A goal keeper for middle size Robocup

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Abstract. In real soccer goal keeper has a completely different behavior that the players. Thus we designed our goal keeper with some basic ideas taken from real soccer, which is moving mainly in goal area and using arms to take the balls. Our goal keeper has a moving mechanism based on 8 motors which enables it to move forward/backward, straight left/right and rotate around its geometrical center, and a sliding arm which moves toward the direction of ball faster than the robot body. Using 3 CCD cameras in front and rear left and right provides the goal keeper with a view of about 210 degrees.

1 Introduction

Since the basic design of our player robots remained unchanged from that of previous year, [1], we decided to focus on the goal keeper. As in real soccer we think a goal keeper robot should have a completely different mission from the player robot. It should be able to move in any direction and use its hands to get the ball and also use its hands and feet to kick the ball. With these mechanisms in mind we designed and constructed our goal keeper in such a way that it provided us with all necessary movements for the robot body and also a sliding arm with a special design to move left or right much faster than the robot body for getting the ball and also kicking it. Since in general, mechanical movements are relatively slow in robots, thus if the goal keeper makes angular movements to look for the ball, not only it will be time consuming but also due to inexact movements after some short period of time the goal keeper might find itself in an unsafe position. Therefore, to cover a wide angle of view, it is better to use multiple cameras than angular movements of robot body itself.

P. Stone, T. Balch, and G. Kraetzschmar (Eds.): RoboCup 2000, LNAI 2019, pp. 583-586, 2001.

2 Goal Keeper Motion Mechanism

Because the goal keeper should keep the goal, it seems that fast and deviation less horizontal movement in front of goal area is a great advantage for it. Therefore, in order to guarantee a nearly perfect horizontal movement for the goal keeper, 4 drive units are installed in the robot (the castor wheel which is used in our player robots [1] has been eliminated because it causes deviation in the robot movements). However, even using 4 drive units, in practice the robot will be displaced after some movements, thus it should have the ability to adjust itself when displaced. Horizontal movements and self adjustment can be done by a combination of the following three basic movements:

1. Move forward and backward (Fig. 1-a).
2. Rotate around its geometrical center (Fig. 1-b).
3. Move straight towards left and right (Fig. 1-c).

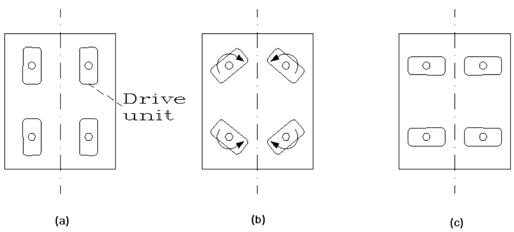

Fig. 1. Goal keeper drive units

In order for the robot to perform these movements, 4 drive units and two steer units are installed in the robot. One steer unit rotates two front drive units round their vertical axes simultaneously in opposite directions and the other steer unit does the same on two rear drive units. The drive units wheel has a diameter of 8 Cm and a gearbox of 1/15 ratio. Measurement of rotation angle for drive units are done by encoders installed on steer unit motor shafts. The equations to calculate velocity vectors and angles are given in [2].

To minimize the robot body movement, its adjustment movements and also increase goal keeper performance, we installed a fast moving sliding arm on it. This arm can slide in left or right direction before the robot body itself moves in these directions. In practice it moves much faster than the robot body and is used to get the ball and kick it from either left or right sides. This arm can slide to its leftmost or rightmost position within less than 0.1 of a second. Considering the front body size of goal keeper which is 23 Cm, and the arm size is 45 Cm (when fully extended in one direction), the robot can cover 68 Cm which is approximately 1/3 of the goal area, within less than 0.1 of a second. Compared to goal keeper maximum speed which is 75 Cm/sec, this arm gives a good protection of goal area from very fast moving balls.

