LuckyStar 2004

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Abstract. This paper describes LuckyStar2004, the RoboCup small-size league team that we are preparing for the Lisbon 2004 competition.

1 Introduction

In this paper, I will briefly describe the changes that we have made to the robots and vision hardware. Both changes are made in response to the new rules requirement. We have also extended the potential field method to do passing.

2 Robot

The robot is basically 2003 robot, modified to meet the new dribbling rule restriction. Beside removing the side dribblers, the dribbling bar is now mounted on a small thin piece of PCB that is secured only at one end. This allows the PCB to move vertically so as to absorb the ball impact.

Figure 1 - 4 wheels omni robot

One of the design goals is to keep the robot light, so as to avoid having to use more powerful motors and higher capacity batteries. We use etched PCB to construct the

robot body. The material is light and very tough. High energy density Lithium Polymer battery is used to power the robot. The robot weighs 1.4 kg, relatively light compared to other teams' robots. The only problem with a light weight robot is that it can be easily pushed aside by opponent robot.

3 Vision hardware

Due to the very large field size, we need two cameras to cover the whole playing field. We also need higher resolution video capture as the area to be covered by each camera is substantially larger than the old field. Our old vision system, which has a resolution of 385 by 275 pixels, is grossly inadequate.

We have to ditch the frame grabber that we had been using for the last 4 years for a IEEE 1394 solution. The main advantages of the IEEE1394 solution are:

1) Low cost. There's no expensive frame grabber card. IEEE 1394 cards are very affordable. Many newer notebooks have built in IEEE 1394 interface.
2) Low noise. Analog video signal is converted to digital signal at the camera before being transferred to the PC. The result is better signal to noise ratio.

We use two Basler 301fc CCD cameras with a notebook with built-in IEEE1394 interface. This new vision system is not only cheaper, it is much more portable as we can finally do without the desktop PC, which is required for the old PCI interface frame grabber. As the IEEE1394 cable is limited to 4.5 m length, repeater is needed to extend the cable length. One disadvantage of the IEEE1394 is the relatively loose connector. It comes off easily if tugged accidentally.

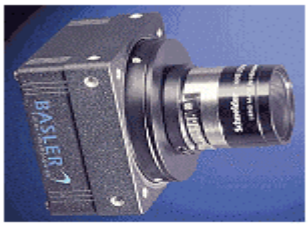

Figure 2 – Basler IEEE 1394 CCD cameraca

We used to use only one desktop for the vision hardware and host software needs. Due to the extra camera and higher resolution video capture, we need to process nearly eight times more number of pixels than the old system. Hence we need a dedicated PC to process the video information. The extracted color blobs information is sent through the Ethernet to the host PC.

4 Potential field based positioning

We have adopted a potential field based method for positioning the robots. By combining the potential fields of all the objects; the playing field, ball, opponent players and own players, a maximum potential can be found, which represent the desired position of the robot. This method is very simple to implement but CPU intensive. To reduce computation, a grid based potential field is used, whereby all the objects' fields are pre-calculated. A simple algorithm is then used to scan the search space in increasing resolution until the highest potential is found.

4.1 Types of fields

Obviously, the potential fields have to be different for offense and defense. For example, during offense, the attacking players want to move away from the opponents, whereas during defense, the defending players want to get close to the opponents so as to prevent passing or to obstruct their movements. Hence, there is a different set of fields for all objects for both offense and defense.

4.2 Offense fields

During offense, the active player (the one controlling the ball) has to look for space to dribble the ball to or for teammates to pass the ball to. The supporting teammates have to position themselves such that they can support the active player.

For supporting players, they should not be near each other as it does not help. Hence teammates should repel one another. They should also stay away from opponent players. Most importantly, theirs receive-ball paths should not be blocked by opponents. Below is the potential field definition of an opponent.

```
pf      = 0     // d < c
                // c = (opponentRobotRadius+myRobotRadius)
                // d = distance from opponent centre

        = 1 - exp( (d-c)/a)*b       // a & b are constants to be tuned
```

From opponent centre to opponentRobotRadius+myRobotRadius away, the potential is zero as no robots could possibly get into that space. Beyond that, the potential rises. To combine potentials from various sources, they are multiplied rather than added. This will preserved the zero potential as no-go region.

