Skuba 2013 Team Description

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Abstract. This paper gives a brief description of Skuba, A RoboCup Soccer Small Size League robot team. The system is designed under the RoboCup 2013 rules in order to participate in the RoboCup 2013 which hold in Netherlands. The system of our team consist of several components which we describe in each section. The main improvement of this year is our robot hardware.

1 Introduction

Skuba is a RoboCup Soccer Small Size League robot team from Kasetsart University, Thailand. The team has participated in RoboCup Soccer Small Size League since 2006. We got 1st place four consecutive times since 2009 to 2012. We also participated in the RoboCup Iran Open 2011 and RoboCup Japan Open 2012. Our team got championship from both competitions.

Our system is composed of two main components: robots and software. Robot consists of several components such as electronic boards, kicking capacitors, motors and other mechanical parts. Software is the artificial intelligence system. It use data from global vision system run by SSL Vision, the shared vision software, to make decision and choose a suitable strategy for particular situation and send commands to each robot via wireless signal.

This year, we decide to build new robots with the new design because our robots don't have any major improvement since RoboCup 2008. Previous year in RoboCup 2012, our robots had serious problems when facing other team robots which have more powerful motors. For instance, robots were pushed by opponent into the defense area causing penalty. Thus, the robot hardware is needed to be improved in order to obtain a better performance and has more power to eliminate those disadvantages.

In order to improve robot performance, more power motors are selected and robot body including electronics and mechanics is redesigned because it has to be compatible with the new motors.

adfa, p. 1, 2011.

2 Robot

This year, eight identical new robots are built with the new hardware and also re-design the mechanical parts to make it fit with the new hardware.

2.1 Hardware

The robot has four omni-directional wheels. For the old version, 30 W Maxon flat brushless motors are used as robot's wheels driven motors. This year, the motors are changed to 50 W Maxon flat brushless motors. Comparing the new motor with the old one, we found that the 50 W Maxon flat brushless motors provide more torque which means the robot can has a better performance when tackled by others.

The dribbling device is round bar cover with silicone tube connect to 30 W Maxon EC brushless motors. The motors can run up to 37,700 rpm and cover the ball 20% of diameter.

The kicker consists of flat-kicker and chip-kicker. The flat-kicker uses solenoid to kick the ball with maximum ball speed is 14 m/s. The chip-kicker uses flat solenoid attached with a 45 degree hinged wedge on the bottom of the robot which can kick the ball up to 7.5 m. Both kickers are driven by four 1200μF 250 V capacitors. Each kicking device is controlled by separated board below the middle plate. Figure 1 illustrates 3D model of our new robots.

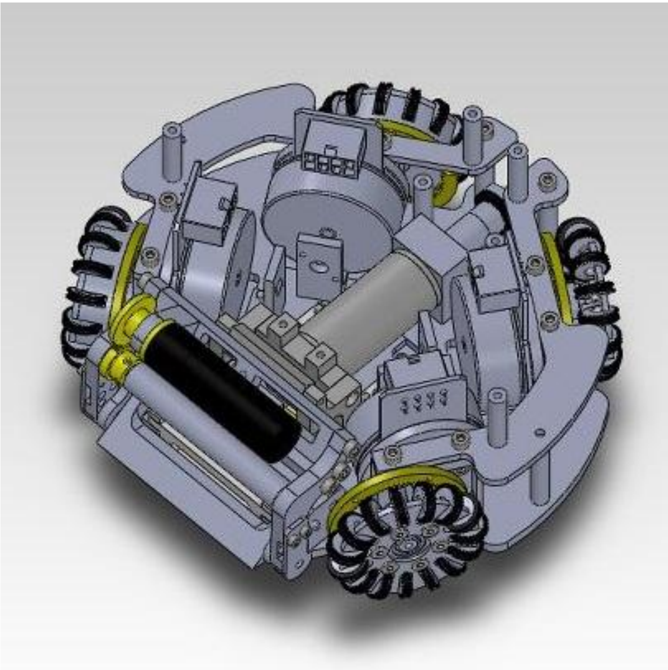


Fig. 1. New robot 3D model

2.2 Controller

The robot hardware is control by a single-chip Spartan-3 FPGA from Xilinx. The FPGA contains 32-bit microprocessor core run at 30 MIPS and interconnected peripherals. This embedded processor executes the low level motor control loop, communication and debugging. The brushless motor controller, quadrature decoder, kicker board controller, PWM generation and onboard serial interfaces are implemented using FPGA logic gates. The robot receives control commands from the computer and sends back the status for monitoring using a bidirectional 2.4GHz wireless module.

