

Parsian
(Amirkabir Univ. of Technology Robocup Small Size Team)
Team Description for Robocup 2008

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Abstract. This team description paper depicts Parsian Robotic Small Size Robocup team activities for preparing for Robocup 2008 Small Size League. It's an overview of all activities done in past two and a half year. It's the third time that Parsian is participating in SSL. Our robots mechanical and electrical design, image processing, strategy implementation and software are described in this paper.

1 Introduction

Parsian Robotic is a robotic research group working in Electrical Engineering department of Amirkabir University of technology (Tehran Polytechnic). After being qualified for two subsequence years (2006 and 2007) for Robocup small size league, this is the third year of Parsian's activity in small size robots' field. During past two years Parsian members published 4 BSc theses and 2 papers about these activities.

In this paper, we will mention some of the most important features of our small size robots team. In first section mechanical and electrical design of the robots will be described in details. In second section software and strategy will be discussed. In the final section image processing unit will be introduced.

2 Hardware Architecture

2.1 Mechanical Design

Our current robot is a three wheel omni directional robot with angle of 120 deg between wheels, The robot consist of two floor of aluminum plate and fastened

together by use of three small aluminum parts which holds the motors as well. The shooter consists of a regular solenoid that is attached at the top plate and the motion is transmitted by a metal bar to the shooter head. The roller is a cylinder mounted on two bearings and driven by a dc motor as shown in the picture.

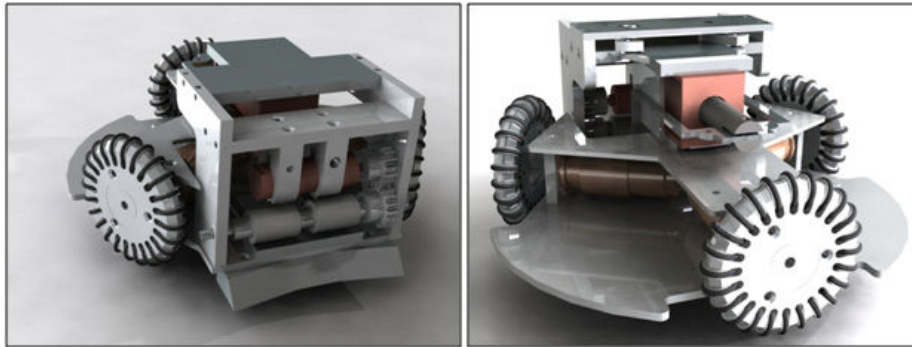


Fig. 1 View of Parsian robotic small size robot (CAD)

2.1.1 Wheels

Last year we designed and manufactured new version of our omni wheels with lower friction loss and 25% less weight.

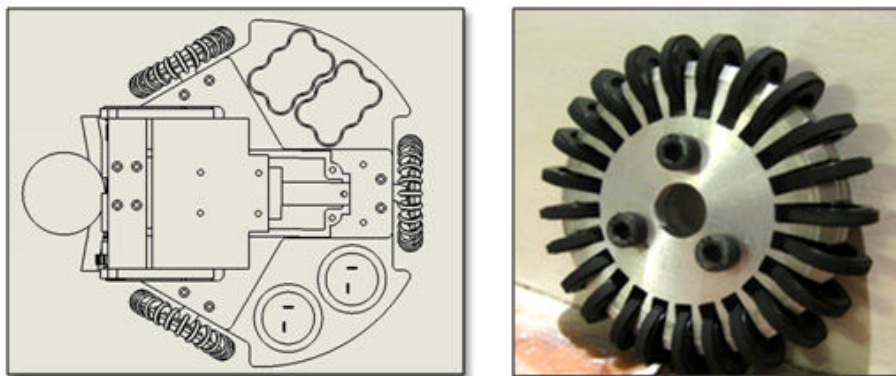


Fig. 2 Top view of Parsian robotic small size robot (Left), Parsian robotic new omni wheel (Right)

2.1.2 Robots Geometrical Properties

Diameter: *178 mm*

Height: *120.0 mm*

Ball coverage (due to RoboCup rules): *19%*

Weight: 1.5 Kg

2.1.3 Next Generation

New pass and shoot method: last year Parsian robotic group designed and manufactured a novelty shooting method, the main idea is to separate the angle of the robot and the angle of shooting system. The advantage of using this method of shooting is that, all teams predict the direction of shooting by drawing a line using center of robot and ball, and the keeper and defenses location are adjusted according to that so this method can mislead the opponent robots especially in penalty and free kicks, beside we can use the best angle for shooting according to opponent robots location. This year we are planning to develop this method for better performance.

