LuckyStar II - Team Description Paper

Ng Beng Kiat (nbk@np.edu.sg), Quek Yee Ming, Tay Boon Hock, Yuen Suen Yee, Simon Koh

Ngee Ann Polytechnic, Singapore

1 Introduction

Our first robotic soccer team, LuckyStar, competed in Stockholm 1999 and was lucky enough to win third place. From that experience, we found that our team weaknesses were due to lack of vision reliability, smooth robot movement control, shooting capability and team cooperation. We decided to concentrate on areas with the most immediate impact on the game, i.e. vision, robot movement control and shooting mechanism.

2 System Description

We continue to use a global-vision-based system except that the vision system now resides in the host computer. The host computer computes the next move for each robot. The outputs, which are the robot's translational and rotational speeds, are sent to the robots via a Radiometrix RF transceiver.

3 Robot

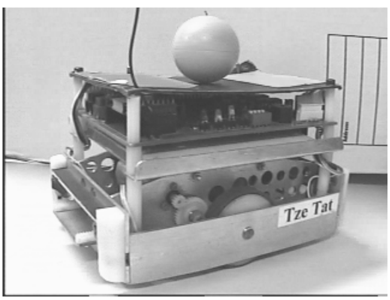

Figure 1. Picture of robot

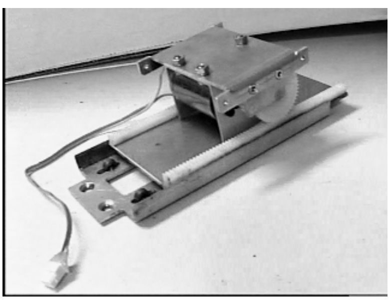

Figure 2. Kicking mechanism exposed

The new robots are similar to the old robot except that they have kicking mechanism. The kicking mechanism is based on a rack and pinion system driven by a DC motor. This allows the robot to kick both way and with varying amount of force. The robot is

P. Stone, T. Balch, and G. Kraetzschmar (Eds.): RoboCup 2000, LNAI 2019, pp. 543-546, 2001.

able to shoot with full force at opponent goal and with just enough force when clearing the ball towards the sloped wall so as to avoid putting the ball off field.

The host system decides completely when to kick the ball. In general, once the ball is within kicking distance, angular error between the robot orientation and the ball-target-to-robot angle is used to determine shooting criterion. The further the robot is from the ball-target, the smaller the angle error allowance.

4 Vision system

One of the problems faced last year is the detection of opponent color. The ping pong balls are small and not evenly illuminated as they are not flat. In order to be able to use only simple vision algorithm, the camera and the frame grabber must be carefully chosen so as not to lose any ping pong ball color pixel unnecessarily.

4.1 Hardware

We tested some cameras and concluded that 3-ccd cameras are the best in term of resolution but they are extremely expensive. Not being able to afford one, we settled for the second best, a single-ccd camera with RGB output. With composite video, the color information are encoded at the camera end and decoded by the frame grabber board. The result is the degradation of signal-noise ratio, hence poorer color resolution.

It is also important that camera has electronic shutter capability in order to be able to capture high-speed object. The shorter the exposure time, the sharper the high-speed object. Of course, we must make sure the lighting requirement for short exposure can be met.

For the frame grabber, we chose the FlashBus MV Pro from Integral Technologies as it provides RGB input and field capture interrupt capability for fast vision processing response.

4.2 Software

We rely on color patches on top the robot to determine robot orientation. In order to play a game, the vision system must be able to detect the orange ball, the yellow and blue team colors and one other secondary colors. True enough, with proper choice of hardware, we are able to use HSI thresholding to detect 5 good colors without any post-processing. This enables us to process the vision data at 50 field per second on a Pentium 500MHz PC with spare capacity for the host software.

5 Robot Motion Control

As in all sport, speed is a major factor in determining the outcome of the game. But if you have speed without good skill and control, then the game will end up pretty rough and unpredictable. One of our major goals is to achieve high speed and smooth robot control.

5.1 Video lag

In general, by the time the robot receives the movement speed commands, there is a time lag of about 4 video field time between its current position and the processed vision data. The time lag is due to a) camera exposure and capture (1 field), b) frame grabber capture(1 field), c) vision and host processing (slightly less 1 field) and d) RF transmission (slightly less 1 field). To have smooth high-speed control of the robot, the time lag must be compensated. There are two ways to do it.

1) Use filtering (e.g. G-H filter[2]) to estimate the robot position, speed and orientation in 4 field time or

2) Use the last four speed commands sent to the robots to estimate the robot position, speed and orientation in 4 field time.

We use the second method, which gives a better estimate unless the robot is obstructed.

5.2 Moving Target

In order to block or kick a moving ball, the system must be able to move the robot to the predicted ball position. This must take into account the current ball speed and direction and current status of robot. For our system, an estimate of the time to get to the current ball position is calculated based on the robot-ball distance, current-robot-orientation and final-robot-orientation difference, and average robot translational and rotational speed. With the estimated time, we can estimate the new ball position. With the estimated new ball position, the process is performed for another 2 iterations in order to get a better estimate of the ball position. In general, this works well for only slow ball and is pretty useless for ball speed greater than 0.2 m/sec. We will be spending more effort in this area for our next team.

7 Conclusion

Our robotic soccer team is fairly reliable and able to play a match continuously without many problems. But it is still very lacking in the area of team cooperation.

Next year, we hope to develop ball-passing skills for our robots. With good ball-pass skills, team cooperation will be more feasible.

References

[1] Manuela Veloso, Michael Bowling, and Sorin Achim. The CMUnited-99 small robot team.

[2] E. Brookner, Tracking and Kalman Filtering Made Easy. A Wiley-Intersience Publication, 1998