SKUBA 2012 Team Description

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Abstract - This paper is description of Skuba, small-size league robot team. Skuba system has two main components: robot system and software Architecture. We explain both in robot and software architecture section. In this year, our research focuses on pass-shoot strategy for 3 robots due to the new rules of Robocup 2012 which increase number of robots.

1 Introduction

Skuba is a small-size league robot team. We have participated in World Robocup since 2006. Last three years, we got 1st place in Austria (2009), Singapore (2010), and Turkey (2011).

Skuba system has two main components. First, robot hardware consists of robot hardware wheels, kicker, microcontroller etc. Second part is robot software which generates robot strategies and makes a decision for all robots. It uses information from SSL-Vision software. Then, It will send command to each robot via wireless.

In this year, due to the new rules, which add robot from 5 to 6, is published. We decide to use 6th robot as attacker, because In Robocup 2011 at Istanbul, We found that It more difficult to scores opponent when They put 3 robots as defender.

Our team use 6th robot is assigned as second attacker because it will give more choices in attacking strategy. But, more robots don't guarantee attacking will be more effective because if it doesn't have a good teamwork, it might be no different between 2 and 3 robots. So, this year, we mainly focus on strategy that 3 robots work together.

We try to add new tricks for pass-shoot strategy for 3 robots. Rather than pass only one times. We use advantage that we have 2 attackers and 1 creator to pass two times before shooting for tempts defender to open more space in defense area.

2 Robot

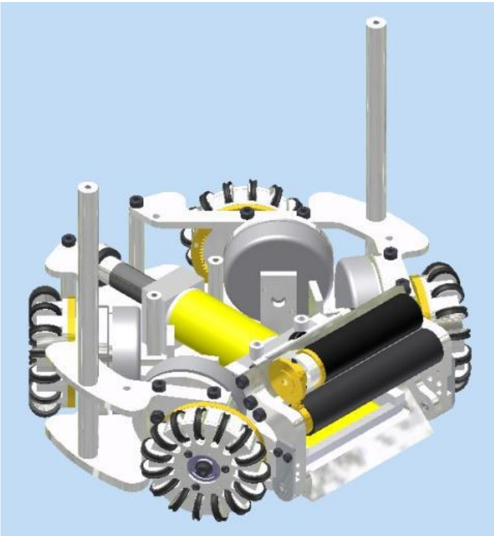
Our team has twelve robots. Each one has diameter 176 mm, and height 147 mm. Fig 1. and Fig 2. show 3D robot model and real robot respectively.

Robot has 4 omni-directional wheels driven by 30 W maxon flat brushless motors. Each motor has been attached by a 360 CPR optical encoder in order to measure motor speed. The Dribbler, which use for drib ball, consist of round bar cover by silicone tube and connect with high speed motor which can run up to 13000 r/m. It will cover 20% of ball diameter when the ball.

The kicker use solenoid to kick the ball with highest speed is 14 m/s. The chip-kicker is a 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 two 2700µF capacitors. Each kicking device is controlled by separated board below the middle plate.

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. The board is separated from the main electronics for safety



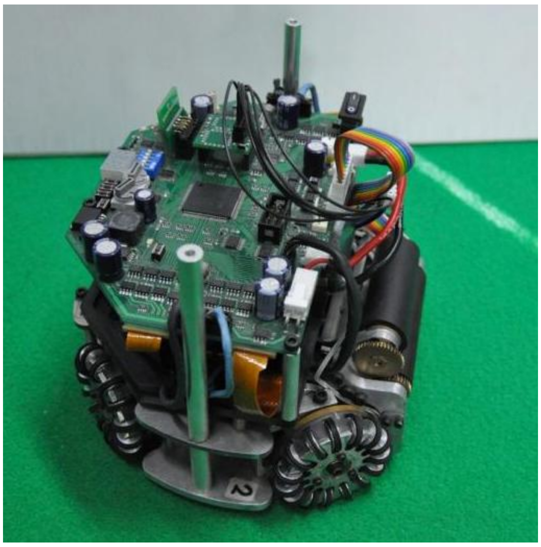


Fig 1. 3D Robot Model

Fig 2. Real Robot

3 Software Architecture

The software based on the strategy structure of Cornell Big Red 2002's software. This software has been being continuously developed since Robocup 2006. The software consists of many modules; in each module has a function to manage something in this software, shown in Fig.3