A Kicker board is a boost converter circuit using a small inductor. This board is separated from the main electronic board. Figure 2 and Figure 3 show the main electronic board and kicker board.

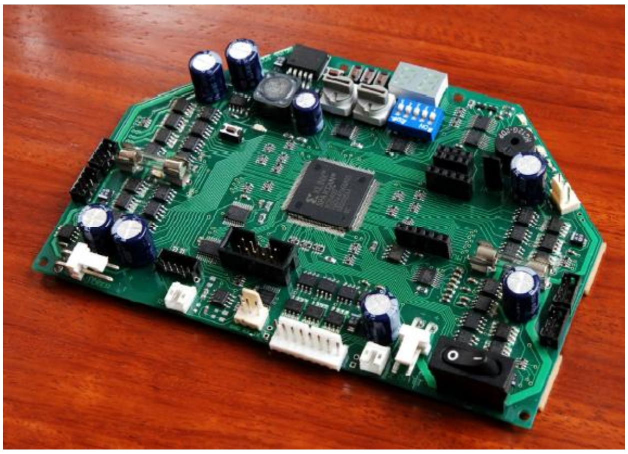


Fig. 2. Main electronic board

Fig. 3. Kicker board

3 Software

The overall software architecture is shown in Figure 4. The software system consists of several modules organized in multi-layer. The Design of software system is based on Cornell Big Red 2002's software.

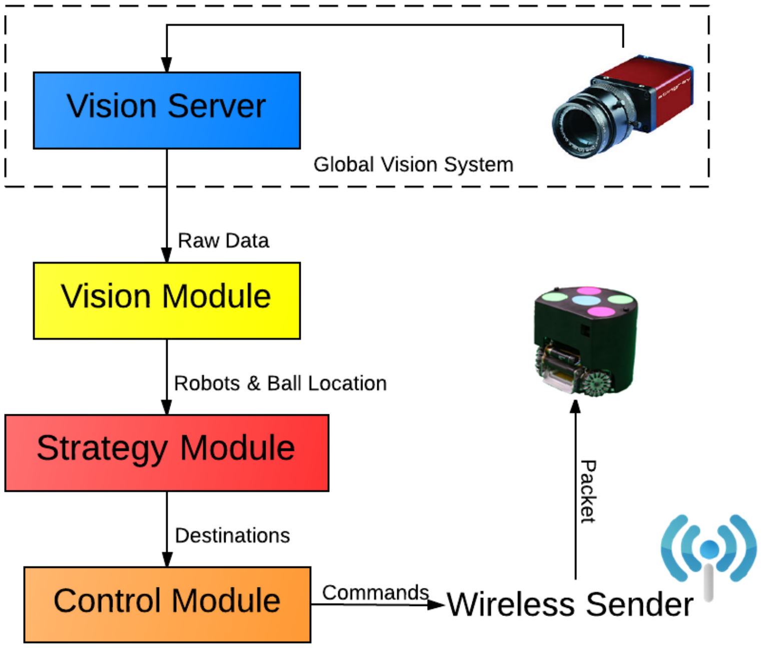


Fig. 4. The software architecture

3.1 Vision Module

Vision Module takes vision data from Vision server and extracts velocity from those data. It also predicts future location of robots and the ball.

Our total system latency, measuring from the period between command velocity and raw velocity, was approximately 133 ms (8 frames). When our robot move at the maximum speed, that is up to about 3.5 m/s, the distance between real robot position and the robot position from vision data will grow up about 47 cm. In order to correct this error we have to estimate the positions and orientations of the robots.

