STOx's 2012 TEAM DESCRIPTION PAPER

Saith Rodríguez, Eyberth Rojas, Katherin Pérez, Jorge Lopez, Heyson Baez, Juan Manuel Calderón
Faculty of Electronical Engineering
Universidad Santo Tomás
Bogotá, Colombia

saith_rodriguez@hotmail.com, ruzzosky@hotmail.com, andreahernandez@hotmail.com, jorlopi@gmail.com, heysonbaez@hotmail.com, juan_mch@yahoo.com

Abstract: This paper shows the state of Small Size League team of Universidad Santo Tomas, it is on duty since RoboCup Turkey 2011 and it intends to participate in Mexico 2012. It describes the software and hardware design emphasizing in the enhancements done over this year.

1. INTRODUCTION

STOx's SSL Team was built by G.E.D. (Study and design group of robotic), it is associated to Electronic Engineering Faculty of Universidad Santo Tomas, in order to join the global Robocup initiative. On 2010, it participated by first time in Latinamerican RoboCup Open held in Sao Paulo (Brazil) where it played the final versus RoboFei team thus obtaining the second place. Subsequently on 2011 it participated by first time at RoboCup World Championship held in Istanbul (Turkey), where it was among the top twelve.

The hardware design is composed of mechanical devices and electronic control systems that comprising the robot, within which are: traction control, dribbling and kicker system. The software design is composed by filtering and prediction modules, High level control and the artificial intelligent system that is responsible to take decisions about team strategies.

This year, the main improves of our team are: the manufacturing of a new PCB, an addition of torque control system and model of kinematics modified and the building of new strategies with six agents.

2. HARDWARE DESIGN

Our primary equipment consists of eight identical robots built on 2011. The mechanical design of these robots wasn't significantly changed. The robot measures are 178 mm of diameter and 145 mm high. The driving system (dribbler) covers the ball by 18%, according to the competition rules. The real robot and 3D model of robot are shown at Fig. 1 and Fig. 2 respectively.

2.1 MECHANICS

Mechanical components are based on previous designs of teams of league, and our team developed our own designs to accomplish the needs of the robots and game requirements.

Fig. 1 Real robot

Fig. 2. 3D Mechanical model of the robot

Chassis: The chassis was built based on the design of Skuba 2009. All the pieces were made with CNC machinery using aluminum 7075. The material used and fabrication process provides to the robot a good balance between strength and weight, also a high quality of parts.

Traction: The robot's traction is omni-directional, with four custom-built wheels. Each wheel has 50mm diameter with 15 rollers, these wheels are attached to the motors through a gearbox of 61:17 based on Skuba design 2009. The robot has four brushless motors "Maxon EC45- Flat 30W", these motors provide a maximum speed of 3.2 m/s to each robot. This year we incorporate double seal o'rings to the rollers to provide a better grip to wheels. The Robot's chassis with wheels and motors is shown in Fig. 3.

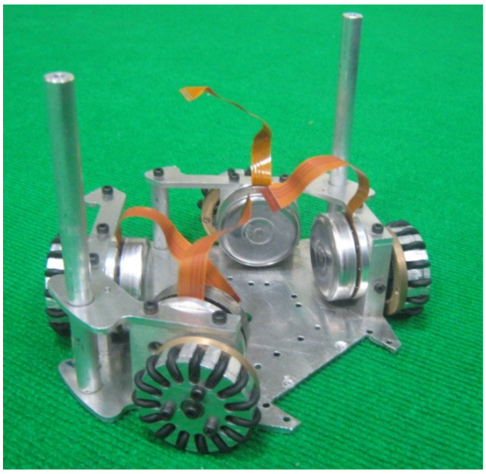

Fig. 3 Robot's chassis with wheels and motors

Dribbler: The ball dribbling system is essentially composed by an EC-22 brushless motor mated to a cylindrical rod covered by rubber with 10mm of diameters. This set provides a maximum rotation speed of 12000 rpms, also the design features a cushioning system to make more effective the ball dribbling. The Fig. 4 shows the dribbling system and the Fig.5 shows the model of dribbling system.

Fig. 4 Dribbling System

Fig. 5 Model of the dribbling system

Flat Kicker: The main kicker device is a custom solenoid. The core is made of Bakelite, wrapped with 6 layers (400 turns approx) of 24AWG enameled wire. The plunger is composed by two parts, a highly magnetic one and other non- magnetic. This configuration provides to robot a maximum kick speed of 10m/s. The speed was limited to 8m/s by software to respect current rules.

Fig. 6. Flat Kicker

Chip Kicker*:* The parabolic kick system is based on SKUBA design and provides a 4m of ball kick distance. It uses a different solenoid that the main kicker.

2.2 ELECTRONICS

Last year each robot used a SPARTAN 3 Starter Kit, for this year we are developing a custom board in order to optimize the space inside the robot.

