Rodetas Robô Clube IEEE Very Small Team Description Paper

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Robot Soccer Player (IEEE Very Small Size)

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***Abstract*—This paper brings the description of the resources and methodology used by the team Rodetas Robô Clube – Universidade Federal de Ouro Preto for the IEEE Very Small Size competition. When "player" is quoted, refers to robot.**

I. Introduction

A controllable platform with varying levels of liberty automatically controlled, reprogrammable, and multitasking which can be compared with robot soccer players. If it had to be typed, the players could be defined as a standalone mobile platform mechanism that sends / receives information from a controller program, through image processing.

The physical part of the robot is responsible for all actions that they need do with high precision, is endorsed at the prototype that had a good provision of space for their components do not suffer with the movements of the robot or a possible internal overheating. In construction, the structure, the electronics and the programming part of the integrated circuit must work together to amplify the technical features of the robot soccer game.

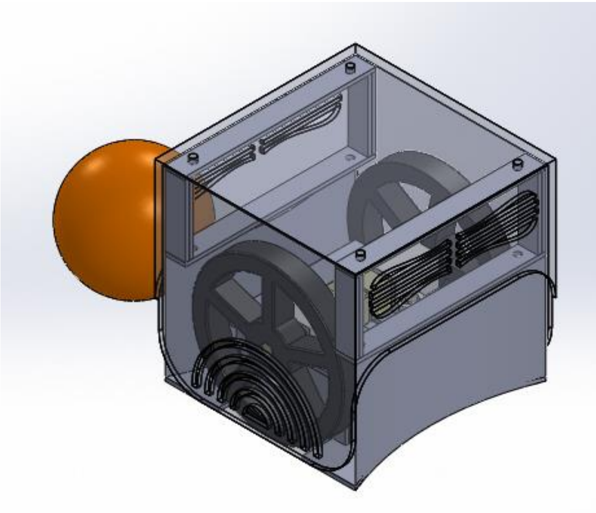

Figure 1 - Soccer Robot Model Structure (RODETAS, UFOP®)

The size and number of the mechatronic components must be precisely calculated considering the needs of a player and limitations of the integrated circuit (input/output), the arrangement of the motors and the microcontroller board must be limited to the specifications of *the rules for the IEEE Very Small Competition*. The internal programming is made through image processing and sent from the software to the players; communication is performed by ZigBee® mode.

II. ROBOT BUILDING

The constructional parts (mechatronics, structural and programmable) of such platform need to be performed at the same time, for the goal be reached.

A. Controlling a DC Motor.

Figure 2 – 50:1 Micro Metal Gearmotor HP Pololu®

Two High-power brushed DC motor with 50:1 metal gearbox and an omnidirectional sphere was used to make the mobility of the platform. Jointly with the motors, an IC was applied to the microcontroller board, to control the rotation of the engines. The motor driver named TB6612FNG can control up to two DC motors at a constant current and his MOSFET-based H-bridges (Metal Oxide Semiconductor Field-Effect Transistor) are much more efficient than the BJT (Bipolar Junction Transistor) H-Bridges used in older drivers such as the L298N, for the soccer robot environment due his circuit size and because these are better for high-power applications because they can switch faster than BJTs, enabling them to use smaller inductors in switch-mode supplies, which increases efficiency.