For opponents and ball, two states Kalman filter is applied to predict opponent robots and ball location with more accuracy location.

3.2 Strategy Module

Strategy Module use vision data from Vision Module to figure out which one is the best tactic for particular situation. The structure of this module is based on STP framework [2].

The module contains several Plays which store in 'Playbook', a collection of Plays, when Play was executed it call the 'Role' of existing Position (For example, Goal-keeper, Defender). Then the Role runs Skill, which keep in 'SkillSet', for related robots. The architecture of Strategy Module illustrate in Figure 5.

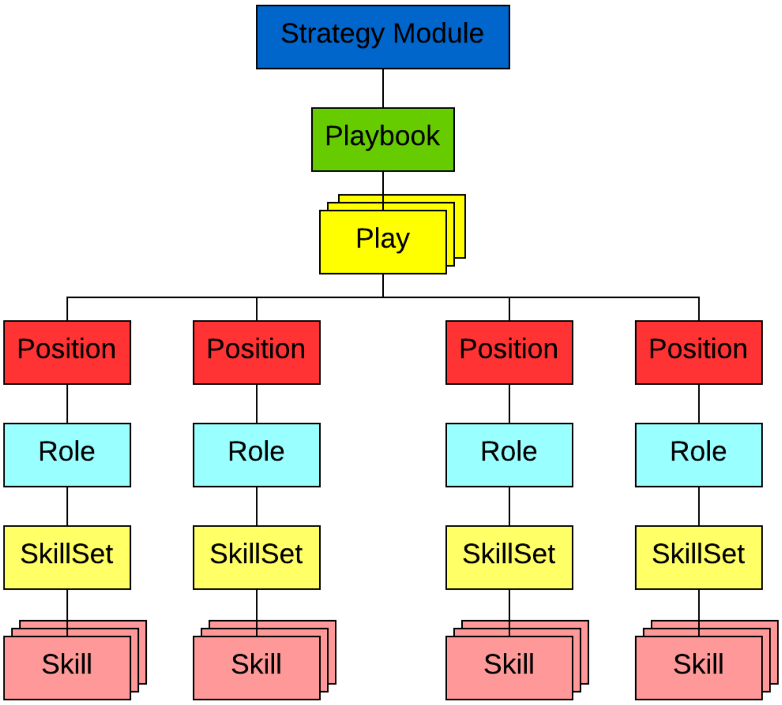


Fig. 5. Strategy Module Architecture

3.2.1 Role Definition

There are four main robot roles: Aggressor, Blocker, Creator and Defender. Each role has specific duty in the field.

Aggressor is the most active role. It always looks for the ball. See a robot go up to an opponent who has the ball, either to screen him from our goal or strip the ball away and try to score whenever possible.

Blocker (Goalkeeper) always remains in goalie box to prevent opposite team from scoring by blocking or intercept the ball. Another duty of Blocker is clear the ball when inside the goalie box.

Creator is a robot that supports the Aggressor. Main role of Creator is to create attacking opportunities. Creator move into position that has high chance to score if Aggressor pass to and rebound the shooting that was blocked by opponents.

Defender is the position that dedicated for defense. This player always remains around our defense zone and cooperate with Blocker to stop opponent from scoring. Defender tries to cover area as much as he can to ensure that the opponent robots can't score. Moreover, Defender also attempts to clear and intercept the ball whenever possible.

There is another role call 'SpecialOp' which can play as extra Defender, Aggressor or Creator depend on current Play. Figure 6 shows the role of each robot in real game.