The robot's electronic system consists of two components: first, the logical system implemented on a Spartan3 XC3S400-PQ144 FPGA and second, the power system that performs a coupling of control logic signals to the motors and sensors.

Traction motors control*:*

It consists in a torque PI controller manually tuned. The speed sensor is implemented by a quadrature encoder 300 PPR. The brushless motor driver consists of a simple combinational circuit that switches the three-phases according to the state of the Hall Effect motor sensors. In order to regulate the motor's speed we use a PWM signal, which is operated by a logical AND with each one of brushless motor driver outputs.

The PI controller is implemented on Microblaze Embedded Processor with Xilinx Embedded Processor Development Kit.

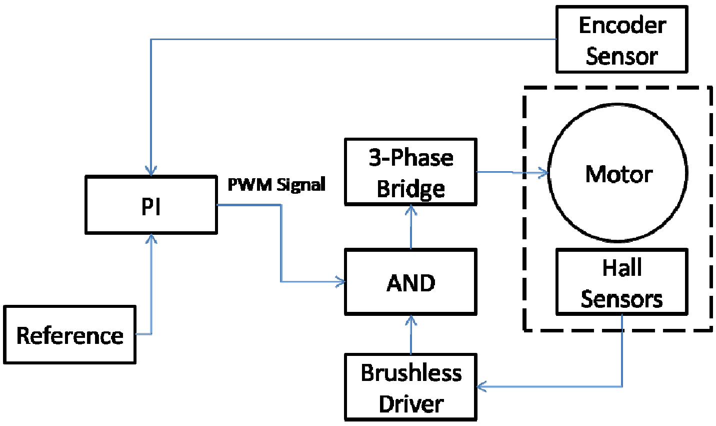

Fig. 7 Control system of traction motors

Dribbler Motor Control: This system is similar to shown in Figure 7 (above). The fundamental difference is that it doesn't use an encoder to measure the speed but uses motor's Hall Effect sensor signals for this purpose. This modification was done because the dribbler control doesn't require a high performance driver. Additionally, it was implemented an over-current protection circuit avoiding the damage of the three-phases Bridge when the motor it's being blocked.

Kicker's Circuit: This circuit consists of two elementary parts: A DC boost converter circuit which charges two capacitors of 2700μF from 0 to 200V in 10 seconds. The second part of this design is the two IGBTs which drives energy from capacitors to corresponding solenoids. The IGBT control signal is a PWM signal that allows the shot intensity modulation.

Ball's Sensor: This sensor is an IR emitter-receiver pair that detects the ball presence inside the robot's Dribbler. The sensor signal is amplified and digitized to be analyzed by the AI system.

Communication: For this purpose we use X-Bee modules, which provide full-duplex communication between the robots and the central system. The X-Bee modules operate in broadcast mode at 2.4GHz frequency and can be set up in 8 different channels. Our team usually used channel 4, but it can be set up quickly into another channel.

Power Supply: This is a single Li-Po battery; it is 11.1 volts and nominal capacity of 2000mAh which provides to the robot with 30 minutes of play autonomy.

3. SOFTWARE DESIGN

The STOx´s software was developed on Microsoft Visual Studio 2008 and consists of different parts like filtering, prediction, control modules and also a multi-agent artificial intelligent system. The system architecture is shown in Fig. 8.

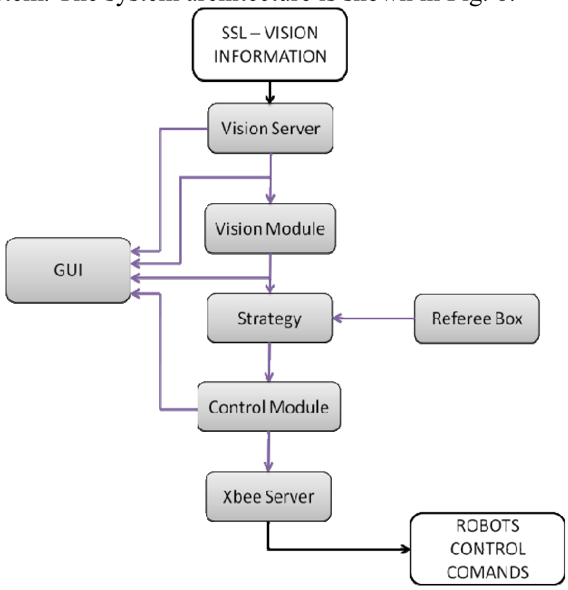

Fig. 8 Software architecture

Vision Server: This block receives the data from SSL-Vision through a UDP Socket, this data joins the information provided by both cameras and it organizes data depending of team color.

Vision Module: In order to compensate the latency of system, the ball position and each robot location are predicted by using Kalman filters, also it performs a ball tracking with the purpose to increase the reliability of ball position into game field.

