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The Conception, Design and Execution of Robots Intended for Competitions

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Abstract- **In this project is presented the process of making a minisumo robot dedicated to robotics competitions. The target of a minisumo robot is to eliminate the opponent from the fighting area. The main components a minisumo robot requires are: proximity sensors, motors, a battery and an electronic controller. This paper presents the functionality principles of a robot and the stages of manufacturing it. After making some calculations to obtain a list of components needed, the electronic circuit is ready to be designed. When the electronic circuit is done, the body of the robot is designed in a 3D CAD Software, the physical parts are obtained and the assembly procedure can be started. In this moment, the robot is ready to be programmed.**

Keywords – robot; minisumo; sensor; control

I. Introduction

One of the most important aspects in the human evolution is the use of machines in order to make physical work easier. Robots are included in this category being privileged by their complexity [1].

People have imagined intelligent mechanized devices which would take a part of their physical work. So, they created automated toys and intelligent mechanisms or they imagined the robots from cartoons, books, SCI-FI movies etc. The Informatic Revolution did the transition from the industrialized society to the advanced computerized one, creating a wave of imporvements in tehnology and education.

The robotic competitions includes multiple categories, one of them being minisumo. The robots are limited by: size – maximum 10x10cm, weight – maximum 500g. Besides these rules, the robots are based on the designers creativity. The majority of the robots are based on the same idea: 2 individual wheels in the rear of the robot (differetial control), proximity sensors on the sides and in the front, a blade to the ground, so the opponent robots lose their traction.

II. The Conception of the Robot

The first step is to analyze a minisumo robot's tasks and obtaining a part list.

To increase the performance of the robot, it has to be heavy and as fast as possible to win at the impact with other robots, [3].

Because they are limited by size and weight, all the components have to be throughly analysed to obtain the biggest power-dimension ratio possible.

To comply with the maximum dimension rules, the most important aspect related to the motors is the lenght because they are placed head-to-head inside the robot.

The motors used in this project have the speed of 860RPM. To calculate the maximum speed of the robot we use the formula:

$$S = \frac{\pi * D * RPM}{60} \text{ (m/s)}$$

D = external diameter of the wheel

In case of the presented robot, the calculation is:

$$S = \frac{\pi * 0.026 * 860}{60} = 1.17\ m/s$$

The minisumo battle ring has a diameter of 77 cm, critical information for the proximity sensor choice.

Considering these criteria, the chosen components are:

Motors: JSumo 36:1 DC

Sensors: Sick GRTE18S-P1342 – 2 pcs

Sick VTE180-2P411862 – 1 pcs

The material used for making this robot is an aluminum alloy (Aluminum 7075) in order to be hard and under the weight limit .

III. Designing the Robot

A. Designing the electronic circuit

The electronic circuit was deigned using CadSoft EAGLE software. The circuit has to be made as small as possible. The electronic parts have to be chosen carrefully in order to meet the requirements.

The microcontroller is chosen according to the Input-Output pin number, processing speed, number of Analog-to-Digital converter pins, Pulse-Width-Modulation pins, supply voltage, [2] etc.

Choosing the motor drivers (H-Bridges) is based on the motor's stall current, the motor's voltage and the working frequency.

To detect the edge of the battle ring, the robot has 2 reflecting IR sensors (IR LED – Phototransistor).

The main components are:

Microcontroller: PIC18F46K22

H-Bridge: L6205

Voltage regulator: 7805

To read the reflective edge sensors, the phototransistor is wired in series with a resistor in order to obtain a variable voltage depending on the intensity of the light reflected by the edge of the fighting area, which is connected to an analog input of the microcontroller. (Figure1).

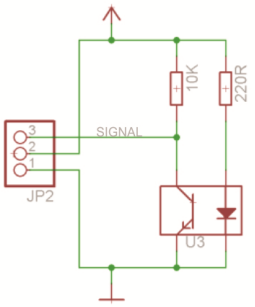

Figure 1. The reflective sensors' wiring diagram

The output signal of the proximity sensors have 12V. The microcontroller used in this project is working on 5V so the sensors' signals have to be lowered.