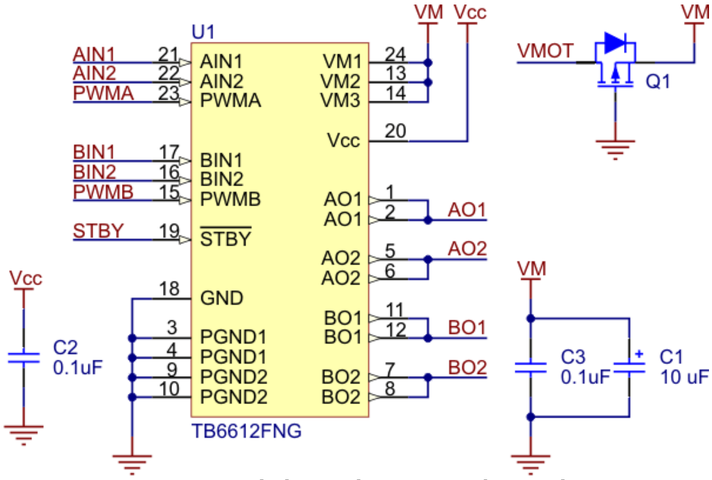

Figure 3 - TB6612FNG dual motor driver carrier schematic diagram.

The circuit used to overturn the motors has for each of the two channels: two directional control pins and a PWM input with a frequency of up to 100 kHz. The STBY pin must be driven high to take the driver out of standby mode. It is capable of supplying up to 13V (2.5-13) and 1.2A (3.2 peak).
Through the connection between the motor driver and the microcontroller, besides the quoted pins above, it also requires some voltage pins, demanding from the external power source enough voltage also for that both motors be powered with high voltage.
Are sent to the control pins, HIGH and LOW signals to make the robot move back and forward.

B. Electronic Circuit

The microcontroller, where the integrated circuits are set, processes and sends information received by the motor driver to the communication device that sends back on the next move, the electronic board contains the microcontroller ATMEGA328P-PU ®, the communication device XBee ® 802.15.4, two QTR-1RC sensors and a TB6612FNG (MOTOR IC). For the properly work of the circuit, voltage regulators of 5 (CI 7805) and 3.3 V (IC LM1117) have been implemented.
The microcontroller on the robot is the first to receive the signals that are sent by the host, and turns them into actions to control the motors, information is transferred to the sensor through pulses that make motors get the desired acceleration and make the player reaches the specified location . The rate and the acceleration are sent back to the microcontroller in a way that the host has full control over each player, the position of each robot opponent and the same team as the ball is received by the camera which works following the pre-defined tactics.

The precision that a robot must have in a game is not limited to have speed control X position of the robot, it is also necessary that the command-response be performed very quickly, for the feedback be shortly. The manipulated variables of the sensors must be the most similar to the PWM signal by the voltage reaching the motor.

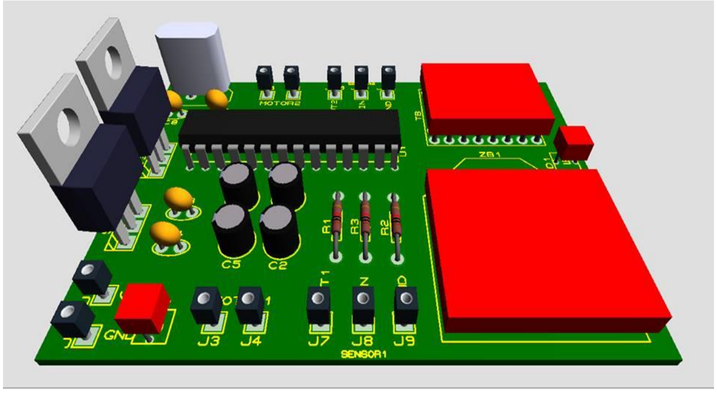

Figure 4 – Rodetas® Eletronic Board design (PROTEUS-ARES)