Strategy Module: In this section we describe all about Team's intelligence. The decisions are taken depending on the different game situations and the orders given by the RefereeBox. The general architecture has a hierarchy form. The vision data and RefereeBox information are evaluated in a module enabled for the team's strategy, which gives the roles (game attitudes) to each one of the robotic agents according to game's situations. The block diagram it's shown in the Fig.9.

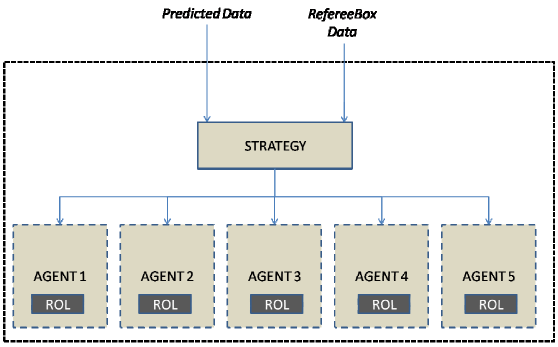

Fig. 9. Strategy Module

Control Module: It consists of two parts: an algorithm of path planning which calculates the robot motion path to reach a goal avoiding obstacles and the Bang Bang algorithm that controls the robot´s velocity changes into the game field.

X-Bee Server: It is responsible for sending and receiving control commands and monitoring each robot.

GUI: It is a Dialog Box which displays the most important information of the system in order to detect mistakes and monitoring processes, also permit to adjust online setup.

Simulator*:* The team uses the simulator supplied by Parsian Robotics.

4. CONCLUSIONS AND RESULTS

This Project began in 2009 and so far we have the same team who participated on the Latin American Robocup Open 2010 taking the second place.

The design and development of these robots has allowed students involve in this initiative. Students can learn how to program every system that can be found in each robot, and also the general artificial intelligence, the electronic and mechanical design required for development of each one of the platforms.

Since 2009 we have faced different problems and challenges of build these robots, but with the help and useful information found in the ETDPs, We could solve many problems and create a platform according to the requirements for the RoboCup F180 League. We hope to take a part this year at the RoboCup 2012 and can share all our experience with teams around the world.

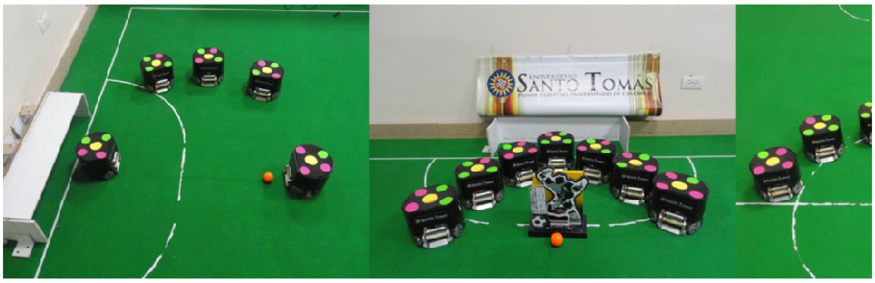

Fig 10. STOx's team

Fig 11. Robocup Istanbul 2011.

REFERENCES

1. Skuba 2011 Extended Team Description. http://small-size.informatik.uni-bremen.de/tdp/etdp2011/SKUBA_ETDP_2011.pdf
2. Skuba 2010 Extended Team Description. http://small-size.informatik.uni-bremen.de/tdp/etdp2010/skuba.pdf
3. Skuba 2009 Extended Team Description. http://small-size.informatik.uni-bremen.de/tdp/etdp2009/small_skuba.pdf
4. Fosler, R.: Generating High Voltage Using the PIC16C781/782. Application note, Microchip Technology Inc. (2005)
5. Bruce, J., Veloso, M.: Real-time randomized path planning for robot navigation. In: Proceedings of the IEEE Conference on Intelligent Robots and Systems. (2002)
6. Valiallah Monajjemi, Ali Koochakzadeh, Saeed Shiry Ghidary, "grSim – RoboCup Small Size Robot Soccer Simulator", to appear in : *RoboCup 2011: Robot Soccer World Cup XV*, 2011
7. RUSSELL, N. Inteligencia Artificial: Un Enfoque Moderno. Prentice Hall, 2004.
8. Gary Bishop, An Introduction to the Kalman Filter: University of North Carolina at Chapel Hill

9. C. H. Messom, G. Sen Gupta, S. Demidenko and Lim Yuen Siong. : Improving Predictive Control of a Mobile Robot: Application of Image Processing and Kalman Filtering: IMTC 2003 –Instrumentation and Measurement: 20-22 May 2003
10. Erik Cuevas, Daniel Zaldivar and Raul Rojas: Kalman filter for vision tracking: Technical Report: 10th August 2005
11. Xilinx EDK Concepts, Tools and Techniques: *A Hands-On Guide to Effective Embedded System Design: EDK 13.1:* UG683 April 13, 2011