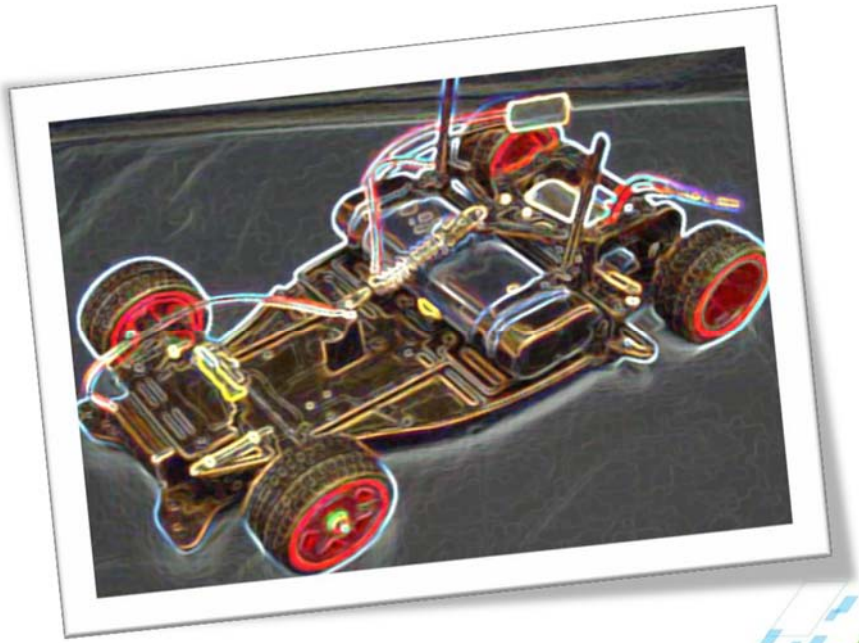
INSTITUTO TECNOLOGICO DE CD. GUZMAN

TECHNICAL REPORT TRAINING FREESCALE CUP GUADALAJARA 2014 "UPDATE SEPTEMBER 2015"-WW Finals



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Objective

The spirit of the Freescale Cup is demonstration of excellent hardware integration and superior programming. The project has the objective to design a line-following car prototype which will be able to automatically identify the racing track and follow two lines by using sensors and camera. The design is implemented with a FRDM-KL25Z as the brain of the whole system.

Description of Mechanical design of car model

The Dragon Flame team must use the car model suite designated by Freescale Semiconductor. The kit contains:

- ***Car Chassis***

  This part was used to place the camera support and FRDM-KL25Z. The wheels are cleaned with a rag to prevent slippage.

Figure 1: Car Chasis

- ***Car Parts Bag***

  In this section we used some parts for fixing the camera and the FRDM-KL25Z.

- **Line Scan Camera**

  The camera was fixed to 12 in and was placed behind of the car to generate a better vision to track. In the camera circuit we put black adhesive tape to avoid the noise occasioned for the electronic devices *(figure 2).*

Figure 2: Camera

- ***Interface/Motor Driver Board***

  In this part we created a control algorithm using the potentiometer for controlling the motor speed. For automatically adjust of the setpoint we use the buttons *(figure 3).*

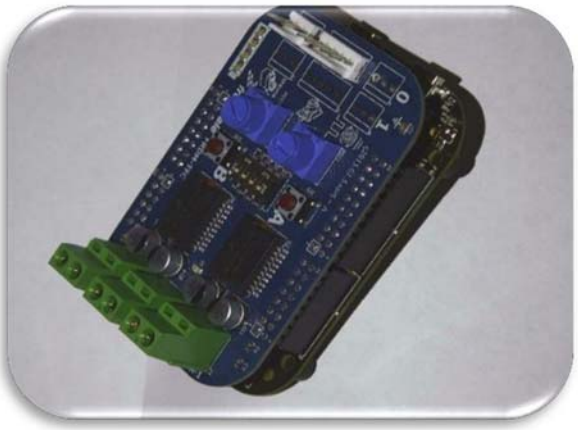


Figure 3: Bridge

- ***Wire Kit***
- ***FRDM-KL25Z***

This part was placed on the servomotors because it doesn't generate noise and the movement is easier for the car.