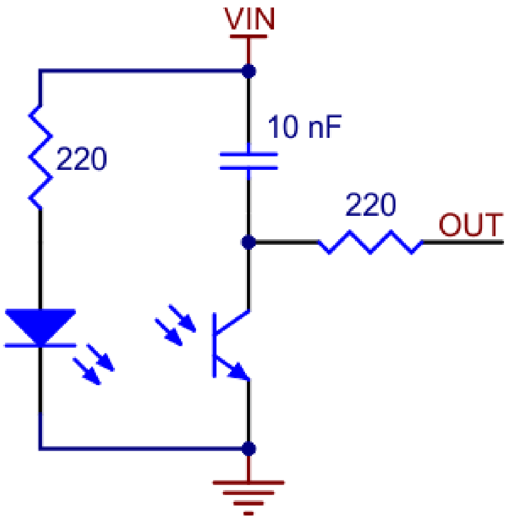

Figure 6 – QTR-1RC pin connections

C. Speed Control

During the game, the algorithm sends information to the ATMEGA and it controls every part of the player, including motors, sensors and other devices. However, the control system needs a feedback circuit to analyze the output speed, later comparing it to the needed speed(sent by the algorithm), in order to correct any errors that may occur. This analysis is made by a QTR-1RC reflectance sensor, which measures the current speed of the robot's wheels and sends this information back to ATMEGA, where a PID controller will do the comparison and correction, if necessary.

Figure 5 - QTR-1RC Reflectance Sensor

The QTR-1RC sensor has a single infrared LED and a phototransistor pair that uses a capacitor discharge circuit that allows the digital I / O line on a microcontroller to take an analog reading of reflected IR by measuring the discharge of the team capacitor. The current requirement can be met by some microcontroller I / O lines, allowing the sensor to be powered up and down through an I/O line to conserve power. Its operating voltage is 5V.

White markings on the wheel were made. When the player is moving, the wheel spins and at each time one of this markings passes into the sensor, it emits a HIGH signal to the microcontroller. Thus is possible to have a relation of number of markings per second, and using data information like the wheel's radius and angular velocity the speed of the player can be measured.

D. Alimetation

Of course all the above mentioned hardware needs energy. The energy is provided by rechargeable Nickel Metal Hydreto (NiMH) batteries, who can afford the needs of the robot.

Figura 7 - NiMH Battery 8,4V - 900mAh

III. SOFTWARE

The artificial intelligence system was created using the QTcreator software along with the OpenCV graphic library. QTcreator is a IDE (Integrated Development Environment) for programming in QT in the C++ and Java languages. This tool has resources that allow easier and more efficient programming, besides its portability, which means, the possibility of executing it in several operational systems.

For the image processing, was added to QTcreator the OpenCV graphic library, largely used nowadays for this function. Basically it is a multiplatform library, free for commercial and academic use, which allows developing apps in the areas of computational vision and graphic interfaces.

The image capture and processing basically occurs by these steps:

Figure 8 – Soccer Player Envir+onment

The computer receives information from a camera located over the field and the algorithm interprets these data, then sending to the robots the command operations.

A. FIELD RECOGNITION

The algorithm, when started, does the field recognition. In this step a filtering system eliminates noise, disturbances and subtracts the image with the robots on the field by another containing only the empty field. This process tries to eliminate any unnecessary elements to the image processing, improving performance.

B. ROBOT IDENTIFICATION

Each robot has in its upper part two circles of different colors, which are used in their identification. Through a recognition function of circular shapes, the program identifies the positions of allies and opponents robots and the position of the ball. According to the arrangement of the circles at the top of the robot, it is possible to know in what direction the robot is headed, then allowing the improvement of the strategy during the game.

C. STRATEGY

With the game information, the image processing ends and the data processing begins. The algorithm interprets the current situation and decides, based on its programming, how each robot must act, considering, among other factors, opponents positions and the ball's direction of movement. The game goes on and at each moment the robots receive new instructions to complete their task: score a goal.

IV. THE STRUCTURE

Under the rules, the sizes of the Very Small category limit the robot to a cube of side 75mm, the structure of the prototype built by the team Rodetas Robot Club that will play the next competitions are being made based on the Solid Works®. The base of the robot contains support for the battery, and plug for the electronic components, the wheels are positioned in a way that one omnidirectional sphere create the balance.

