ZJUNLICT
Team Description for ROBOCUP 2008

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Abstract. This paper describes the improvements of ZJUNLICT we have made during last year. We emphasize more on robots' stability and robustness. We changed for new motors for ball dribbling to achieve better ball control. We realized dual-direction communication this year and made some alterations in mechanical design, which enable our robots to easier adapt to different venues. As to our vision system, we added functions of chipkick detection and opponent robot identification. We are now able to recognize the pose of opponent robots of some certain ID blob configuration. The architecture of our AI module has been amended to emphasize more on the team cooperation, rather than single robot ability.

1 Introduction

Our team is an open project supported by the State Key Lab. of Industrial Control Technology in Zhejiang University, China. We started the project in 2003 and have participated in RoboCup 2004(Lisbon), 2005(Osaka), 2006(Bremen) and 2007(Atlanta). The competitions and communications in RoboCup games benefit us a lot. We were the champion team of China in 2006, 2007, and won the fourth of the world in Robocup2007.

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 (figure 1).

In the past 2007, our robots' mechanical capability has been improved a lot [5]. The new changed motors have a good performance in stability and robustness, while the improvement on the dribbling bar greatly increased the ability of ball controlling.

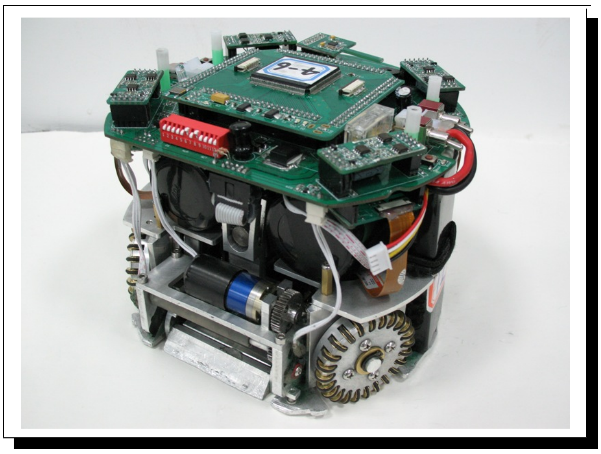

Fig. 1. Hardware of ZJUNLICT2008

However, after Robocup 2007 in Atlanta and China Open 2007 in Jinan, we found there were still many disadvantages which need to be solved. Firstly, the ball-controlling was still not satisfying in fierce competition with opponent robot, so we chose new and more powerful motors for ball dribbling. The mechanical and electronic design for the new motors has been done to achieve more on strength and stability. We still keep trying new material for the dribbling device, hoping that it can perform even better. Moreover, the problem that the kickers sometimes couldn't rebound freely is solved after we improved the design in assemblage. Finally, some other improvements have been taken to enable our robots to easier adjusted to different ground conditions.

3 Electrical System

Our circuit architecture does not change much this year. We use FPGA-based all-in-one solution as the central processor module as we did last year. The brushless DC motor and wireless module based on nRF2401 are not changed either.

Still, we make two improvements to make system stronger. One change lies in the dribbling motor, in which we use high-power brushless DC motor instead of the motor with brush. Thus our robot becomes a better dribbler now. The other change is the mode of wireless module. The communication between robot and central PC was unilateral before, and only the robot could receive the message of central PC. Now we alter the communication to bidirectional by rewriting the software of FPGA. The robot and the central PC can now talk to each other.

4 Vision System

4.1 System Configuration

The global vision system consists of two Basler A311fc cameras, each of which covers a half-field. The maximum resolution or each camera is 652 * 491pixels. Under current hardware condition(CPU of Dual Core 3.0GHz, and RAM of 2.0GB), stable performances of our vision system can be achieved at a processing rate of even 73 frames per second. However, currently the image data is captured at 60 frames per second and then sent to PC through IEEE 1394a Protocol at 30 M pixels/second transfer rate. After image data processing, the vision system communicates with AI system through a UDP port. For the ball, this year we are expecting to make motion reconstruction and get the position in 3-D world coordinate.

4.2 Chipkick Detection and Calibration

Tsai's camera calibration method [1] established coordinate transformation in relation to the image from the real world. Both coplanar and non-coplanar calibration parameters of Tsai's method are applied in our system. Since chip kick skill is widely used in Small Size League games, we are also holding experiments on detecting the motion tracking of the ball according to the FU-Fighter's method [2],. Theoretically, the non-coplanar method is considered to be applicable of computing the chipkick flight reconstruction. The algorithm has been programmed in Matlab, and the filtered ball track and regression analysis will be applied for optimization due to better precision.