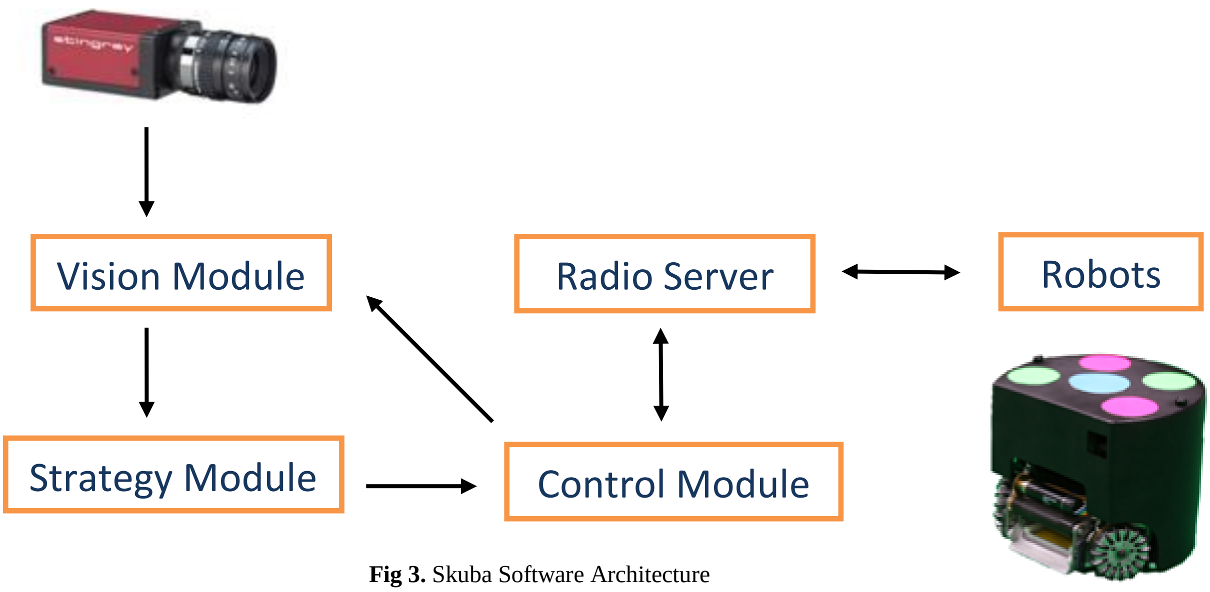


Fig 3. Skuba Software Architecture

3.1 SSL-Vision

The use of shared vision system named SSL-Vision is required by the competition rule. This new vision software can be integrated into the system by simply replacing our Vision Server software. With some code changes in the vision protocol, the existing software works with the shared vision system successfully.
Strategy

3.2 Ball Prediction System

The estimated state from Kalman filter is not accurate enough to predict the real ball position and velocity because two main issues. One is ball model is not good enough and two is vision system which are lens curvature and an overlap area between two cameras. The precise model of the ball movement is described. There are two state of the motion, first is rolling and second is slipping [2]. But if the motion of the ball is directly implement, the extended Kalman filter is used. Moreover, all of the parameters in the equation must be found in different field. Therefore, in order to make the predictor easier, the experimental approach is selected. The velocity of the ball, which is controlled by robot kicking system, in
every frames are collected and fitted to a single equation which is the cubic polynomial expression shown in Fig. 4. Peak of ball velocity is considered and used as a main component in order to fit the cubic curve. The cubic polynomial is now use as the new pre-predicting function and used in every module in our software.

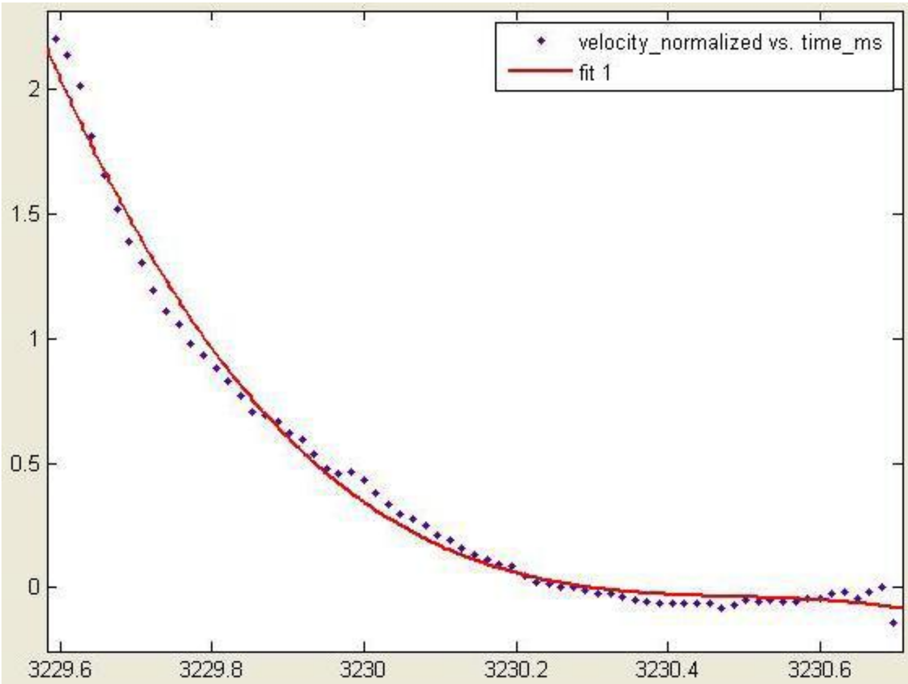


Fig. 4. Cubic Polynomial function between ball velocity and number of frames

3.3 Strategy Module

Strategy module is used for plan a strategy and calculates command for robot. We separated into 3 levels which are Skills, Actions and Plays.

