RoboCup Junior - Soccer Lightweight: TDP Biotech

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ABSTRACT

This document describes all the work carried out by the team in detail in the Robocup Junior Soccer Lightweight competition. We included the development of our robot in the process, addressing improvements and developments in the field of construction, electricity and code.

INTRODUCTION

Formed in May 2024, our team was born with the purpose of uniting creativity, technology and innovation to meet challenges in the robotic areas and technological development. The team has four members with complementary skills.

Enzo - Coder

Fernanda - Electrical Engineer

Hyvinin - Coder and designer

Vinicius - Mechanical Engineer

We participated in two tournaments, in regional and national competition, winning first champion's in both competitions and we had the opportunity to participate in the biggest robotic tournament and innovation in the world (Robocup Junior).

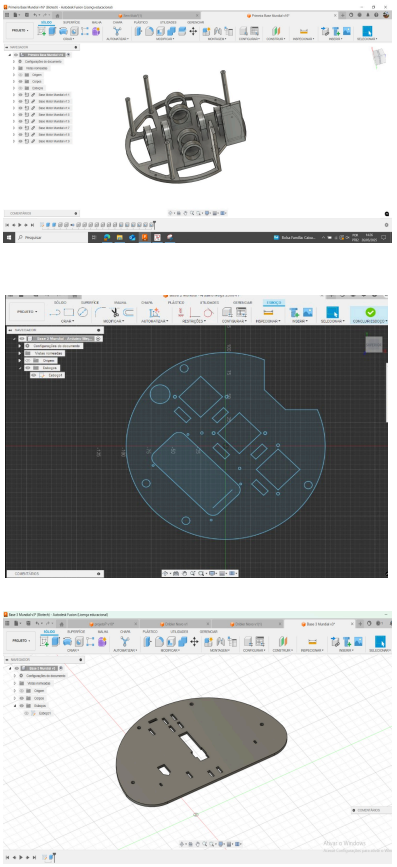


Picture 1: Team members.

MECHANICAL DESIGN

To project our robot, we choose to use Fusion 360 app, with which we can develop projects and analyze the best format to build our bases. After we analyzed and made tests to determine the best material, we decided to use PLA filament in the 3D print and MDF piece, because it has the stronger and compact structure.

We choose to make round bases with specific cuts, including sockets for the Mega 2560 Pro Mini board and driver L298n, to minimize the robot weight by allowing the use of more components. We also added a dribbler and left spaces for the installation of sensors.



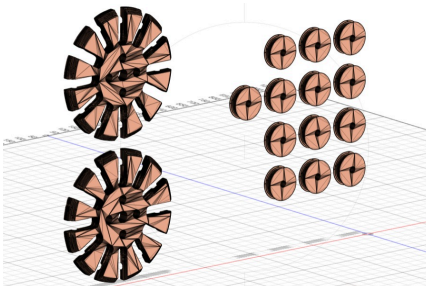
Picture 2: Bases of robot.

To decide what would be the best materials for our robot, we did various tests and research. We conducted a study to determine the best wheels and we identified two wheels

models omnidirectional: omni wheels and mecanum wheels. We decided to use the omni wheels as they give us the best range of movement and direction, as well as offering good flexibility, allowing for more precise maneuvers.



Picture 3: Omnidirectional wheels.



Picture 4: Wheels design in fusion 360.

We inserted in our robot a dribbler which has the function of providing more ball control. He captured the ball with a simple gesture, easing the handling of the robot during the match. The base was built in 3D using a laser cutter with MDF boards, and we used a motor to move it.

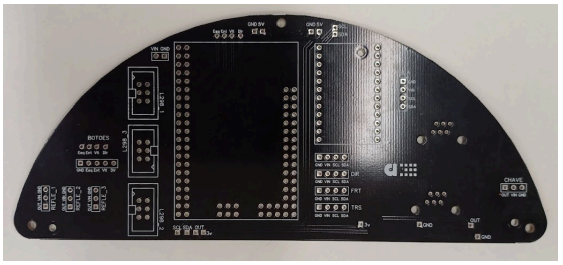


Picture 5: Dribbler.

PCB

Printed circuit boards(PCBs) have several positive points that make them essential in electronics. One of the main benefits is the organization and compactness they offer, allowing components to be assembled efficiently in a small space, eliminating the need for loose wires and disorganized connections. In addition, PCBs guarantee greater reliability and electrical stability, with firm connections that reduce the risk of failures and electromagnetic interference.