Sliding arm movement is carried out by a rack and pinion mechanism, as seen in Fig. 2. To control the amount of arm sliding, an encoder is mounted on

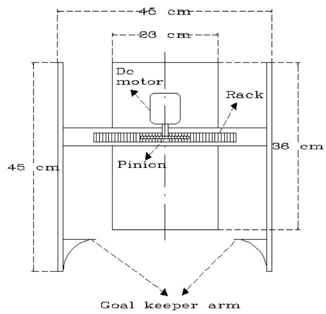

Fig. 2. Sliding arm movement

the shaft of pinion motor. It is necessary to fix the arm when goal keeper is in a stuck situation with other robots. This is done by using a solenoid which can lock the arm in its present position. In addition, a kicker installed in front of the robot, uses a solenoid with controllable kicking power. The power of kicking is controlled by duration of 24 DC voltage applied to the solenoid.

2.1 Goal Keeper Vision System

To cover a wide range of view for the robots, we used multiple cameras installed in front, rear left side and rear right side. We used three Computar CCD camera Model CY-200 with a f2.8 wide lens each covering about 75 degrees. Therefore, these 3 cameras give a view of about 210 degrees, for the goal keeper. We use a commercially available standard analog multiplexer CMOS 4041 which has 8 inputs with 3 address lines. It can switch between input addresses in 15 nano seconds. The software of the vision system consists of three main parts, real time object recognition, motion control and decision making. Software which is based on deterministic algorithms is written in C++ using DJGPP (DJGun Plus Plus) compiler in MS/DOS[3].

The object oriented design of software has 4 classes covering functions for working with frame grabber, machine vision system, interface between software and hardware and finally all robot playing methods and algorithms. For color classification we used HSI [4] color model . In practice we replaced the "I" component of HSI with "Y" component of YIQ color model [4] which gave much better results. The reason for this replacement was that, the "Y" component resembled a real monochrome image where the "I" component gave a faded unrealistic monochrome view of the scene. So we call our color model HSY.

2.2 Goal Keeper Basic Algorithm

Initially the goalkeeper is located in middle of goal area. It moves in horizontal direction towards left or right following the ball, but this horizontal movement is limiteduntilcertainpositionwhichisthegoalleftmostandrightmostpositions. However,duringthishorizontalmove,therewillbesomeangulardisplacement inrobotbodyrelatedtothehorizontalwhitelineinfrontofthegoalarea.Insuch cases the robot adjusts itself in the proper horizontal position by appropriate movement of its drive units and the steer units.

The goal keeper tries to locate the ball right in the middle of its front camera. However, when the ball moves diagonally, first the robot moves its sliding arm in that direction, and then moves its body, until it reaches to the displacement limits. For example, if the ball is seen by the left rear camera, the algorithm will keep on using only that camera and no multiplexing is done. The robot will stay to its left most limit position, but if the ball comes near, it will use its sliding arm to kick the ball. The same approach is done on the right side. The front kicker is used when the ball comes within its kicking area.

3 Conclusion

In Robocup, a goal keeper misses the ball, basically in two situations, not seeing the ball and seeing the ball but not being able to move fast enough to catch it. To solve the first problem we think the best approach is to have the widest view possible form sides and front, process the scene and find the ball at least in a commercial frame grabber rate which is 1/25 of a second. That is why we used 3 fixed position wide angel CCD cameras linked to a multiplexer and one frame grabber which can cover about 210 degrees. Our fast object finding algorithm gives us a near real time rate for ball detection. In this approach with almost no mechanical movement, the goal keeper can find the ball position. Our approach for the second problem was to design a sliding arm which can move toward the direction of ball much faster than the robot body itself. In addition a kicker in front acts as a leg which shoots the ball when necessary.

One main problem with small front size of our robot (23 Cm) was that we had to make the robot tall enough (58 Cm) to install all equipment in it. This caused some instability in robot body movements, specially in fast movements. However, by using special components to make robot short enough, we can reduce or eliminate this problem. One disadvantage of this goal keeper is that it does not communicate with our player robots. Our team Sharif CE took the 3rd place in middle size Robocup 2000.

References

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