AIS Team Description Paper

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Abstract

This paper describes the current development status of our SSL team, AIS, with the purpose to qualify for the RoboCup 2017. We present the design and implementation we have got so far in order to achieve this goal, showing the electrical, mechanical and software topics involved in our work, which were designed according to satisfy the RoboCup rules.

I. Introduction

Innovacion y Robtica Estudiantil founded at 2001, corresponds to an agroupation of undergraduate and graduate students from many faculties, whose members are mainly from Electronics, Informatics and Mechanical Engineering Departaments at this University. This RoboCup team belongs to one of several projects at this agroupation, where we can found students specialized on computer science, control and automation, or power electronics, mechanical engineering, as well as industrial engineering students.

This document describes our design and the implementation we have got so far, showing all the work made in the different areas involved at this category. In particular, we describe mechanical design, electronics design for different devices and algorithms implementation for the (robotic) team coordination, and also the expected implementation we are planning to reach by the time of the competition.

II. Mechanical Design

This model correspond to the second version of the robot designed by our team, the new features include better quality on materials and simpler design for manipulation.

-Height: 150 mm.

-Diameter: 180 mm.

-Maximum coverage of the ball: 18%.

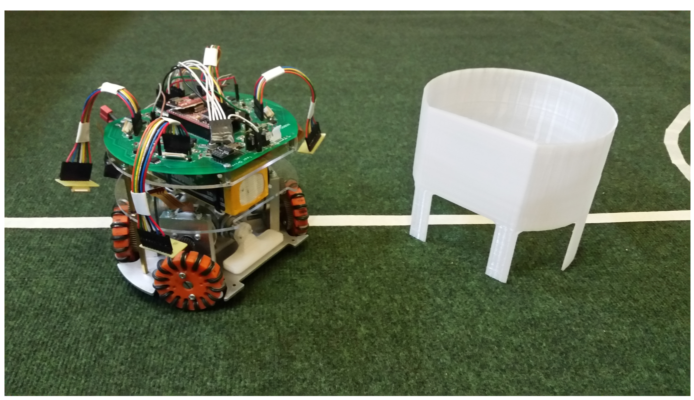

Fig. 1: Robot and case model

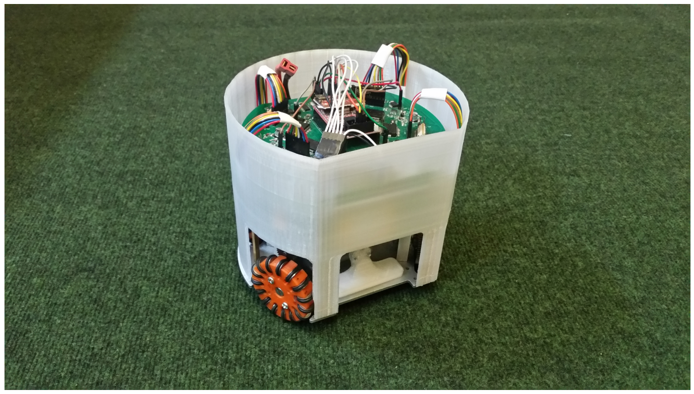

Fig. 2: Robot assembled

A. Drive System

Each robot has 4 omnidirectinal wheels made in PLA, each one with 55 mm of diameter an 15 sub-wheels of 13.5 mm of diamter, so the robot can move in all directions.

Each omnidirectional wheel is driven by a motor Maxon EC 45 30 Watts and integrated electronics wich enable us to program a velocity control for each motor, ensuring that the robot moves to our desired speed.

Figure 3 and 4 shows the described wheel.