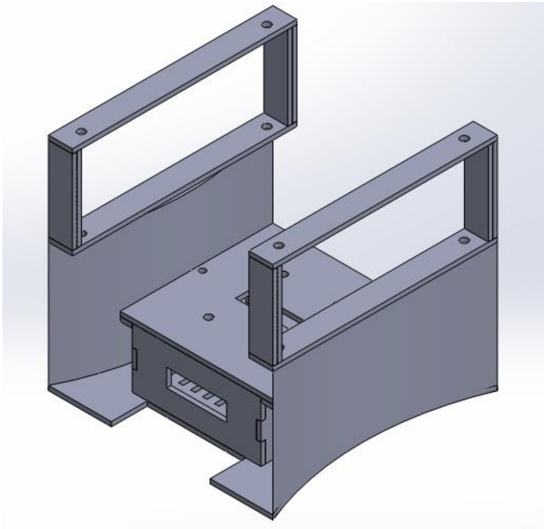

Figure 9 - Soccer Robot Base Model Structure (Rodetas R.C.®, UFOP)

The base of structure was designed attempting to reach the maximum mobility for the electronic components and batteries as well as their protection.

The battery bracket is designed to not have direct contact (except connections) with any of other components of the robot; in order to prevent that possible overheating may affect the running of the circuit board and / or engines. Edges were designed to facilitate the visibility of the circuit when the movable cover is placed on the robot which allows use of heat sinks on the voltage regulators. The material used (Acrylic) has low thermal conductivity and high durability allowing the motor to be screwed into the base.

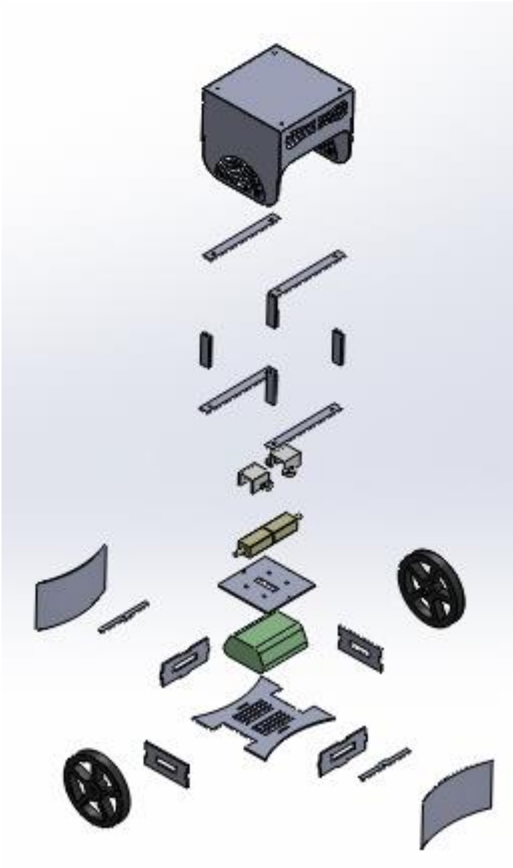

Figure 10 – Soccer Robot Model Structure (Rodetas Robô Clube® – UFOP)

V. OTHER APLICATIONS

A. Have the complete control of the robot soccer is a hard task in a dinamic environment, every thing move fast and the smarter micro built wins. By playing a friendly match against some opponents last year, the team have found a lot of things that have shown to be improved. The experiences in other competitions are very important to improve the national technology and application in other categories or departments of the automation (environment and industrial robotic).

B. The use of physical and virtual tools relating robotics in Latin America today is a result of an impressive evolution process, and practices like robot soccer in universities serves as an example of a teaching methodology of a possible introduction In the University to a industrial robotic study, allowing this area of knowledge be more advanced than has been in the last decade.

Nowadays, the funds destined to support the university are currently viable thanks to the support of partner companies and government institutions. The insertion of the college student, during its graduation within projects directed to improve the living for example, causes the society progress, puts the undergraduate in touch with the labor market and prepares the engineer with updated techniques and tools for the future.

C. Events like lectures, workshops and competitions are examples that friendly challenges are some type of educational politics that should be applied, as well as the student and institution will have more opportunities to connect with other universities and companies.

VI. ACKNOWLEDGMENTS

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