Small Robots League, Team *Dynamo-Ilmennau*, pages 39–42
http://www.ep.liu.se/ea/cis/1999/006/06/

Team Decscription for Dynamo Ilmenau

Dynamo-Ilmennau

Simon Abraham, Thorsten Roellich

SA, TR: TU Ilmenau

Abstract. *An overview of the technical parameters of a robot-soccer team matching the regulations of the F180-League is shown in this paper. Our team intends to take will consist of five players and one specialised goalie robot who play on a table-tennis field sized arena.*

1 Introduction

In this year the RoboCup takes place for the third time. The goal of RoboCup is to force and demonstrate the abilities of autonomous robotic systems in a competition of several teams. In recent months our team designed a field player and a goalie robot at the University of Technology of Ilmenau. The robots are remote controlled by a PC via infrared data link. The global vision system uses a colour CCD-camera mounted above the field and a frame grabber connected to an PC. The robots are designed in a wheelchair configuration powered by two 7 Watt DC-Motors. The position is measured by optical incremental encoders fixed on the motor axis. A board using an 80C535 micro-controller was developed for controlling the movement, managing the data exchange with the PC via infrared and for some other functions. A kicking mechanism is implemented in the field players to improve their capabilities to play soccer. The specialised goalie robot is designed to react as fast as possible on a short distance and to be able to catch and kick the ball.

2 The Robots

2.1 Mechanical Design

Our Robots are designed for maximal manoeuvrability and agility. They are driven by two DC-Motors mounted on an aluminium-frame. Two Teflon skids are fixed on front and rear of the frame. The height of the skids is adjustable to cope with different surface qualities. The frame also carries the micro-controller and power-boards as well as the kicking mechanism. The geometry of the frame provides a wide plane area (140mm) for contacting the ball on front and back. By now the kicking mechanism only works for

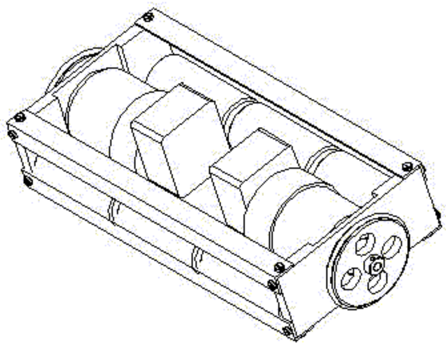

Figure 1: CAD-Model of the robot frame without electronics and kicking mechanism

the front direction. A small gear motor is used to wind up a spring that pulls the kicking lever. The lever is released by an electromagnet to achieve accurate kicking timing . After a kick the gear-motor pulls the lever back and tensions the spring again. The electromagnet is activated either by the micro-controller or by a light barrier that detects an approaching ball. The light barrier is also used as sensor for the ball when dribbling. When hit, the ball is accelerated to a speed of up to 6 m/s. The robot itself has an acceleration of about 3 $m/^2s$. It crosses the whole table in 1.5 seconds including acceleration and braking.

2.2 Controller Hardware

We use a special designed controller-board in our robots. The board is based on a 80C535 micro-controller with 32kBytes of RAM and 32kB of EPROM. For decoding and counting the signals from the incremental encoders an peripheral circuit containing two 24-bit counters is used. It is connected to the data and address bus for fast read/write operations. The controller communicates with the PC either by serial cable for programming or via infrared during the game. To avoid interference with other teams using infrared communication as well, the modulating frequency of the infrared signal can be adjusted. Some additional circuits for the kicking mechanism are placed on this board too.

2.3 Power Electronics

Each motor is powered by a MOSFET H-bridge configuration that amplifies the pulse-width modulated signal generated by the micro-controller. So the wheels can be driven individually in both directions. For braking two modes are implemented. In the passive mode, the bridge is connected as a short circuit for the current generated by the braking motors. Better braking performance is achieved in the active mode, where the voltage on the motor is reversed until the robot has braked down to the desired velocity. A rechargeable NiCd battery pack providing 7.2V and 1.8 Ah is the source of energy on the vehicle. The peak current consumed by the entire robot while accelerating is approximately 4A. During normal play conditions the energy lasts for more than 30 min. Therefore it is discussed to use smaller batteries in order to reduce the weight of the robot.

3 Global Vision System

A colour CCD-camera (resolution 768 x 576) captures images of the field. These images are processed on the PC. The algorithms for object detection are specialised in detecting coloured spheres at high speed and under variable lighting conditions. First the computer performs a rough pre-scan of the image. When detecting a pixel of the searched colour, the program tries to find all points of the same colour in a small area close to this pixel. Then the centre of the coloured area is computed. In order to get faster algorithms the RGB vectors are transformed into HSV vectors. Currently we achieve to process 20 frames per second in position detection. But there is still room for improvement when processing half frames. By now we use a PentiumII/233Mhz system and a standard PCI-Bus frame grabber. The Computer detects the coloured markings of the robots and then calculates their position and orientation. When comparing two frames also the speed can be computed. These data are transferred in a strategy and path planning task which also runs on this computer.

4 Game Strategy and Path Planning

The strategy and path planning task evaluates the information provided from the object detection task. The strategy contributes the high agility and the kicking mechanism of the robots. The task knows several actions like:

- goto a relative position
- kick towards a relative direction
- kick coming ball immediately
- rotate about a specific angle

It decides from the current situation which command to send to the particular robot. For every robot all possible actions are weighted depending on its own position, the position of the ball and the position of the opponents. Normally the robot closest to the ball has the highest priority and gets his command first. Only in defensive situations the goalie robot is served first. All commands sent to a robot use relative coordinates and angles depending on the current position and orientation of this robot.

5 Conclusion

The robot soccer team of the University of Technology of Ilmenau is existing in its first year know. By now the fundamental functionally and basic hardware is designed. Since our team belongs to the department of mechanical engineering we also added some additional mechanical features, such as the kicking mechanism to our robouts. This helps our robot to play a more dynamic and human like soccer.