4.3 Object Recognition and Illumination Invariance

Regional threshold method is used under inconsistent lighting situation. The match field is divided into many blocks, each of which stores its own set of regional configurations, including color differences, threshold parameters and background coefficients. The orientation of opponent robots has been detected reliably through two routines: One is to convert the intensity (also called brightness) of the cover to 1-D signals by scanning at a constant radius from the center of a certain robot [3]. The other is to search identical blobs by identifying the color differences. The annular information of a robot with off-line sampling enables us to find the orientation.

5 AI System

5.1 Strategy Hierarchical Architecture

Our A.I. module is implemented in a play-based approach. The procedure of strategy-making in one cycle is an iterative and tree like processing. Figure 2 gives an overview of our strategy structure.

Plays A Play represents a fixed team plan, in which each team player will be assigned a role according to the selected strategic zone he is in , and has a task to execute. A play comprises of different types of subplays.

Subplays Subplay is a strategy layer between Play and Skill, and generates tasks for a group of robots collaborating in a local mission, such as two robots' passing and attacking, or three robots' defending. When a subplay processes in any cycle, it selects proper roles for its special mission, assign to these roles corresponding skills to execute.

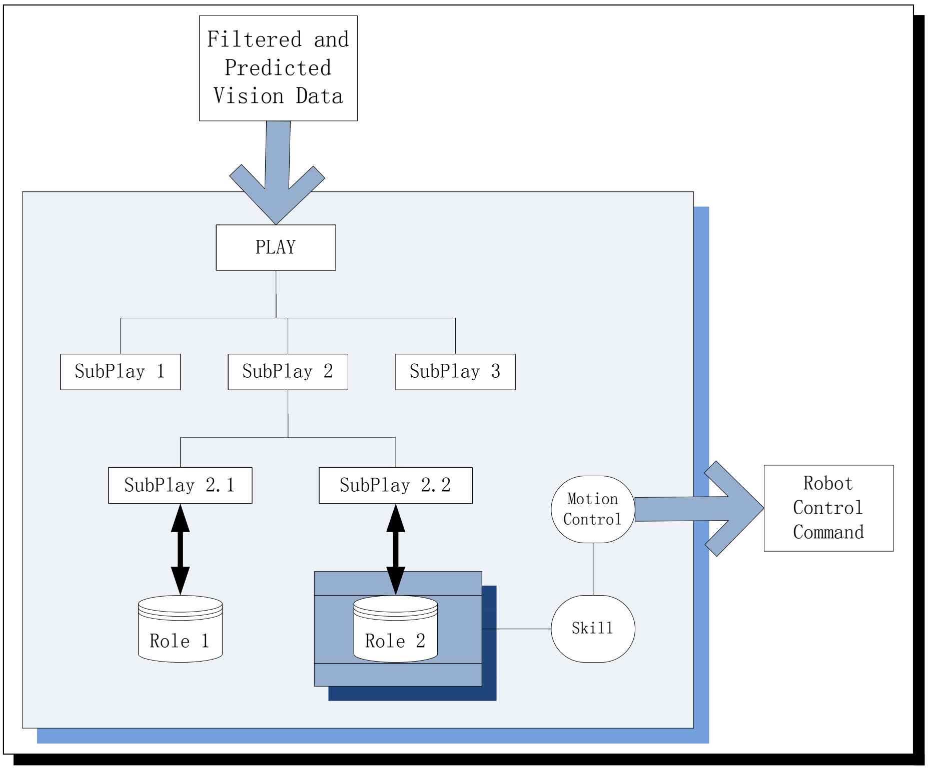

Fig. 2. Strategy Layer Structure

For code reusability, our subplay is a tree like structure, in which a bigger subplay may be decomposed into smaller subplays. For more flexible cooperations, we also add communication ways between subplays. Thus a subplay can obtain other subplays' state and determine its own behavior in a collaborative way.

Skills A skill is executed independently. They are actually the highest level of a single robot behavior, such as shoot, pass, goalie, etc. For one specific skill, a special action planning is executed. For example, the destination information for robot is calculated, which includes target positions, the statuses of kicker device and dribbler deveice, and etc.

5.2 Control and Self-Learning

We also put our emphasis on self-learning ability for a robot, which enables him to adapt to the different conditions of field surface, or 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.

This year we can develop our online learning system since the implementation of the dual-direction communication. For example, each robot's maximum speed is an important parameter for motion control algorithm. However, it varies in different field surfaces, which makes it hard to set a fixed offline value for it. If feedback speed detected by the robot itself is acquired, our program can compare the command sent to the executing result, and then calculate a proper maximum speed parameter of the playing field.

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