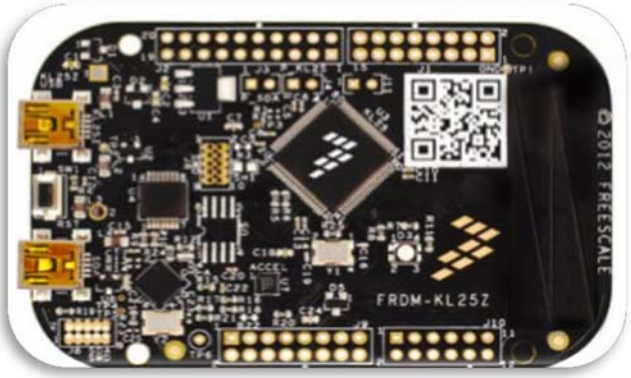


Figure 4: FRDM-KL25Z

We do not developed more circuitry, only we used the FRDM-KL25Z. The car finished is shown in the figure 5.

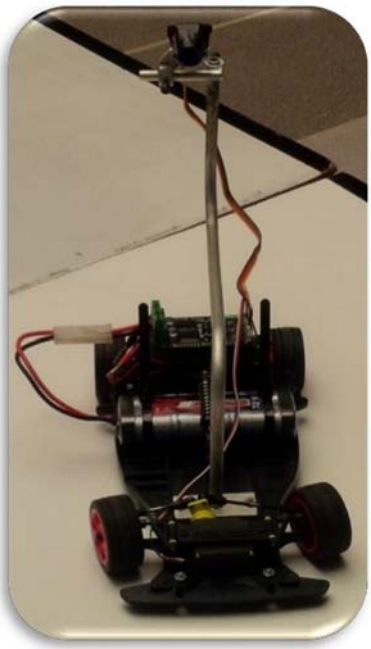


Figure 5: Front view

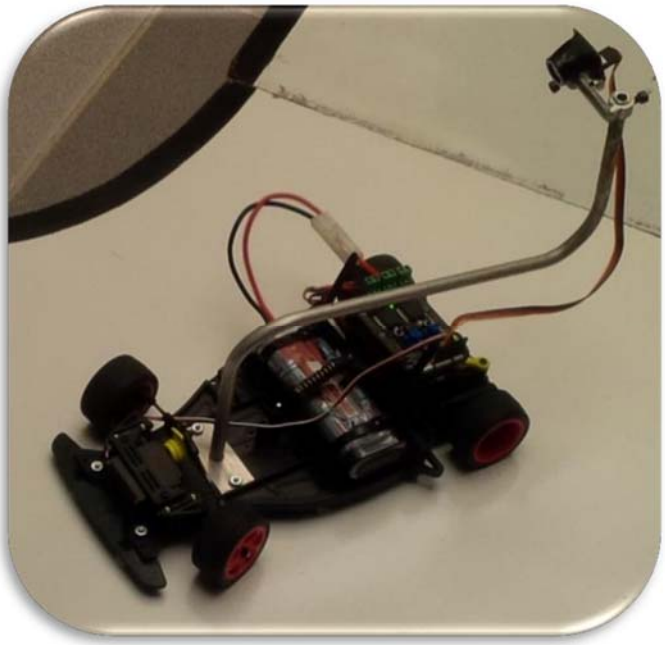


Figure. 6: Side

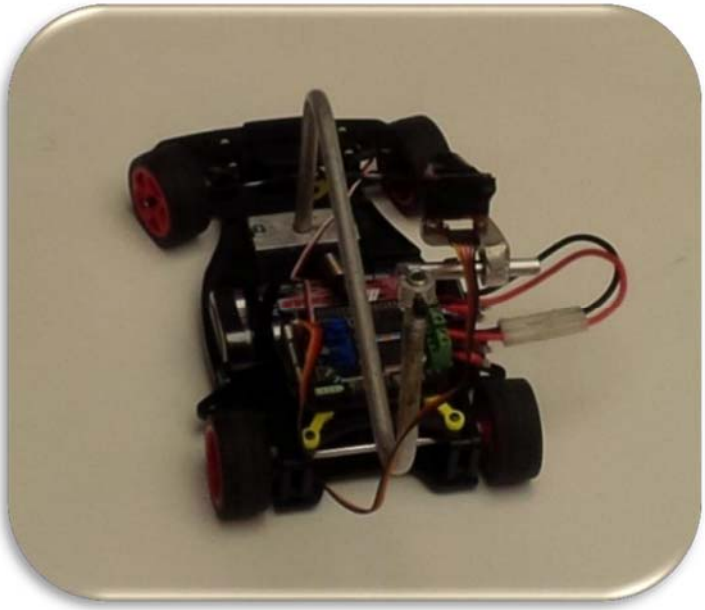


Figure 7: Top view

In the figure 8 is shown the track used for car tests:

Figure 8: Car in the track

Description of Control circuit design

Servo motor control.