Another strong point is the ease of mass production, since their standardized design allows for automated, large-scale manufacturing, which lowers costs and increases consistency between units. PCBs also make maintenance easier, as the components are positioned in a standardized way and often identified by silk-screening on the board itself, which speeds up diagnoses and repairs.

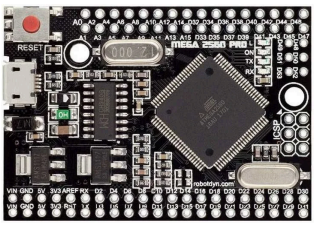


Picture 6: PCB board.

HARDWARE

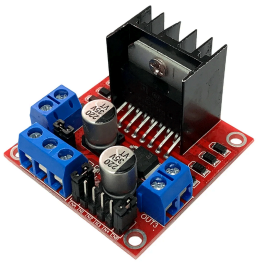
We used some materials in the build that will allow the robots to receive commands and execute the challenges. Aligned with the code, we will make the robot have good performance during the matches. In order to have all the processing, along with the connection between functions in our robot, we used the arduino Mega 2560 Pro Mini board,

with a variety of digital, analog, communications and power ports.



Picture 7: Mega 2560 Pro Mini board.

To help the robot move the motors precisely, we chose to put a L298n board to control the movement of the motors and help our dribbler. This choice is due to its reliability in controlling DC motors, allowing it to independently control both the locomotion motors and the auxiliary motors, such as the dribbling system. With this, we were able to effectively integrate the movement systems and support mechanisms, optimizing the robot's performance in the field.



Picture 8: L298n board.

For our robot to be able to identify the distance of the ball, which has an infrared signal, and also to know where the opponent's goal is, we use sensors developed by LEGO from the HiTech set. One of them is an Infrared Seeker and the other is a HiTech Compass Sensor. In addition, we added the hc-sr04 ultrasonic sensor, which allows us to measure distances from the walls of the table. We positioned these sensors at three strategic points on the robot: at the back, on the right and on the left. We have placed three reflectance sensors so that the robot can detect the white lines of the competition field.

The limit switch is used to identify when the robot has possession of the ball. It also limits movement, thus ensuring optimum positioning accuracy.



Picture 9: Sensors.

TESTS

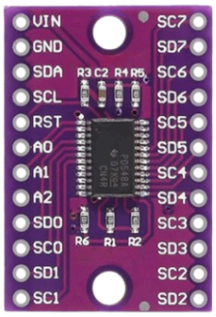
We did a test and discovered that it would be necessary to use a regulator. The voltage regulator is a component used to maintain a constant electrical voltage in a circuit, even if the voltage supplied by the power supply varies. It is essential for protecting electronic components and ensuring stable system operation.

To test the voltage regulator, a multimeter is used to measure the values at the input and output terminals. The input voltage must be higher than the output voltage, and the output must have a fixed and stable value. If the output voltage is incorrect, unstable or absent, this is a sign that the regulator may be faulty, poorly installed or operating outside its specifications.



Picture 9: Voltage regulator.

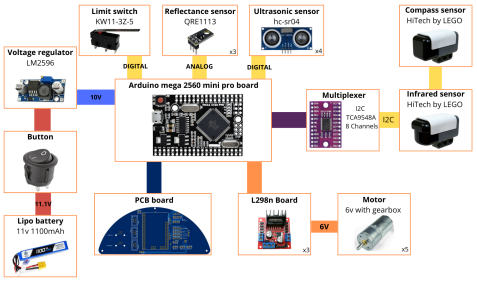
Also, we add a multiplexer. This is a component that chooses one of several inputs to send to a single output, controlled by selection signals. It helps to organize and simplify circuits. To test, you check that the output corresponds correctly to the input selected according to the control signals.



Picture 10: Multiplexer I2C TCA9548A

FLOWCHART

We made a flowchart to better demonstrate how we made the connections for each of the robot's componentes.



Picture 11: Flowchart.

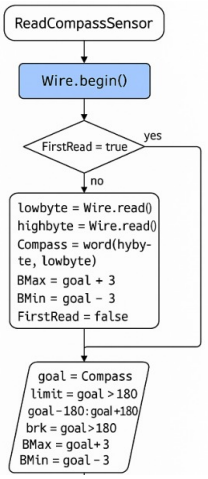
CODE

We seek to implement a summarized and simplified form in our code. We had a different code style, which we have separated into: Main, Motors, Drives, Sensors, Extra, Modes. All the code was done by the team members.