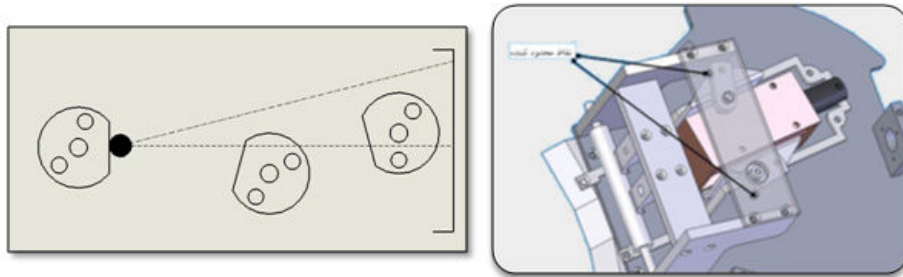


Fig. 3 Advantage of new shooting method (Left), Parsian robotic new shooting method using four-bar mechanism (Right)

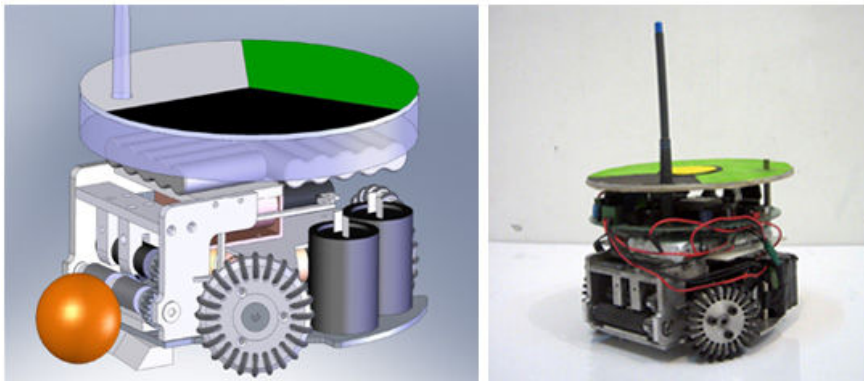


Fig. 4 New design for 2008 (left) and Prototype (Right)

2.2 Electrical Design

This year, our electrical design is the same as 2007. Our Robots' main electronic circuit consists of three parts:

- Communication receiver
- Motor and Spinner driver
- Kicking System Driver

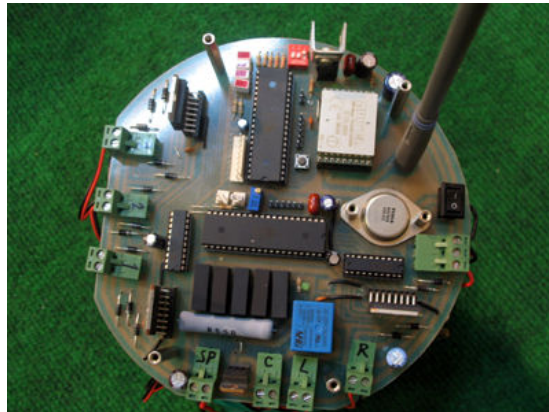


Fig. 5 Main Circuit

As demonstrated in figure 5, circuit board is industrial standards' compliant. For increasing the reliability of the system, each part of the circuit have separate power supplier.

Three motors are driven using two LM298s. The board's microcontroller first processes the input signal of shaft encoders and then controls the speed of each motor through generating proper *Pulse Width Modulated* signals.

A simple infrared sensor in front of the robot senses the ball presence and triggers the microcontroller to start the spinner.

For performing kicks, we use 5 DC to DC converters to increase the voltage from 18 to 180 volts. This voltage charges two 2200 micro farads capacitors. When kick signal receives the microcontroller drives a relay which opens the discharge path to the solenoid. The microcontroller adjusts the relay opening time in order to control the kick strength based on the received command.