In the servo motor control. The servo was controlled by the FRDM-TFC board, so no additional hardware was required.

We used a proportional control for reducing the error generated in the curves and increase the speed in the straight paths. The equation used is as follows:

$$m = K \ast Err r$$

We derived the camera signal (what is camera seeing?) and found the critical points that are the minimum value and maximum value; we establish the values in the algorithm how a set point. For making a better explanation the control used in the camera is shown in the next figure.

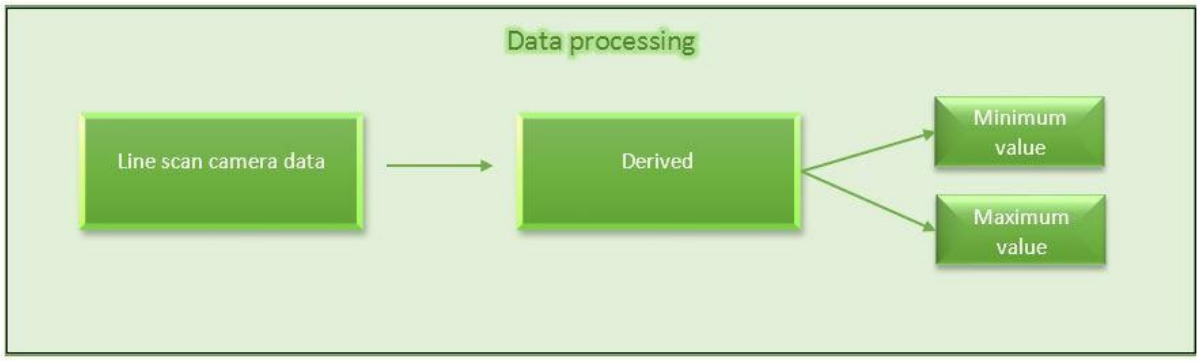


Figure 9: Data processing

We use the capture data from camera in the differential control in the curves for reducing the speed and then passing this curve, increase the speed in the straight line.

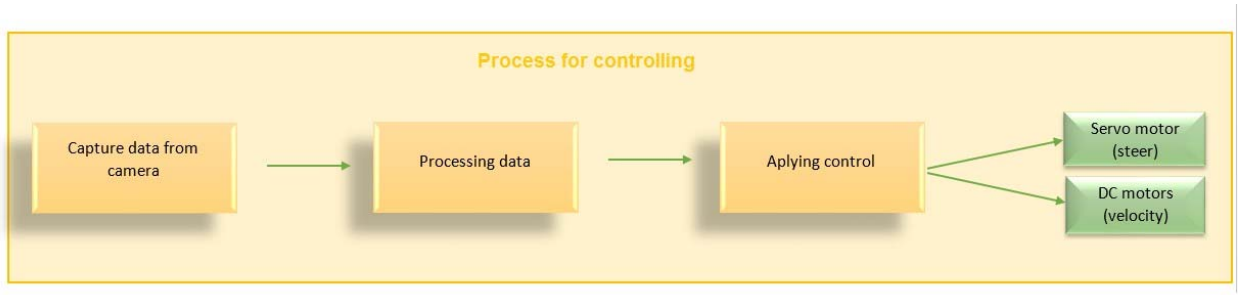


Figure 10: Process for controlling

DC motor control.

In the DC motor control part, we used the drivers integrated in the board. We created a function that return the value of normalize current speed (From 0 to 1, where 0 the car is stop and 1 it has a maximum speed). The speed of each motor is controlled by a PD algorithm is controlled by enabling or disabling the motors via a PWM signal.

We used the Sample Code proportionated by Freescale where we took the drivers for control of motors, the servomotors and camera. We condition the speed depending of error in the curves and straights, if any condition was true we apply a differential in the back wheels and a balance of speed in the straight.