1) Skills are implemented as an individual behavior for a robot. Imagine like basics action in human soccer such as pass, shoot, chip, go to point etc.

2) Actions are behaviors of a group of robots (such as defender, attacker). It construct from skills, when you want to group of robots to do some behaviors. This part is giving you more flexible to implement individual behaviors and then combine together rather than implements all robots which are very complex.

3) Plays represent formation of team like human football such as 4-4-2, 4-3-3, 4-5-1 or something else. It specified how team will play and position of each robot. Play consists of Action and Skill.

3.2 Automatic Strategy Planning

We implement automatic strategy planning to our strategy module by use information from log file in past year and simulator matches. By use this information we can predict opponent's robot duties and strategy to choose which strategy we should play.

4 Pass-Shoot Strategy

Skuba tactics is emphasized on attacking more than defending. We have several attacking approach to score opponent. The one approach that we regular use to be Pass-Shoot strategy. Pass-Shoot strategy is a popular attacking strategy for robot soccer (same as human soccer). It uses two robots to pass and shoot without touch. This tactic works because, in general, defender will stand in position which relate to the ball. When ball is passed from robot to another the defender's position will be change according to the ball position. If a robot passes and shoots a ball with high speed, it might cause a defender can't change position fast enough and a robot will get a goal. The key of this strategy is you have to found position that receiver go to wait the passing ball .Fig 5 show visual image of this strategy.

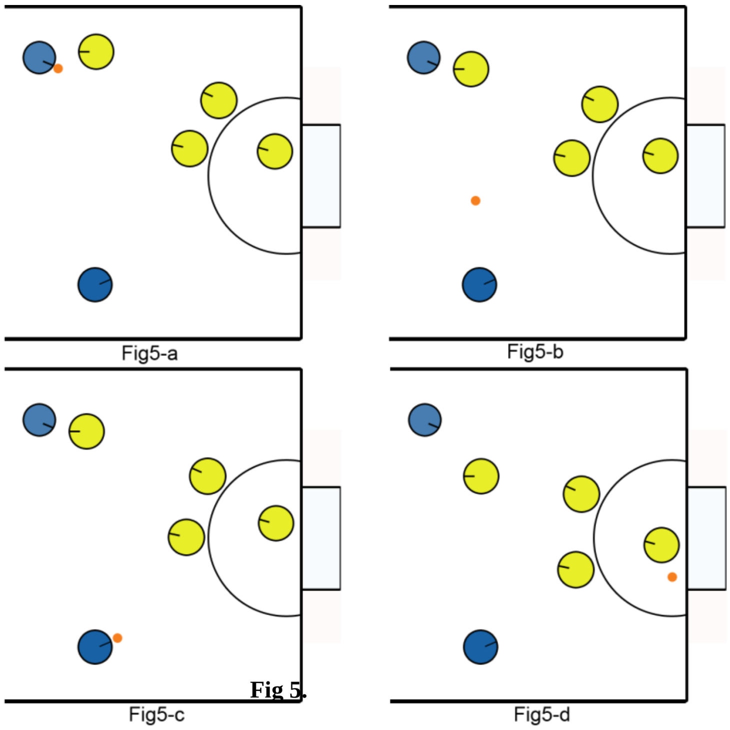


Fig 5.

Fig5-a. defender stand to block attacker from shooting.
Fig5-b. when ball was passed defender try to change position according to ball.
Fig5-c. ball is at receiver but defender doesn't can't go to block because ball is faster.
Fig5-d. receiver shooting and defender can't defense.

New tricks are added to strategy which made it hard to predict and more complex. Since, in the past, we only use one robot as an attacker, when we want to pass-and-shoot we can pass only one time. But, this year, 2 robots are assigned as attackers and one is assigned as creator. So, from this advantage, robot can perform two times passing strategy before do shooting. Two times passing will possibly make opponents open more space than pass just one time. In order to use this new trick, there is a condition that you have to pass and shoot quick enough to guarantee that the system can be considered as a static. To valid this trick, software has to evaluate two possible wait positions for two robots which don't have a ball before pass. Fig 6 show new trick of pass-shoot strategy.