Figure 3 shows the potential field of a supporting attacking player, 4L. Player-Dr is dribbling the ball. The lighter region represents the high potential area, with player-4L occupying the highest potential. Note that player-4L has positioned itself such that it

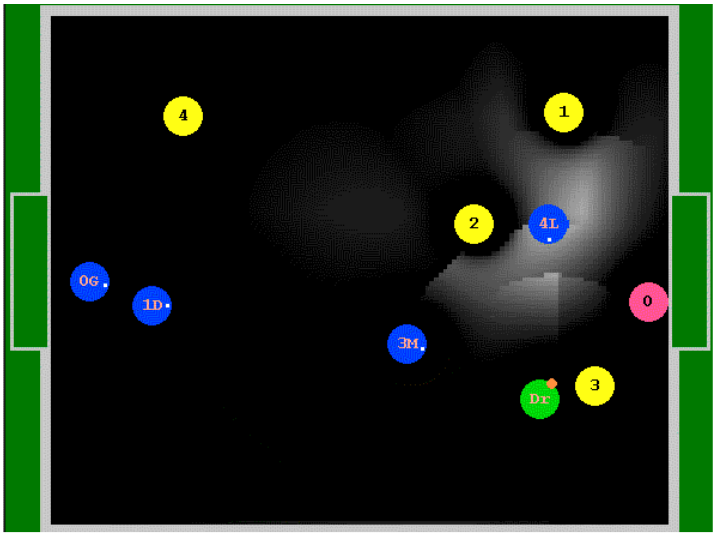

Figure 3 Potential field of attacking player, 4L

is not blocked by opponents. Thus the evaluation function is a combination of the potential field multiplied by the clearance of opponents from a possible ball pass from player-Dr.

Figure 4 shows the potential field of active player-Dr, which is dribbling the ball. During dribbling, it is actively looking for space that it can move to, space that allows it to shoot the ball into the opponent goal. The space must not be clouded by opponents; must not be too far from opponent goal; must not be too far from current position. All these factors are combined to produce the potential field that defines a good position for the active player to dribble to. In the figure, the red line points to where the high potential is. The position indicated below is probably not very good as it is too far away. The new rules also discouraged long distance dribbling. The field can be easily adjusted to prefer nearer location.

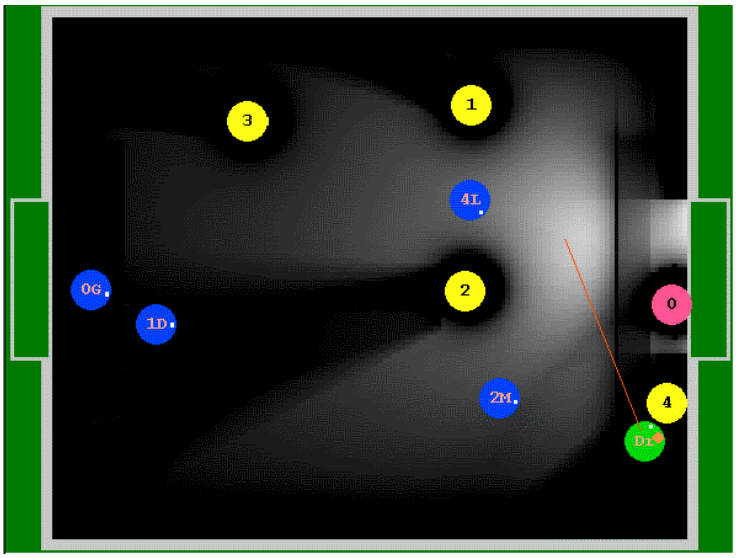

Figure 4 Potential field of active player,Dr

4.3 Tuning

The tuning of the various potential field parameters was done by hand. It was fairly easy to get a reasonable result after spending an hour or so. It shows that the method is not so sensitive to the optimality of the parameters. Initially, there were plan to use genetic algorithm to find the optimal parameters. This was later dropped as we don't find it necessary and partly because it is rather tedious to do.

5 Conclusion

We have developed and tested the potential field method for the left field, mid field and right field player for both offense and defense on our simulator. We have also introduced some form of ball passing behaviours based on the potential field. We need to work more on the passing as the current performance leaves much to be desired.

References

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