Speed according your direction

In the curve beside to left, the left wheel reduce the speed and the right wheel increase the speed.

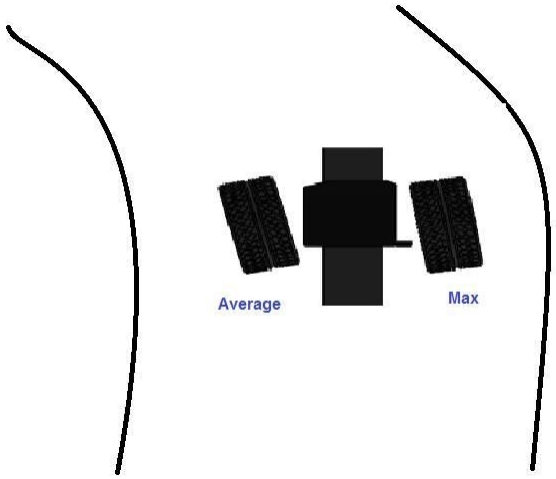


Figure 11: Left direction

In the curve beside to right, the right wheel reduce the speed and the left wheel increase the speed.

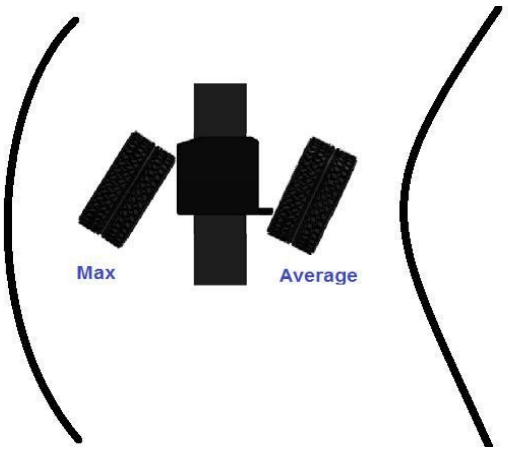


Figure 12: Right direction

In the straight direction, both wheels have the same velocity, is the time when increase the speed.

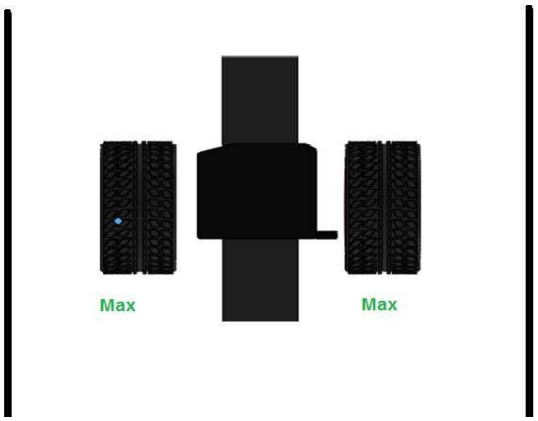


Figure 13: Straight direction

The next figure shows the block diagram of the part of the software that's taking care of the control of speed of the propulsion motors.

