CHS Kepler Team Description Paper

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Abstract: This paper intends to report the process of building and programing robots of the CHS Kepler team, that will compete in the Latin American Robotics Competition Soccer Lightweight Challenge. The robots are identical to each other and play soccer together against an opposing team without human interference, following the code written by the team.

I. The Challenge (Soccer Lightweight)

The Latin American Robotics Competition Soccer Lightweight Challenge consists of a reproduction of a soccer field for robots, in which four robots, two of each team (one robot can be assigned as a goalie and another as the striker or it can be both strikers for one team), have the objective of making as many goals they can on the opposing team's goal, while defending their own.

A broad overview of the rules follows:

- With each goal, the team receives 1 point on the scoreboard
- A robot cannot damage another team's robot
- There can't be human interference during the match
- If a robot leaves the playing field area, determined by white lines on the extremities of the field, it will receive a penalty and will have to remain 1 minute out of the match
- One match consists of two 5 minutes halves, with a 5 minute interval after the first half, when teams can make adjustments on their robots
- Two robots cannot defend their respective goals at the same time
- Robots that have kicking mechanisms must have a set limited power.

II. The Team

The team is composed by three members who already have experience in robotics: Davi and Felipe have worked in robot soccer for more than 3 years, and Victor is competing in this division for the second time. Davi's role in the team is to create and maintain the electric circuit of the robot, in which he has designed the printed circuit board for both robots. Felipe maintains the mechanical aspects of the robots and the programming, with the help of Davi in programming and Victor in the 3D modelling of the robot. Felipe and Davi developed the algorithm for the robot's task. Victor is involved with the structural aspect of the robots, especially with the omnidirectional wheels, and with planning a schedule for testing.

III. Project Development (2015)

March: Product inventory based on previous projects is created. Research for suitable sensors the team had familiarity with started, but since some of them weren't available (a specific compass sensor from sparkfun had stopped its production), we looked for new sensors suitable for the challenge.
April: Research for sensors and components for the project completed.
May: Design of the electric circuit of the robots is done through the Altium Designer software. The structural design is done through the Autodesk Inventor PRO 2015 software.
Junho: Arrival of the electrical components, including the printed circuit board.
Julho: Preparation of the structural and mechanical aspects of the robots. Assembly of the omni directional wheels based on a previous project from a robot that competed in RoboCup 2013.
August: Organization for the basic functions of the robot in programming.
September: Tests and Adjustments

IV. Components (Hardware & Software)

The components used by the team are:
IR Sensor (TSOP2240): Through this sensor, it will be possible to know the exact position of the ball during the match. 15 of these will be used in this robot. The team chose this component because it has an angle of vision favorable of 45 degrees of detection. Some of these sensors used will have an area of vision that interlap, but this will not be a problem, since it can be fixed in the programming.

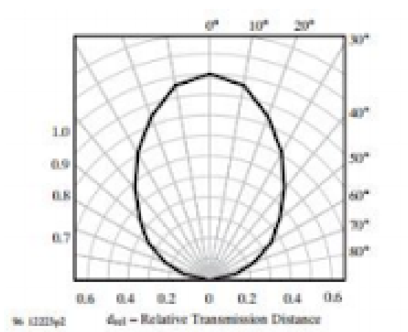

Figure 1 - Detection Range of the IR Sensor (Image taken from component's data sheet)

Arduino Due: This specific microcontroller was chosen because of its processing speed and the number of analog and digital terminals it offers. Furthermore, the platform is compatible with a variety of electrical components

Phototransistors: Through these sensors the robot will be able to precisely know if the ball is or isn't in its possession (on the front of the robot). Two of these will be used in the robot, located as follows in Figure 2:

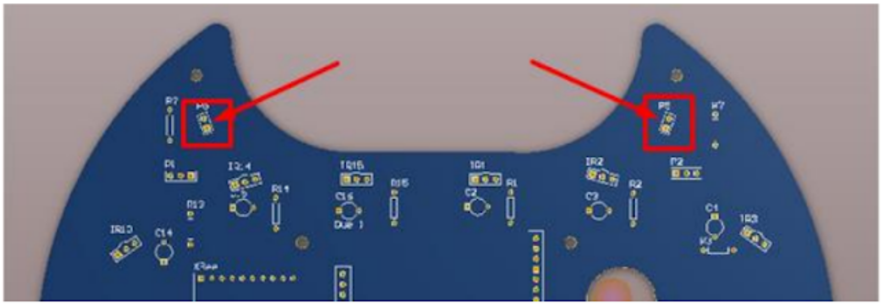

Figure 2 - Section of the robot's printed circuit board (Image taken directly from the Altium Designer software)

Ultrasonic Sensor (PING)))): Through four of these sensors, the robot will be able to process its location on the soccer field. Each sensor will identify the distance of the robot from one of the walls on the extremities of the field.