2.3 Wireless Communication

Communication system plays an important role in a small size team. Due the demand on high bit rate, frequency stability and low error rate we chose AUREL XTR series wireless modules. Our communication system can operate in both 434 MHz (using XTR 434) and 868 (using XTR 868) frequencies.

The manufactured proposed circuit and PCBs for the module were not suitable for our usage; therefore, we developed new microcontroller based designs for both transmitter and receiver. The receiver circuit is integrated into main robots electronics board. The transmitter is a separate board which receives data from PC via RS232.

In order to reach reliable data transmission, several error checking and correction algorithms have been implemented. This microcontroller used is ATMEGA16 from Atmel AVR series.

Our wireless system can transmit data with the bit rate up to 57600 bps. Its effective range is about 20 meters.

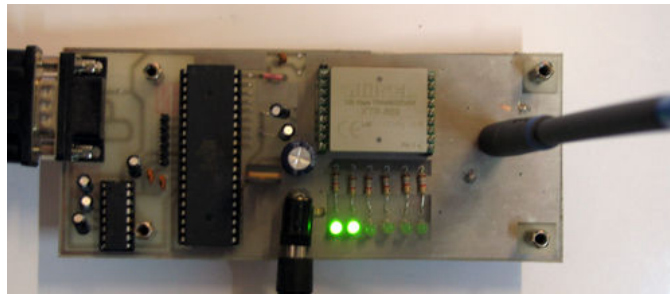


Fig. 6 Our wireless transmitter.

3 Software

During this year, we've completely re-designed and re-coded our software in order to reach a high reliable software framework. In comparison to the 2007 software, the new one is not an integrated program, but it consists of a set of programs which communicate via network using UDP¹ protocol. The software schema is shown in figure 7.

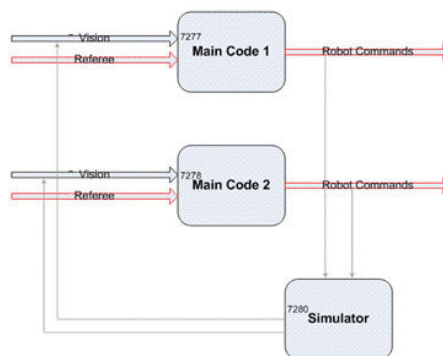


Fig. 7. Software Schema

¹ User Datagram Protocol

3.1 Main Code

Main code is the brain of the system. An overview is shown in figure 8. In each cycle it receives both vision packets from the vision software [or the simulator] and referee commands from the referee box. Then it generates the world model and makes decisions based on game status and world model. In the case of movement, the obstacle avoidance algorithm corrects the target points in order to avoid obstacles. Finally the main code compiles the decisions to robot commands and sends the generated command to wireless transmitter via RS232.

The main code is written in ANSI C++ and runs under Windows. As the main code itself runs in text mode, there is no need to a powerful computer during game play. In simulation mode, two instances of main code can be run in parallel, in order to simulate a one-to-one game.

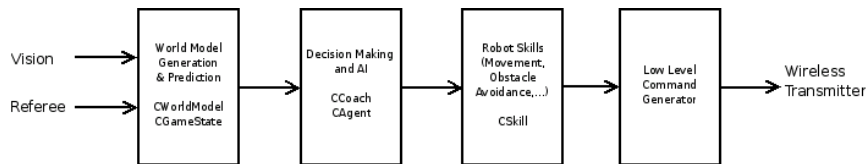


Fig. 8. Main code overview

3.2 3D Simulator

Due the high setup times and high costs of robots, one of the biggest concerns for us was developing software with minimum dependency on real robots. Our “3D Small Size Soccer Robots Simulator” is written in C++ with help of “Open Physics Abstraction Layer” (OPAL) and “OpenGL graphics library”. OPAL itself uses “Open Dynamics Engine” (ODE) as its engine.

This simulator can fully simulate Omni directional movement, robot’s spinner and kicker. With help of this simulator we can fully test both individual skills and team work in real-time without any need to real robots. The similarity between simulated results and practical results are quite satisfactory. In figure 9 you can see a snapshot of its output.