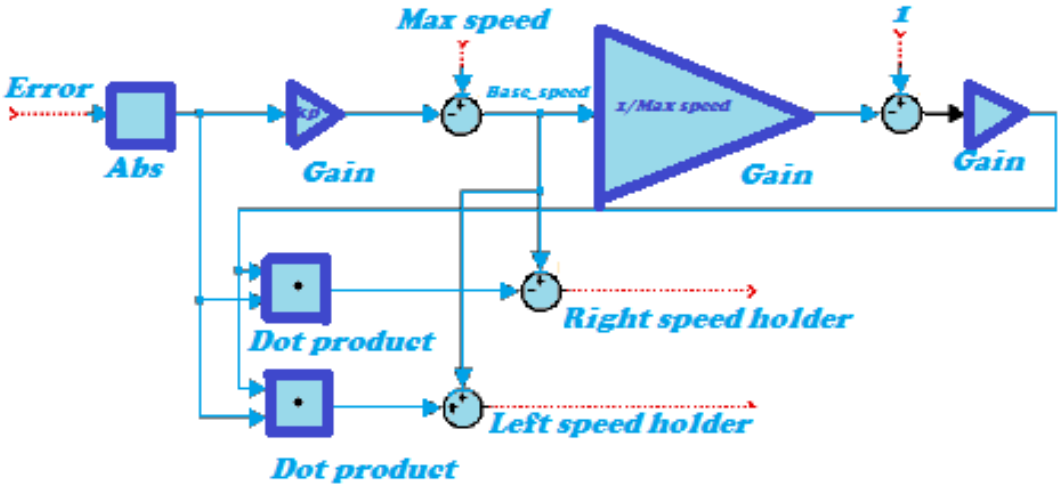


Figure 14: Block Diagram of the control

Description of Electronics design

Camera Vision

The camera was fixed to 12 in and was placed behind of the car to generate a better vision to track. In the camera circuit we put black adhesive tape to avoid the noise occasioned for the electronic devices.

LabVIEW

We used LabVIEW to understand the signal that is processing by the camera. In LabVIEW we can see minimum and maximum value from the signal. The minimum value is white color and gray tone. The maximum value is the color black that's mean the two lines blacks. With the maximum value we adjust set point in our code. In general the maximum value it's between 10 to 110 pixels approximately.

When we started, the set point it was adjust manually. The value was definite like a constant, but we improved our code and now the adjust is automatically.

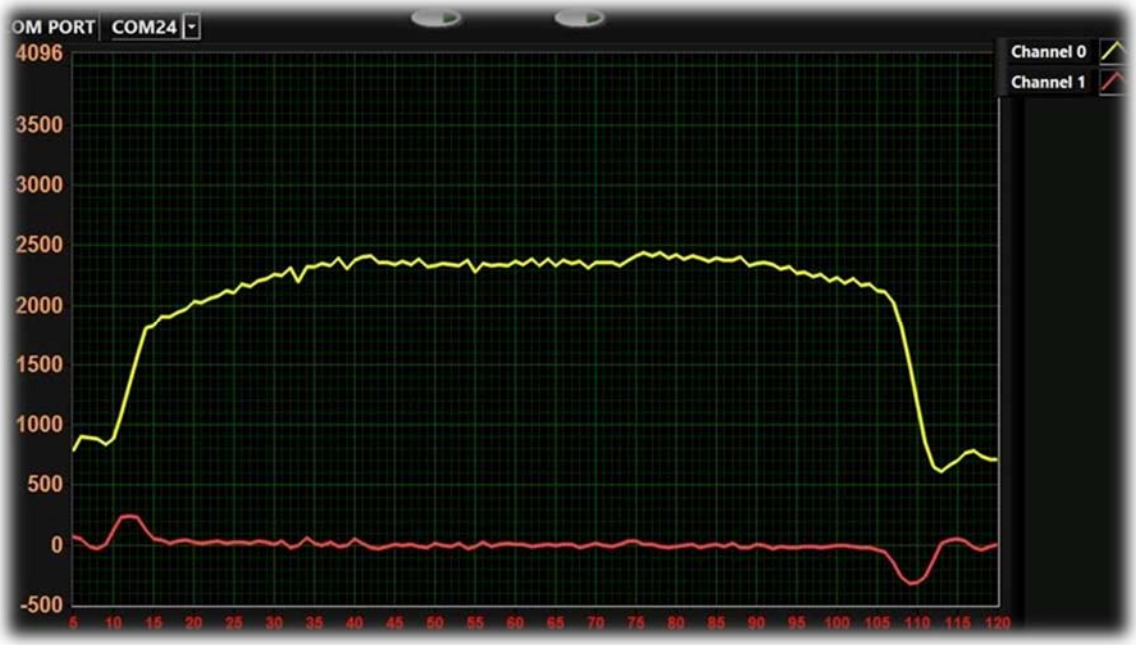


Figure 15: LabVIEW Front Panel

Description of Control software design

SW architecture and module interaction block diagram.