Compass Sensor (LSM303D 3D): This sensor will allow the robot to know the direction of the opponent's goal. The direction of the opponent's goal will be defined when the robot is turned on with the direction of the magnetic field at that moment.

XBee: This sensor allows the communication between robots. For example, in the eventuality that one of the robots is penalized by leaving the lines of the field, the other robot still in the match will know that the other robot has been taken out and will assume a defensive position in the field. One of these will be used per robot.

Light Sensor (QTR-1A): Through this sensor, the robot will have an added measure of not leaving the field lines (which are white while the field's turf is green). Four of these will be placed on the bottom of each robot.

Pololu Motors: The team chose these motors because of their familiarity with these motors. More specific factors include its specifications: 275 RPM / 24 oz-in (Torque); Three of these will be used per robot, with an angle of 120° between each.

Motor Drivers (MC33926 Single/Dual): These allow the communication of the motors with the arduino due microcontroller. Two of the motors will be attached to the dual driver, while the remaining will be connected to the single, in each robot.

Bateria LiPo 7.4V (1600 mah): One of these batteries will be used per robot.

Omni Directional wheels: These allow for the movement of the robot in every direction, when combined with the three motors. One of these wheels is pictured in Figure 3 as follows:

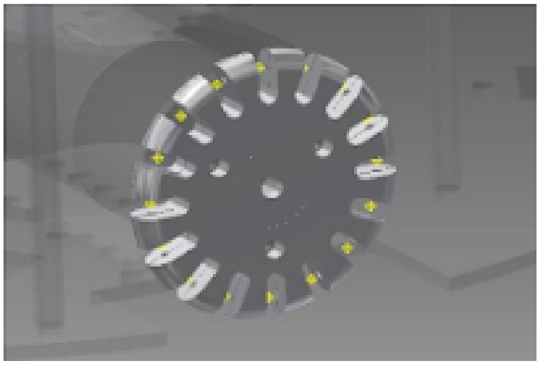

Figure 3 - Omni Directional wheels (Image taken directly from the AutoDesk Inventor software)

V. Robot's Structure

The robot, pictured in Figure 4, seeks to follow the design of a robot already utilized by a previous team from the robotics institution, that won Best Robot design in the International RoboCup Junior Soccer Lightweight division and that one of the team members, Davi, was part of. The team made certain adjustments to the design, however, such as in changing the length of the spacers between each section of the robot. The robot has three levels: the base (1st level), where the motors and the light sensors are situate; the printed circuit board (2nd level), where the IR sensors, arduino due, Xbee, and the motor drivers are situated; and the last structure that supports the ultrasonic sensors and the compass sensor (3rd level). The 1st level will be made from acrylic and the 3rd level will be made from an ABS polymer.

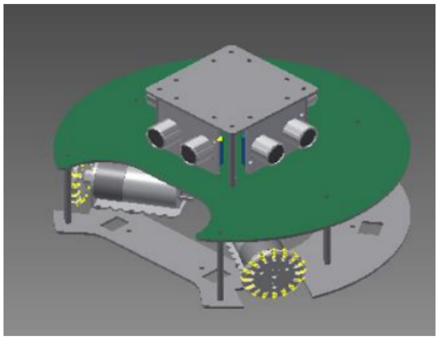

Figure 4 - The robot's structure (Image taken directly from the AutoDesk Inventor software)

VI. Electronic Circuit

The circuit connects all of the electrical components of the robots. Thus, the values detected by the sensors will be processed by the Arduino so that the robot can move according to the algorithm in the program. The circuit also connects the sensor system with the movement system of each robot. This circuit was designed through the computer software Altium Designer.