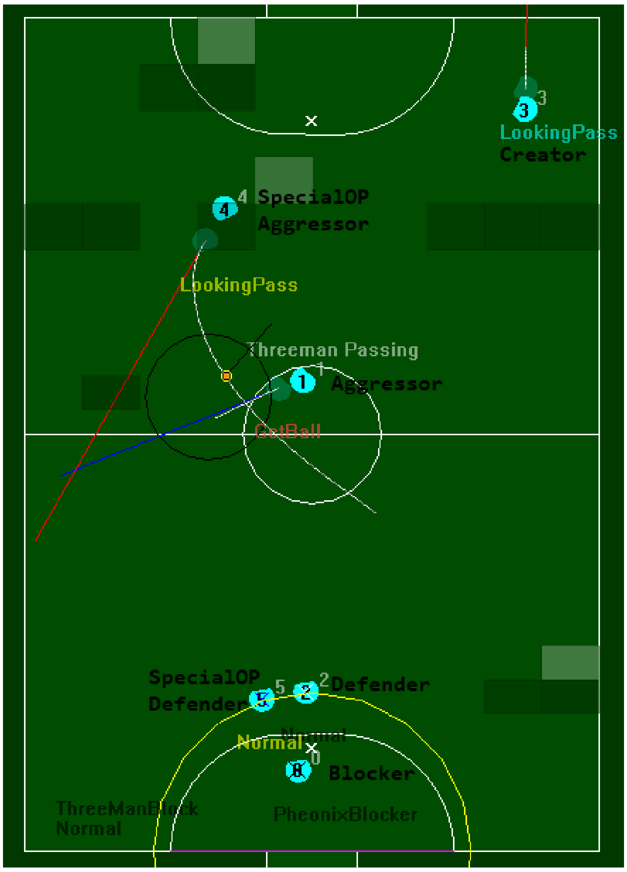
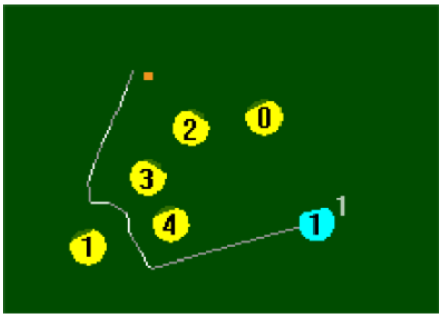


Fig. 6. Role of each robot in real game situation.

3.3 Control Module

Control Module receives destinations from Strategy Module and make robot go to those destinations. This module also uses vision data from Vision Module as a feedback for Closed Loop control.

The important component of Control Module is path planning algorithm. We have implemented two path planning algorithms: Rapid-Exploration Random Tree (RRT) and Sub-goal Path Planning. Figure 7 shows paths generate by RRT algorithm and Sub-goal algorithm.



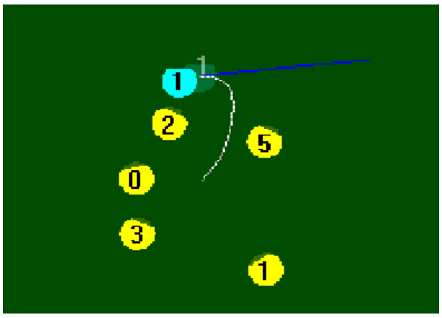


Fig. 7.1 Path generate by RRT algorithm **Fig. 7.2** Path generate by Sub-goal algorithm

3.4 Wireless Sender

Commands which are generated by Control Module will be packed into single packet for each robot. Then, the wireless board will distribute packets via wireless signal and the robot will receive only the packet that sends for itself. In addition, we also get real-time information, for example battery level from robots by let it send wireless signal and use the wireless board to receive those data. Last year, we were facing messy frequency channel. This issue made the robot uncontrollable. Thus, this year, wireless is shifted to other frequency in order to reduce jamming issue.

3.5 Simulator

Simulator is developed in order to simulate robot behavior. The Simulator receives a sequence of packets which is identical to packets that are sent to real robots then calculates some simple physics and returns the coordinate of objects in the field to the software as same as the VisionServer does. Our Simulator is entirely independent from AI System which is capable of simulating all the field objects and latency of the system.

4 Conclusion

This year we mainly focus on develop new robots because we never make any important change to the robots since 2009. We changed many hardware especially the motors to improve robot overall performance. We hope that the changes we made in this year will solve the problem that we faced in RoboCup 2012 and help our team to perform better in this year competition.

5 Reference

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2. Browning, B., Bruce, J.R., Bowling, M., Veloso, M.: STP: Skills tactics and plans for multi-robot control in adversarial environments. In: Journal of System and Control Engineering. (2005)