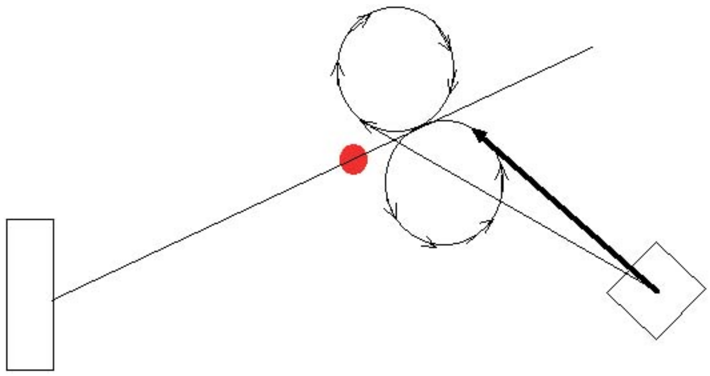

Figure 1: Path Planning

4 Software Description

4.1 Robot recognition Algorithm

Vision system send the position, size and color of the objects pictured from the CCD camera. From these data, the main objective of Robot recognition algorithm is to identify ID number and to calculate position and direction of robots in real coordinate system with informations. For distinction our 5 diffirent robots, we use 3 diffirent colors and select 2 color objects each robot. by the combination, 6 maximum diffirent object can be distinguished.

4.2 Trajectory generator

In the robot soccer, it is a fundamental movement that a robot kicks a ball toward goal. Trajectory generation is an algorithm that it establishes the position of the robot so as that the robot may do the movement mentioned above.

In generating the trajectory, it should be considered deeply that the robot has to kick the ball correctly without time delay. Fig.1 displays the basic idea of this algorithm.

This algorithm has several merits for the robot soccer system. First of all, in the robot soccer system, the position of all objects changes continuously so that static path planning algorithms have some problems adapting to the dyanmic system. But this is not. Because, this algorithm basically assume dynamic system. Secondly, it is very simple as well as generates a trajectory correctly. Because of its simplicity, the computational time can become rapidly.

The algorithm suggested in this paper is not based on the angle between robot and some objects but the circle generated by some special conditions. So the movement of our robots is based on tracing the circular trajectory. If the method based on the angle were used, we couldn't calculate a length of path and moreover if some considered points were placed at the point where had the same angle between that point and robot, the target position couldn't be detected. But the suggested method has two merits. One is that the robot moves the same velocity regardless of the direction, and the other

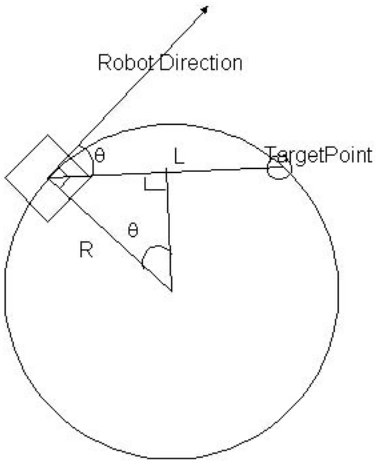

Figure 2: Tranjectory generator

is that the path length can be calculated correctly. In addition, from the volecity and the length, we can calculate the arrival time used in a role changing and prediction algorithms.

4.3 Game Strategy

This algorithm determines the role of each robot, which are the striker, defenders and the goalie. Depending on the current situation, the new position of each robot has to be assigned at every sampling time. The role of each robot except the goalie isn't fixed. The goalie keeps our goalpost entirely, regardless of other robots situation in order to prevent sudden goal. So, the goalie moves only in our goal area.

In this situation, other robots perform their roles throughly. Our four robots change their roles dynamically depending on the current situation so as not to occur unreasonable movements. For example, when a robot is fixed as a striker, it may attempt to get the ball, although other robot is located at the good position to shoot the ball. In this situation, the role of two robots must be changed.

So, we determines the role of each robot as the striker and defenders according to the current locations of the ball, robots, the goalpost and the goalie.

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