Aperture Robotics Soccer Team Description Paper 2021*

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Abstract. This document describes the project carried out by Aperture Robotics Soccer for RoboCup JR 2021 in Soccer Lightweight category representing Brazil, formed by four members.

Keywords: Soccer · lightweight · new team · Raspberry.

1 Introduction

By this TDP, we will present the objectives, strategies and all the work done by the team, showing the mechanical, electrical and programming processes. It is important to note that we are adapting the simulator code to the real robot, so we have added a raspberry, which operates in Python.

2 History

The team is already in its third generation. The second generation was the winner at LARC 2019, getting a place for the world championship in France, which did not happen. During the pandemic, members of the second generation graduated from school, then the current generation began, formed earlier this year.

3 Purpose

The main objective of our team is making everyone feel comfortable and happy besides prevailing the incentive and the focus on learning robotics.

4 Team communication

Nowadays, our team chose to use the Discord platform to keep the communication and the organization of the work. Each weekday, two group members go to school where we can work and test the robot with greater effectiveness.

* Supported by Objetivo School.

Fig. 1. All team members on the platform discord

5 Strategy

5.1 Hardware

The structure of the robot, inherited from the previous generation, consists of two parts: one of them (the base) was printed on the 3D printer and contains in its structure the motors and color sensors. The other platform, is a fiberglass PCB which is the place responsible for the sensors and microcontrollers and the two platforms are supported by threaded bars, giving firmness to the structure. The team has two robots that use four microcontrollers each, the Arduino Mega 2560 ("Bridge"), two Arduinos Nano ("Slaves") and the Raspberry Pi 3. Thus the "Slaves" work as data pre-processing (one to process IR and the other to Magnetometer and Ultrasonic), soon after, the data is gathered and sent to the "Bridge" and then sent to the "Master". The structure was modeled in the software OpenScad and the parts were printed on a 3D printer. The motors are of the DC type and are operated by the H-bridges, in addition, the 3 motors are positioned 120 degrees one relative to the others. The omnidirectional wheels were modeled in OpenScad and printed on the 3D printer. Each one contains 20 smaller wheels in the wheel rim, giving greater mobility in the field, this ensures that the force is applied in a single direction by each of the engines. As we added a Raspberry Pi 3 and its cap to the robot, it was necessary to remove weight from the structure. So, we drilled holes in the base and PCB, redesigned the sensor caps and changed the handle material to felt.

5.2 Electronics and sensors

All components are connected to a PCB, which was designed by the previous generation, where we soldered and connected all the sensors. We listed some of the main features of the PCB:

-Sockets for two H-bridges;
-One socket for the Arduino Mega 2560 microcontroller;
-Two sockets for the Arduinos Nano 328;
-Two LM7805 voltage regulators, to supply general purpose power;
-Power and logical connections for all IR sensors;
-Connection for sensors in general.

IR sensor To detect the ball, we used the infrared sensor TSOP 6140 and for data processing we use the Arduino Nano which gives back more objective values to the Arduino Mega 2560. The TSOP 6140 sensor gives back low signal when there is a presence of frequency modulated infrared signal 40kHz.

Fig. 2. Sensor TSOP 6140

Color sensor To identify the markings on the field we use a color sensor made with a RGB LED and a phototransistor, the LED emits RGB light, which reflects off the surface and then the phototransistor captures this light and generates an analog output.

Ultrasonic For the robot to locate itself on the field, we use the sensor HC-SR04. The sensors emit ultrasonic pulses and according to the time between the pulse sent until the moment when the pulse reflects on the object and returns to the sensor, it is possible to determine the distance between the sensor and the object (in this specific case the object is the walls of the field). The ultrasonic sensors are fitted into the sockets on the PCB and data is processed in the second "Slave". The sensor uses the interface I2C to communicate with the controller. The I2C interface is based on several "Slave" devices that communicate with the "Master". The interface uses only 2 wires for signal. It is necessary to process the data of the axes so that we can have the angle in relation to the earth's magnetic field and this is done by the same Arduino Nano that processes the signals from ultrasonic sensors. With the measurements calculated by ultrasonics, we find where in the four-quadrant Cartesian plane the robot is located in the field.

Magnetometer We use the three-axis sensor HMC5883L so that the robot has a sense of direction. Using the data from the axes and trigonometry, it is possible to determine the alignment of the earth's magnetic field sensor and consequently know to which direction is the earth's north magnetic and what is the orientation of the robot in relation to the field and then know which direction the opponent's goal is.

Fig. 3. Sensor HC-SR04

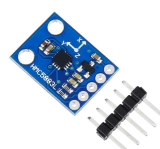

Fig. 4. Bússolar HMC5883L

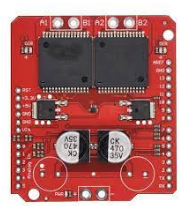

Fig. 5. Ponte-H VNH2SP30

H-bridge To control the motors we use H-bridges based on the IC VNH2SP30 that supports up to 30A of current of peak and 40V. This gives us the freedom to choose a wide range of engines so that our needs related to engines are satisfied.

To control the motor there are 4 pins: "Enable" which activates the bridge; "INA", "INB" which control the direction of the engines and "PWM" which controls the speed, in addition to an analog output for monitoring the chain. The H-bridges are fixed in sockets on the board, (fixed by screws as they are on the reverse side).

5.3 Software

Some parts of our code were adapted from what was done for the simulator. An example is our route planning algorithm, Potential Fields. Potential Fields is one of the most used planning and navigation approach nowadays. The system consists of a assignment load of theory to the various elements of the field, being elements with opposite charges being attracted to each other and elements with equal charges being repelled. So, if our robot has the opposite charge to the ball and equal to that of their opponents, it will walk along a route, dodging opponents and going to the ball, for example. To communicate between Arduinos and Raspeberry we use Serial. We chose to use 3 Arduinos to do not overload them and Raspberry since reading the ultrasonic and IR sensors takes time and this could cause problems like the robot leaving the field. We use trigonometry to control the engines to always keep forward in the same direction and also to assist in the processing of data from the Infrared sensors. As the simple engine speed control optimally is not enough to ensure that the robot always walks pointing to the same direction, we use a compass to make sure the robot is pointing to the same side.

6 Conclusion

Our team concluded that progress is a synonym for dedication, friendship, study, perseverance and team work. Besides that, robots must have a stable location system and reliable localization system in addition to good recognition of field. It is important to highlight that the experiences of older generations in robotics competitions also taught us a lot about how to be better organized for such a big and complex competition. We concluded that we should always try to improve our robot regardless of the difficulties faced by the team, and also that an organized code always helps a lot in the progress of robotics and the team.

7 Future

The team always intends to gain more experience and knowledge with competitions. We all want to evolve as people and become the best version of ourselves. As for the project, we are seek to improve the code to be the most efficient and practical as possible and in the robot we intend to put more sensors and a dribble.

8 Acknowledgments

The Aperture Robotics Soccer team thanks Objetivo for offering us this opportunity to participate in the competition! We thank all colleagues and relatives who supported us during this journey! Finally, we thank all the teachers: Almir Junior, Caniloi Júnior, Emília Holanda, Igor Tironi, João Cavalotte, João Roberto and Vinícius Nicassio Ferreira, for supporting us and giving guidelines for the creation of our project.

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