An example of our programming is the ReadCompassSensor function. When executed, it starts communicating with the address of the compass sensor, requesting two values in byte format. These two values are then combined and compressed to generate a value corresponding to the direction in degrees. This value can be used as a reference for alignments on the field of play, whether for general orientation of movement, strategic positioning or even to locate the direction of the opponent's goal.

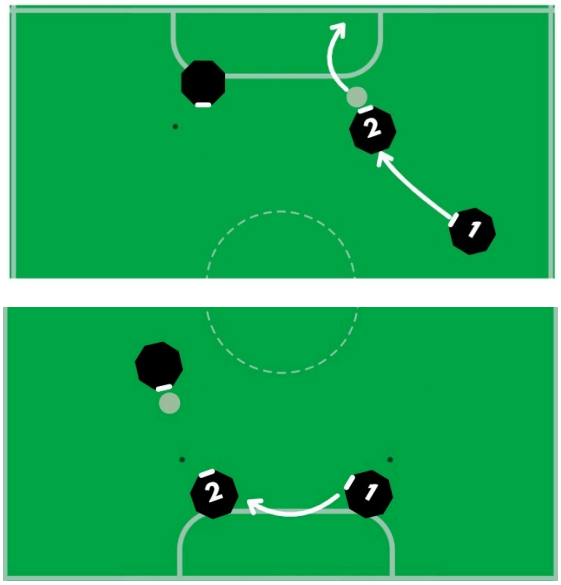
```
2   Wire.begin();  // Initializes I2C communication
3
4   // Initializes the compass, setting the operation mode
5   Wire.beginTransmission(compassAddress);
6   Wire.write(0x00);  // Register to configure the mode
7   Wire.endTransmission();
8
9   // Command to request compass reading
10  Wire.beginTransmission(compassAddress);
11  Wire.write(0x44);  // Read command
12  Wire.endTransmission();
13
14  // Requests 2 bytes of data (high byte and low byte)
15  Wire.requestFrom(compassAddress, 2);
16  while (Wire.available() < 2)
17    ;  // Waits for the data to be available
18
19  byte lowbyte = Wire.read();         // Reads the first byte (LSB)
20  byte highbyte = Wire.read();        // Reads the second byte (MSB)
21  Bussola = word(highbyte, lowbyte);  // Combines the two bytes into a 16-bit value
```

Picture 11: Code.



Picture 12: Code flowchart

STRATEGY



Picture 13: Defender and attacker strategy.

Our strategy is based on a robot that is responsible for scoring goals and a goalkeeper who is responsible for defending the goals. In our robot, we have programmed it to be very precise when scoring goals, so that when the limit switch is activated, it will send the robot directly in front of the goal. The goalkeeper is responsible for always being active, moving and waiting to save a goal.

CONCLUSION

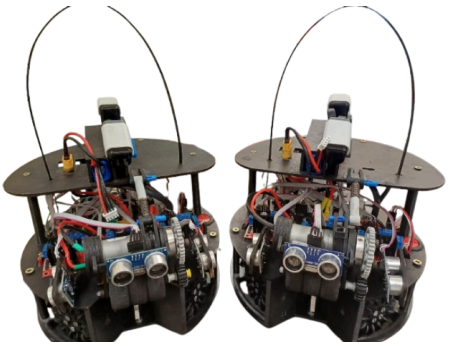
Throughout the process of building our robots, we've had new ideas and continuous evolutions. At first we thought of using a dribbler made of Lego, however, exploring and studying how we could improve it, we decided to create a dribbler made of MDF pieces and a motor. This approach, as well as being more robust, will give us greater assertiveness in controlling and possessing the ball and optimum precision.

We added a PCB to our robot, one of the main objectives of which is to guarantee the organization and capacity they offer, allowing for the efficient assembly of components in a reduced space. This gave our robot better wire organization.

We have evolved and improved every detail and accessory so that, together with the construction, programming and electrical work, our robots have produced excellent results. These are all the results obtained so far, and we plan to make future modifications for better performance.



Finished robots:



Picture 14: Improvements and finished robots.

REFERENCES

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3. https://www.monografias.ufop.br/bitstream/35400000/1873/1/MONOGRAFIA_DesenvolvimentoRob%C3%B4Omnidirecional.pdf
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6. https://escolalbk.com.br/glossario/o-que-e-omnidirectional-wheels-rodas-omnidirecionais
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