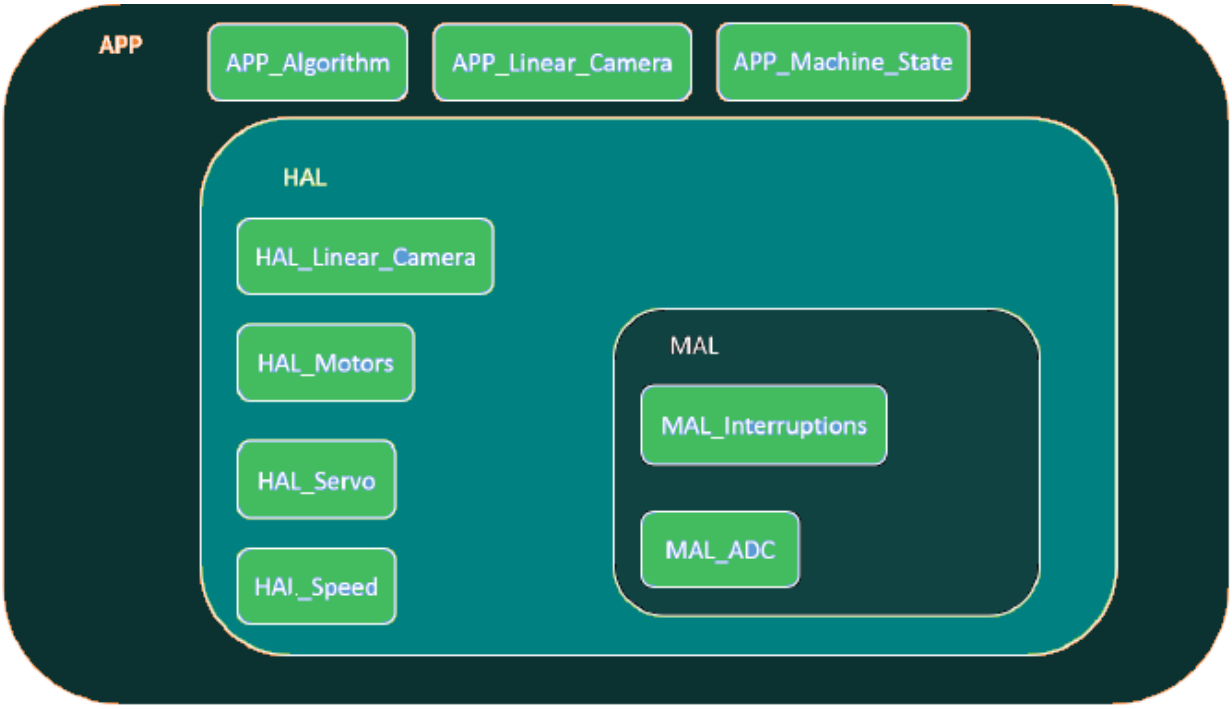


Figure 16: Architecture and Module

All code source files and project files

The code is found in:

`http://main-project-dragon-flame.googlecode.com/svn/trunk/ main-project-dragon-flame`

Repository

Changes:

Figure 17: Repository Activity

Google code is

`http://main-project-dragon-flame.googlecode.com/svn/trunk/ main-project-dragon-flame`

Scheduler

NOTE: We had complications with our code in the Scheduler, but so far we could accomplish and advance testing practices of the Scheduler, to provide us at any given time to finish.