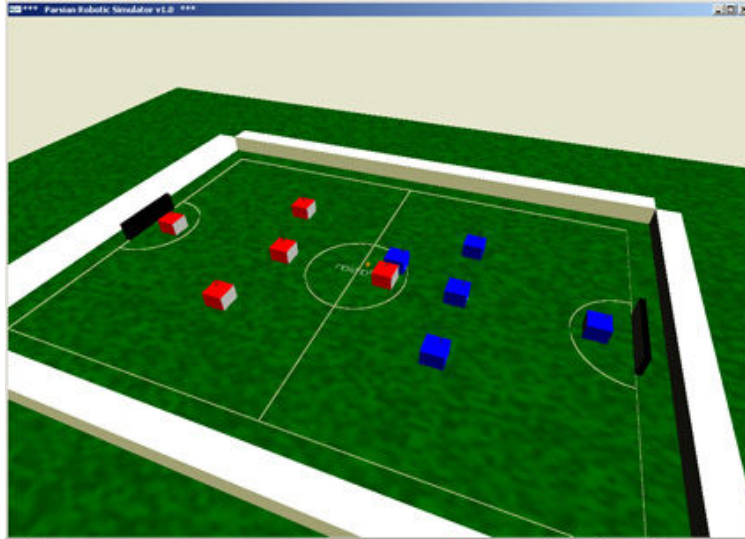


Fig. 9 Parsian Robotic 3D Simulator

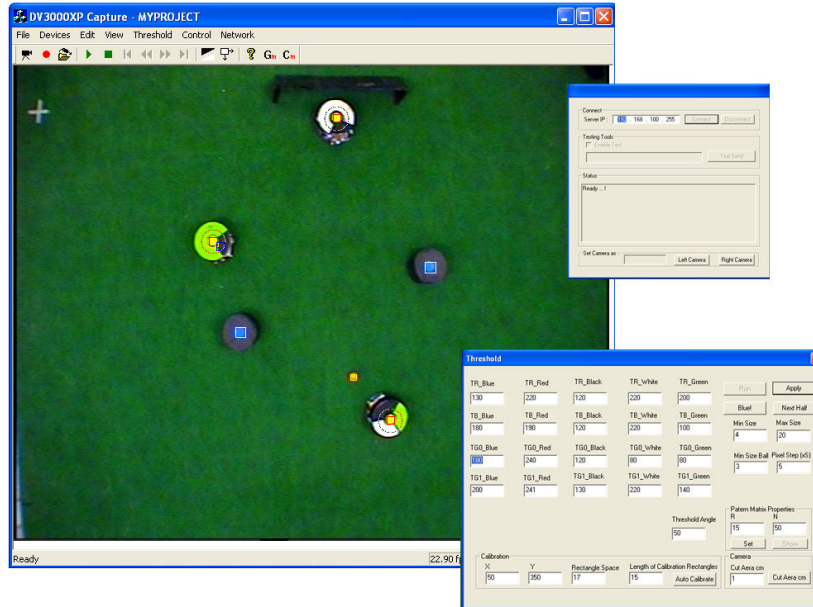
4 Vision System

At this time we use two CCD-Analogue Cameras (but due to the fact that the size of field was increased we are planning to use four cameras). One camera placed above the right half of the field and the other placed above the left half and two cameras have some overlap in center of the field. This overlap should be at least about a robot diameter so at least one of the cameras always can see the robot. Each camera is connected to a separate PC. Images then get captured by use of a standard frame grabber that can capture images with frame rate up to 30 frames per second.

We used “DirectX SDK Direct Show Libraries” as the main framework for developing the Vision software using Visual C++.

In order to identify each robot, we use a new color pattern this year. The team color circle is placed at the center of the robot. In order to identify each robot distinctively we then paint the head of the robot radially. We separated the whole circle to four equal parts (each part is 90 degrees) and then we used three colors for painting them. In this way we only need to locate team color circles. For this purpose we use a pixel grouping algorithm. After that, we immediately can identify our robots by checking few points around the center circle. This increased the speed of our vision algorithm.

Each PC runs the same software to process its images and sends its data through UDP protocol to the merging server program (MSP). This program merges collected data in to one pre-world model. The MSP finally sends the merged information through UDP protocol to the software PC.



1. Fig. 10 Image processing Software

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