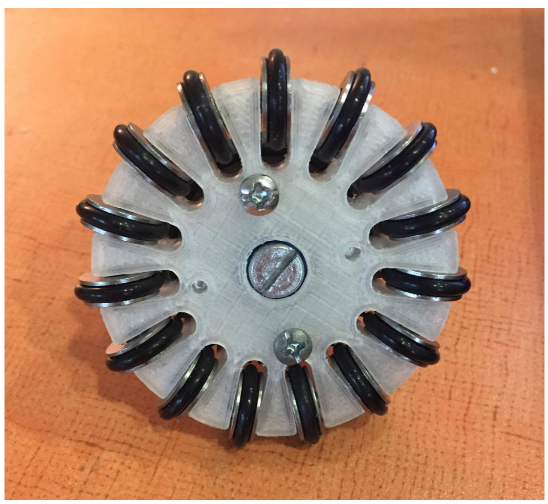

Fig. 3: Omnidirectional wheel front view

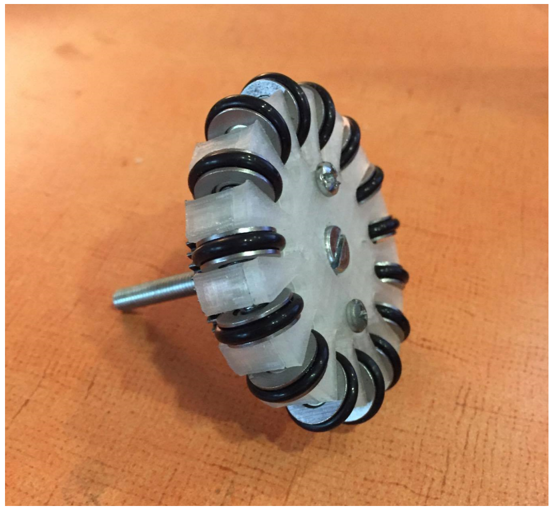

Fig. 4: Omnidirecitional wheel angle view

III. Hardware

Each robot is controlled by an PIC MX440F256H using Pinguino Development board. This model was chosen because of his versatility and peripherals, allowing us to control everything from this microchip.

We choose the PIC because is easier to program and allow us to reduce considerably the size of the PCB and release space. The peripherals also replace a lot of external electronic needed to control the motors, and dribler.

A. Kicker

The circuit of the figure is used for the kicking system. This consists of a chip chip charger controller with regulation which is a controller of flyback of high voltaje, raising the voltage from 24V to 200V on a capacitor of 2400uF and, therefore, storing an energy of 480 [J]. The charge of the capacitor takes 5 seconds to reach this voltage and can be regulated to kick with different intensities.

This circuit implements a Flyback with a turn ratio of 1:10 (PRI: SEC). When the NMOS is on, the voltage on the primary is Vtrans - Vds (ON) and current in the primary coil rises linearly at a rate (VTRANS VDS(ON))/LPRI. This voltaje is mirrored on the secondary winding as N (VTRANS VDS(ON)) Which is blocked by the diode and thus the energy is stored in the core of the transformer. When the current limit is reached the NMOS switch latch and the energy flows into the output capacitor.

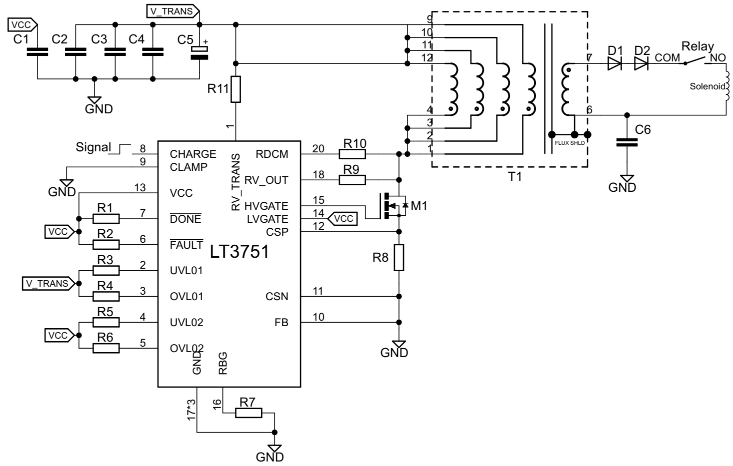

Fig. 5: Kicker's circuit

B. Dribbler

According to RoboCup rules, the robot is allowed to cover up to 20ball. Experimentally, it has been proved that it's easier to catch the ball when the dribbler has a slightly curve to center the ball on its own. So, this design involves two diameters, D1 and D2 and based on this information, maximum height possible is calculated and we obtain this expression:

$$H = \sqrt{\frac{1}{4}(D_2(2d + D_2) + D1(4pd - 2d - D_1) + 4pd^2(1-p))} + \frac{d}{2} \tag{1}$$

where d and p corresponds to the ball's diameter and maximum coverage of the ball respectively. Figure 5 shows the relation between those variables.

