TDP of ZjuNlict 2007

Wanli Jiang,Han Ouyang,Lin Dong,Jiangbo li,Wenfei Wang,Rong Xiong

National Laboratory of Industrial Control Technology
Zhejiang University
Zheda Road No.38,Hangzhou
Zhejiang Province,P.R.China
wfwang@iipc.zju.edu.cn
http://www.nlict.zju.edu.cn/ssl/WelcomePage.html

Abstract. This paper describes the improvements of ZjuNlict we have made during last year. We make changes in the selection of motors, design of dribbling device and wheels. and for the electronics part, our circuit architecture, motor driver, wireless system as well as the shooting device. Our vision part has made improvements in color sampling to accommodate the varying light condition, and are now able to recognize opponent robots with some certain ID blob configuration. Our AI module are improved to emphasize more on the team cooperation, rather than single robot ability.

1 Introduction

Our team is an open project supported by the National Lab. of Industrial Control Technology in Zhejiang University, China. We have started since 2003 and participated in RoboCup 2004, 2005 and 2006. The competition and communication in RoboCup games benefit us a lot. In 2006 Robocup, we were one of the top eight teams of the world. We also won the second place in Robocup China Open 2006, and are now the champion team of China.

2 Mechanical Design

Our new robots' mechanical information:

- Height: $145mm$
- Diameter: $178mm$
- Percentage of ball coverage: 18%

Our robots are equipped with four $30 - watt$ brushless motors with external $4:1$ gears, a dribbling device, a shooting device and a chip kick device. From Robocup 2006 at Bremen, we saw the problems in our mechanical design. One is that the ball controlling ability is still weak. Another is that the motor axles are easily crooked when robots are running, and the reason is because the wheels are connected directly with the motor axles.

We tried some ways to improve on the mechanism of the dribbling bar for the subsequent Robocup China Open 2006, and are glad to see that those changes greatly increased the ability of ball controlling. And also to prepare for the Robocup 2007, we have taken many steps on the mechanical design. The first and also the most notable change is the new selection of our motors. Our new motors are shorter in length and larger in diameter than the previous ones, so that there can be enough room on the chassis for the electromagnet mechanism of the chip kick device. Secondly, we keep trying new design and new material for the dribbling device, hoping that it can perform even better. Moreover, the wheels are changed to be smaller and thicker. And with gears connecting the motor axle and the wheel this year, we can decrease the radial load of the motor axles when a robot is running. For all of those, we believe our robots will show a brand new appearance and also an even better mechanical performance at Atlanta.

3 Electronics

Several big changes are made to our circuit architecture, motor driver, wireless system as well as the already-strong shooting device. We switch to FPGA-based all-in-one solution as the central processor module, so that we'll have only one PCB to do all the jobs. Meanwhile, the on-board firmware has been well re-designed and rewritten. The new framework is believed to be well modularized and scalable. To support newly-equipped brushless DC motor, the motor driver is replaced by a compact module based on $MC33035$. We will try to implement our own brushless driver on the FPGA in the near future. We have been changing our wireless module for the last three years, and there is no exception this year. A commercial wireless module based on $nRF2401$ will be implemented in our new robot, and this will give our robot the ability to talk with the central PC in full duplex mode and with high speed (up to $1Mbps$). The strong shooting device last year was amazing, even beyond our expectation. To take one step further, now we choose two smaller capacitors with higher voltage, to achieve a better result. This will help us save more power and permit several shots in short intervals.

4 Vision System

Our vision system is a concentrated system in which data of the images captured by cameras are transferred through 1394 FireWire to PC, where each frame of image is then processed to obtain the positions of the ball and robots.For our own robots, as well as opponent robots whose identify blobs are organized in certain pattern, we can distribute each of them a special number. Under the contemporary hardware condition (CPU of $3.0GHz$, and RAM of $1.0GB$), we can achieve a processing rate of $60f/s$.

4.1 Hardware

We use two Basler A310a Fireware cameras, one for each half-field. The image data is sent through 1394 FireWire to PC at the speed of $60f/s$ and the resolution of the image data is $640 * 480$.

4.2 Calibration

Calibration parameters are computed via Tsai's method[1], which is programmed in MATLAB, and are then used to map the object coordinate on the image to the coordinate on the field. The error between the computed field coordinate and the actual one is less than $15mm$.

4.3 Sampling

In order to differentiate the various objects on the field, i.e. ball, our robots and opponent robots, we need firstly to decide the color thresholds for these objects. Considering the inconsistent light condition of the field, we decided to use local thresholds method, which divides the whole field into many blocks, each of which stores its own set of threshold parameters. Moreover, in order to obtain these sets of parameters more conveniently, we designed a cover with special color configuration, which can be wore by our robot and ran over the field so that every block's threshold data are updated.

4.4 Object Recognition

To minimize the computation load, we first take a background image without any objects in it. Then, during procession, the new image minus the background image is changed to HSI color space, and colors on the image are decided using the threshold parameters that previously set. Contour tracing method is used to find connecting regions with a same color. Blobs of different colors form a certain configuration enable us to recognize the ball and the robots. After both of half-field images are processed, in accordance with history information and sizes of the blobs, information from these two images are merged to generate our final result.

5 AI Module

This year, our AI module has been improved to enhance more on team cooperation than single robot abilities. Our former AI module is a hierarchical architecture consisting of Play, the top strategy of the whole team plan, and Skill, the lower strategy for single robot behavior. This year we add another strategy layer, called *SubPlay*, between Play and Skill, for cooperating behaviors of two, or three robots. The addition of this strategy layer can facilitate us to create more cooperation between robots to finally form a competitive team behavior.

We also put our emphasis on self-learning ability for a robot, which enables him to adapt to the different conditions of field surface, ball and robot's mechanical state. Self-learning system adjusts parameters related with single robot skill, which can be held off-line or online. Our initial goal is to develop a basic off-line learning component and put some primary use of it in some single robot skill, for example, the shoot skill.

References

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