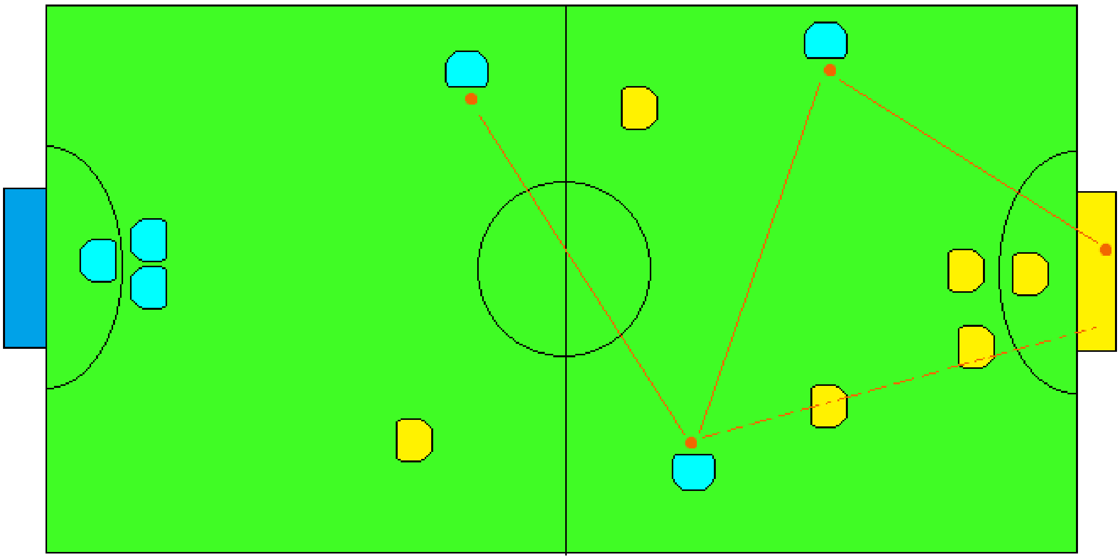


Fig 6. New trick for pass-shoot. First, pass to fake defenders that you gonna shoot then pass again to other teammate and shoot.

In order to evaluate the possibility of this trick, we test it by using a real play of both normal pass-shoot and the new one. Experiment result is show in Table 1.

Strategy	Situation	Result(%)			
		Defender Block	Off target	Intercepted	Goal
Pass-Shoot	Open play	38%	25%	22%	13%
	Set play	42%	21%	15%	21%
New Pass-Shoot	Open play	26%	20%	41%	12%
	Set play	25%	19%	38%	17%

Table 1. Experiment result.
-Defender block means that shooting was blocked by defender.
-Off target represented shooting that out of target.
-Intercepted means that opponent intercepted the ball before we shooting.

Table1 shows results of experiment. We collect data from real game separate into 2 phases: Open play and Set play (corners, free kicks, throws in, etc.). We see that new pass-shoot has equal goal percentage as the old one and it was intercepted by opponents around 41% and 38% in Open play and Set play experiments respectively. But notice that It was blocked by defender less than the old pass-hoot about 12-17%%. This mean if opponents can’t intercept the ball, it has more chance to score than the old pass-shoot.

So, if we develop our AI system to pass more accurately, we will have more opportunity to scores. We start to development a new grid decision evolution for this new trick called "Double layers gird decision evolution" to reduce the interception problem.

5 Conclusion

In this year, we mainly focus on developing strategy module which relate to AI system due to we already have stable robots. Our new trick in pass-shoot strategy which we add in this year still need more experiment and we try to do it in Robocup JapanOpen2012. This new tactics will make attacking more complex and hard to predict for opponents. If the result is coming out good enough, it possible to see a beautiful and complex passing game in robot soccer like in human soccer. Tab 2 shows all competition result of Skuba since year 2005.

Competition	Result
Robocup Thailand Championship 2005	3rd Place
Robocup Thailand Championship 2006	Quarter Final
Robocup 2006	Round Robin
Robocup Thailand Championship 2007	3rd Place
Robocup Thailand Championship 2008	2nd Place
Robocup 2008	3rd Place
Robocup 2009	1st Place
Robocup China Open 2010	1st Place
Robocup 2010	1st Place
Robocup Iran Open 2011	1st Place
Robocup 2011	1st Place

Tab 2. Competition results for Skuba SSL RoboCup team

6 Reference

1.Krit Chaiso, Teeratath Ariyachartphadungkit, Kanjanapan Sukvichai : Skuba Team Description. In Proceeding of Robocup 2011.
2. James Bruce, Stefan Zickler, Mike Licitra, and Manuela Veloso : CMDragons: Dynamic Passing and Strategy on a Champion Robot Soccer Team.