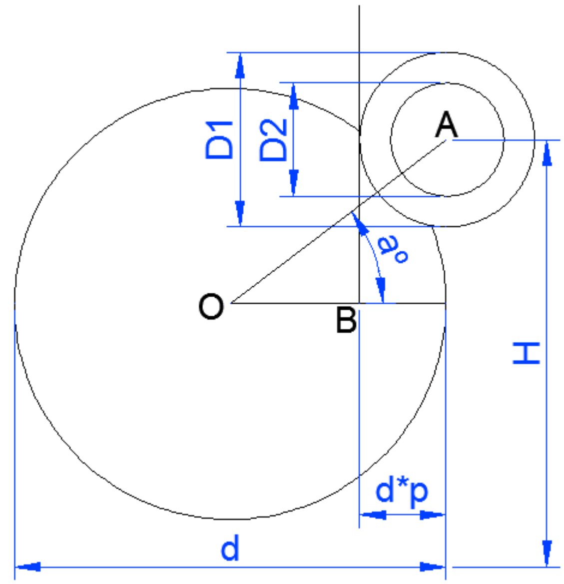

Fig. 6: Relation between variables involved in dribbler design

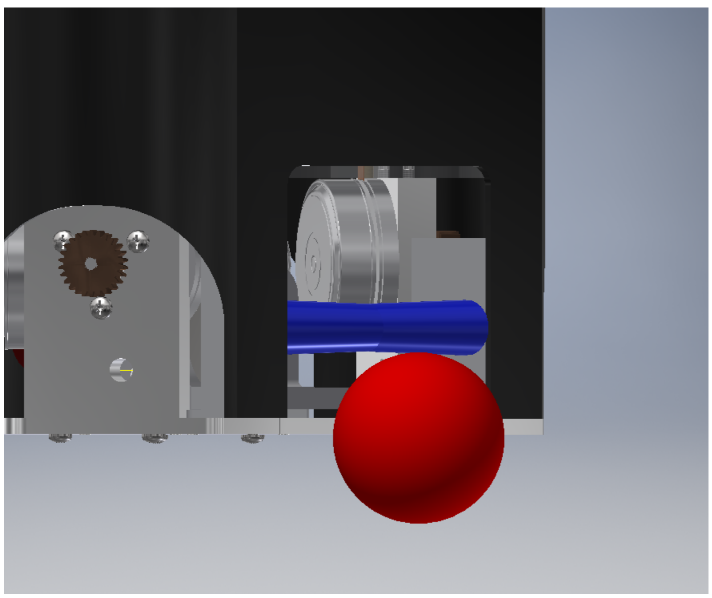

Fig. 7: View of case and dribbler

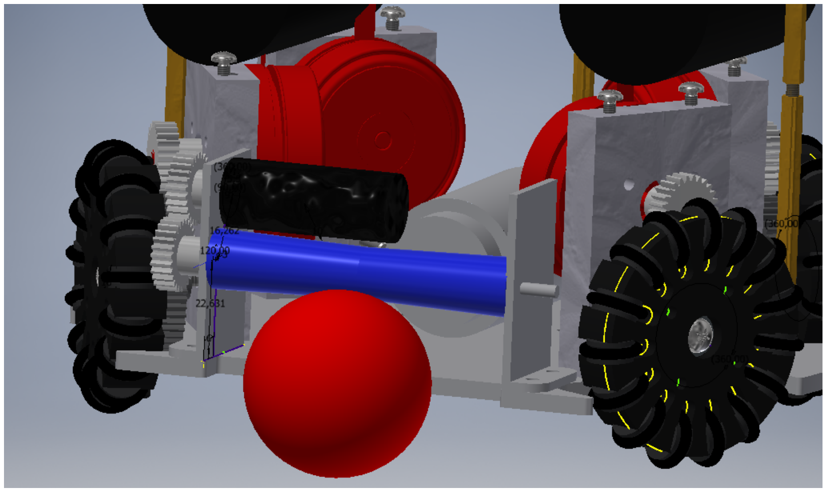

Fig. 8: View of Dribbler assembly

IV. Communication

For wireless communication between robots and the main computer, we use Wifi Module ESP8266 as clients on the robot and a TP-Link router at 2.4 GHz. The network consists on a coordinator (computer), which sends sequential instructions to all robots using TCP wireless connection as a server, where each robot receive their data by his own static ip. Instructions protocol consists on 7 bytes per package, formed by:

- 2 Bytes XY position
- 1 Byte Robot's front angle
- 2 Bytes XY destination
- 1 Byte desired angle
- 1 Actuators

V. Software

A. Simulation

In order to simulate the robotic team coordination, and test different multi-agent algorithms, we make use of GrSim [4], software that has been very helpful to test game strategies.

In simulation, we evaluate the best candidates to pass the ball, in order to shoot to the goal area. The idea is to develop a gameplay more focused on attacking, and then the decision maker evaluates the game for deciding if we are in disadvantage and then change to a defensive gameplay.

B. Team coordination

An important aspect of a RoboCup team intelligence is Path Planning. We have tested different methods looking for a suitable algorithm which gives good results at the moment of avoiding obstacles.

The first method tested was Potential Field algorithms [2]. This proposes a potential field representation for obstacles and target, using sources for the prior and sink for the latter. In this way, vector trajectories are generated avoiding obstacles and leading the agent to the target, as we let a ball fall down. A disadvantage of this method, is that we could obtain local minimums without reaching the target.