To obtain the sensors' output voltage of 5V it uses a voltage divider circuit because the communication is made only in one direction, from the sensor to the microcontroller.

To control the motors' speed the microcontroller uses PWM (Pulse Width Modulation) signal at the frequency of 10Khz.

After finishing the electronic circuit design (Figure2), the next step is designing the chassis.

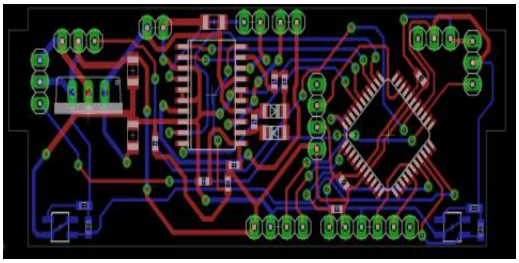

Figure 2. The electronic circuit design

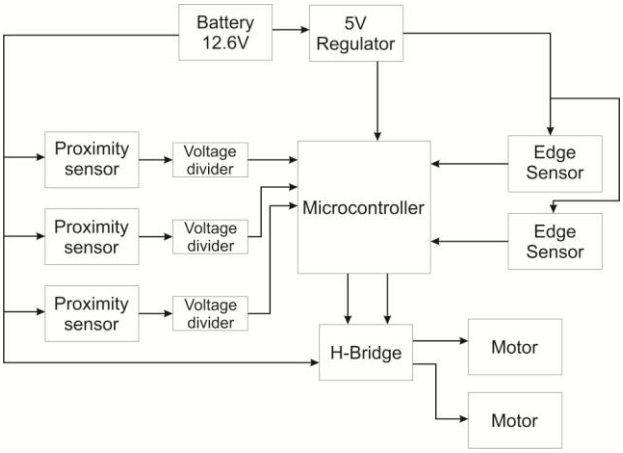

Figure 3. The electronic circuit's block diagram

B. Designing the chassis

The software used to design the chassis is Solidworks, where all the mechanical components were created based on their datasheets and then the aluminium parts were designed around them. The chassis is designed to be made out of 12mm thick aluminum sheets. (Figure 4).

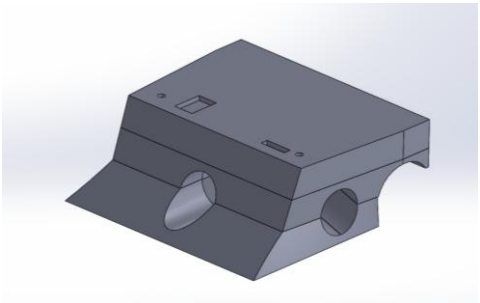

Figure 4. The designed chassis (without components)

IV. Robot Manufacturing

After the robot is designed, the aluminum parts are milled on a CNC Router (Figure 5). The required G-Code was generated by the RhinoCam software.

Figure 5. Milling

The electronic components are soldered on the PCB which is placed inside the chassis along with the sensors, motors and the battery. After this step, the wiring is made.

At this moment, the hardware part of the robot is ready (Figure 6) and the only remaining task is the programming.

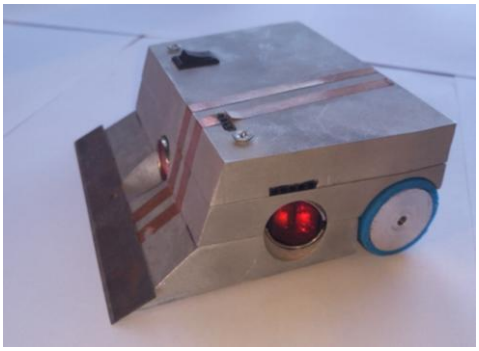

Figure 6. The assembled robot

V. The Programming

Every robot has an algorithm in order to be autonomous. [4]. A minisumo robot has 3 main functions in a priority order:

1 – Don't leave the battle ring

2 – Search opponent

3 – Take out the opponent

The most important task is not to leave the battle area. If the robot isn't in danger, it goes to the next task, the opponent robot's search. The robot moves around on the battle area to find the opponent. When the opponent is found, the robot goes towards the opponent with maximum speed to take it out. These 3 tasks are repeated until the robot is shut down. (Figure 7)

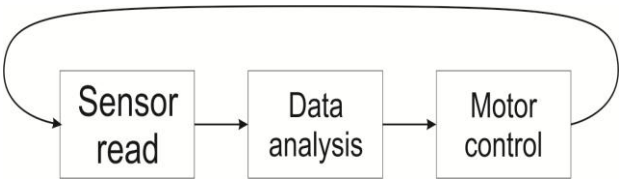

Figure 7. Operating cycle

The robot's code is written in C language in MikroC for PIC IDE Software. The benefits this software offers are the libraries which helps the programmer to write the code faster.

After the main code is finished, a lot of tests are made in order to improve the functionality of the robot.

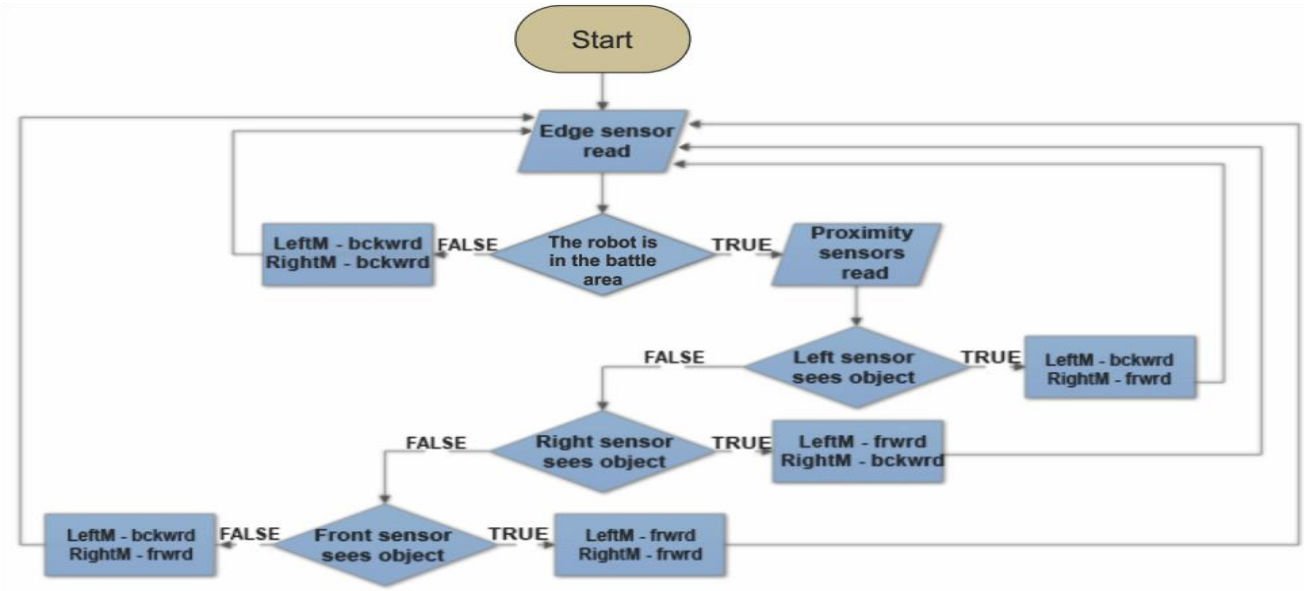

Figure 8. A simplified operating

VI. Conclusions

After these steps, the robot is ready to compete against other robots at competitions. The biggest challenge was to fit all the components and wires inside the robot.

The robot presented in this paper won the 1st place at the Robomaniacs competition held in Timisoara, Romania and 2nd place at the RobotChallenge competition held in Oradea, Romania.

Acknowledgement

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