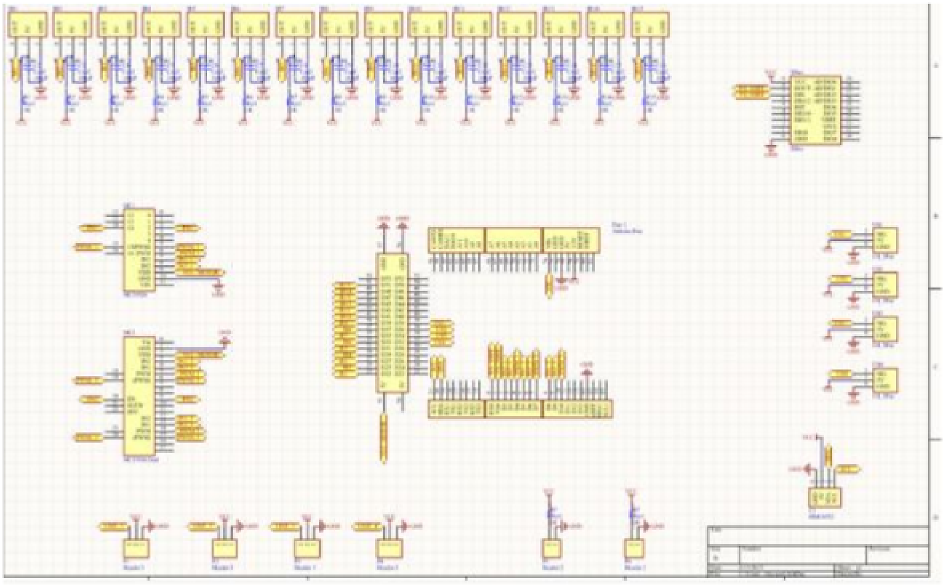

Figure 5 - Design of the connections of the circuit (Image taken directly from the Altium Designer software)

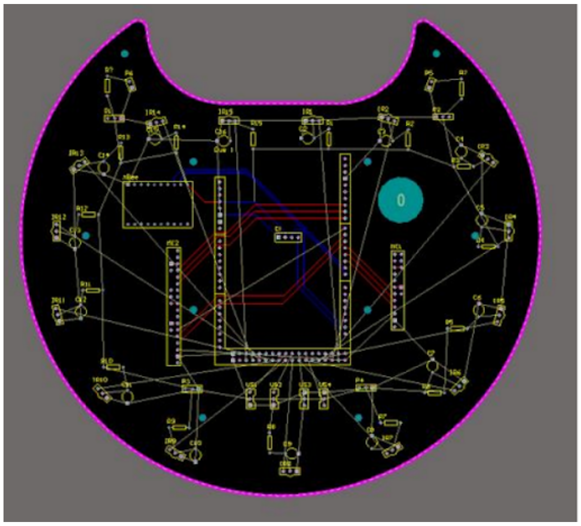

Figure 6 - Layout of the Printed Circuit Board (Image taken directly from the Altium Designer software)

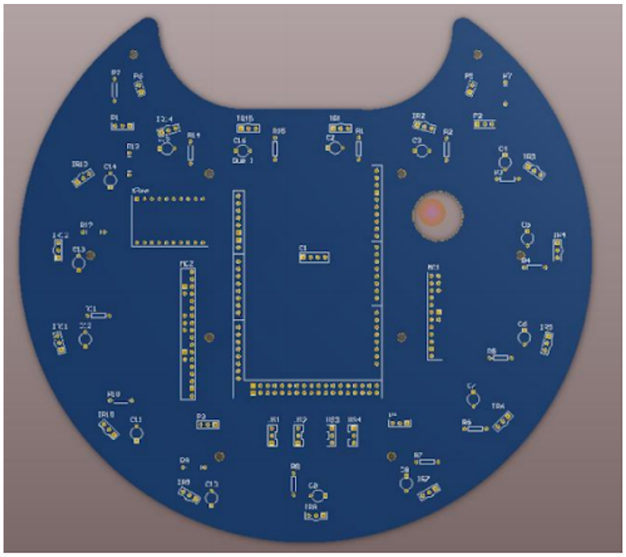

Figure 7 - 3D model of the Circuit Board (Image taken directly from the Altium Designer software)

VII. The Programming

The programming will be made through the proprietary Arduino software (Arduino IDE); the team. The most important factor for the robots to play is the interaction between the motors and the IR sensors, which work in unison for the robot to have the possession of the ball or for the robot to defend its goal. The microcontroller processes the data from the 15 IR sensors and, according to the angle in each of these were soldered into the circuit board, it signals each motor to turn in a respective rotational direction and speed. The compass sensor is also important, since it allows the robot to always face the opponents goal. Additionally, the ultrasonic sensors allow for the robot to know its approximate location in the field, so that it can position itself accordingly.

VIII. Acknowledgements

We thank our mentors: Luiz Rogério da Silva (Comphaus Coordinator), Wagner Luiz Soares Pereira (Mentor), Vanessa Ianaconi (Coordinator), Milton Peres Cortez (Teacher), Ciro Salzmann (Mentor), and Tiago Salzmann (Mentor) for guiding us in this project.

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