The second method tested was Rapidly Exploring Random Trees (RRTs) [3], which consists on expanding a tree on the target zone, avoiding to add nodes that could produce collisions with targets. The added points to the tree are randomly chosen with probability p in a straight line to the target, and with probability 1-p selecting a random point on the space, making more exploration and avoiding to get stucked on a different location to the target.

For improving its performance, we have implemented and tested some of the algorithms based on RRT, way-points, smoothing and some extensions like RRT* presented on 2011 [1].

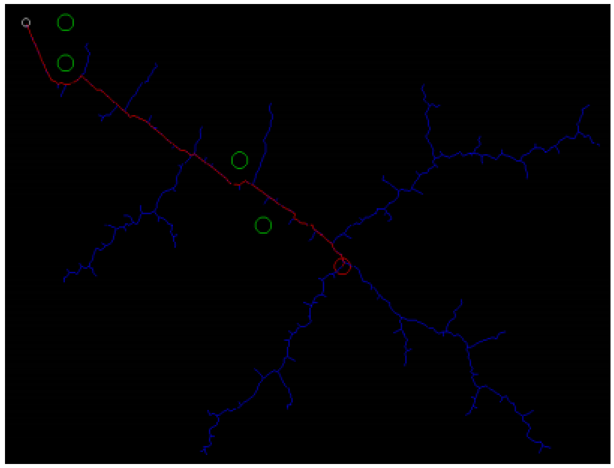

Fig. 9: Path planning simulation

VI. Expected Capabilities

By the time of the competition we expect to have built at least four robots, if there were not any more electrical failures in hardware we would expect to have built five robots, and have improved some aspects like:

-Improve the motion control for each robot, in order to be able to follow the ball facing it in a more efficient way. At the time of qualifications, robots are not able to face the ball at the same time they are chasing the ball.

-Implement dribbler and kicker on all the team, at the moment 2 robot have kicker and no one have dribbler.

-Referee box has already been tested, but there are remaining constraints in order to cover all rule cases.

-Test the implementation of game strategies with the final team (with the final number of robots).

References

[1] Adam Bry and Nicholas Roy. Rapidly-exploring random belief trees for motion planning under uncertainty. In Robotics and Automation (ICRA), 2011 IEEE In- ternational Conference on, pages 723-730. IEEE, 2011.

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[3] Steven M LaValle. Rapidly-exploring random trees a ew tool for path planning. 1998.

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