Total weight and dimensions of the reengineered car

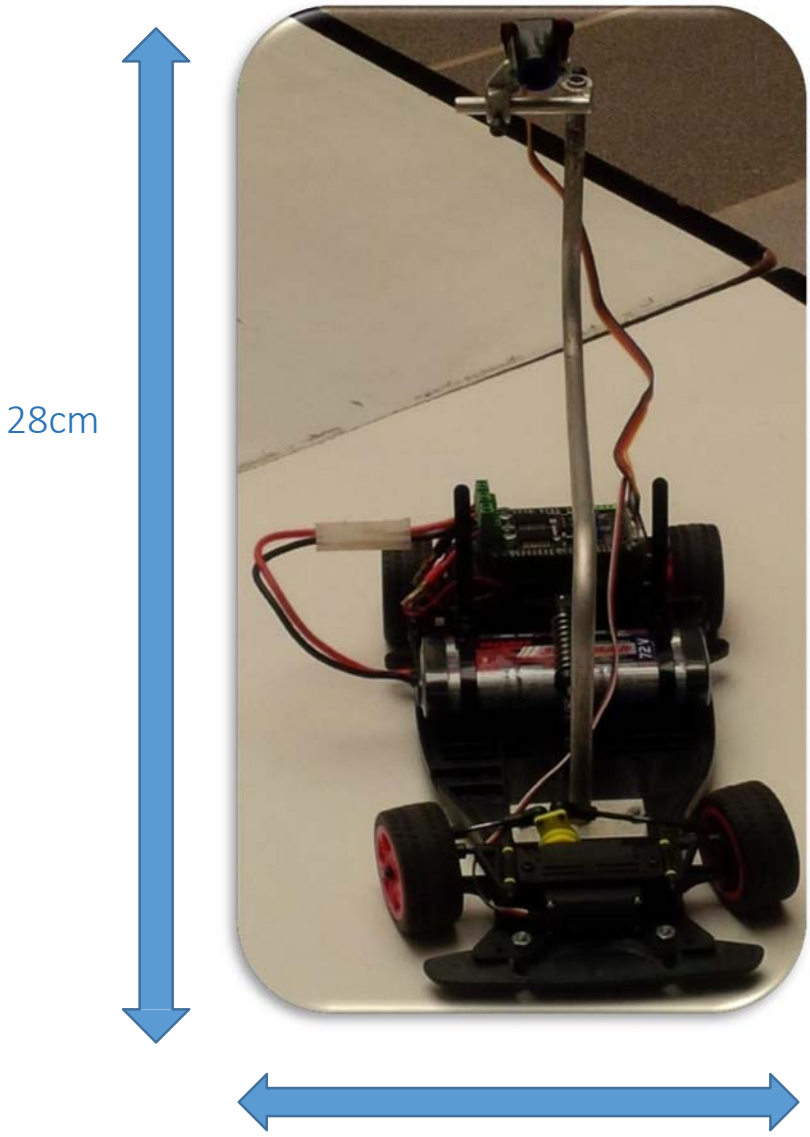


Figure 18: Car dimensions 1

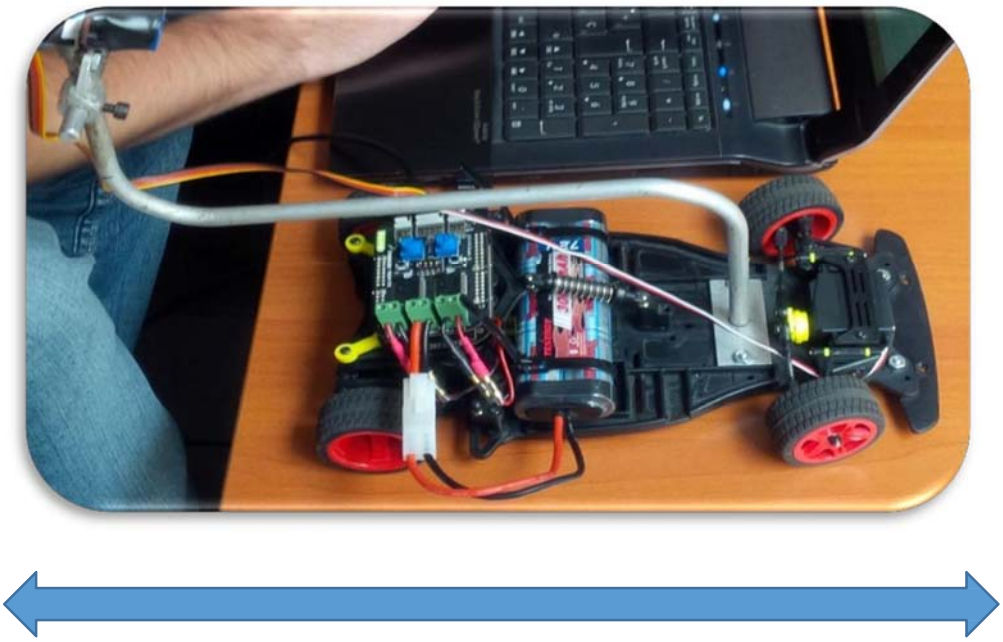


Figure 19: Car dimensions 2

Weight 1.2Kg.

Electrical specifications

Battery

3000 mAh 7.2V

Actuators

We used three actuators in total.

1 servo motor. (Futaba S3010 High Torque Servomotor). Provided by Freescale.

2 DC motors. (BDCC DC motors). Provided by Freescale.

Sensors

The sensor that we are using is a linear camera. Provided by Freescale.

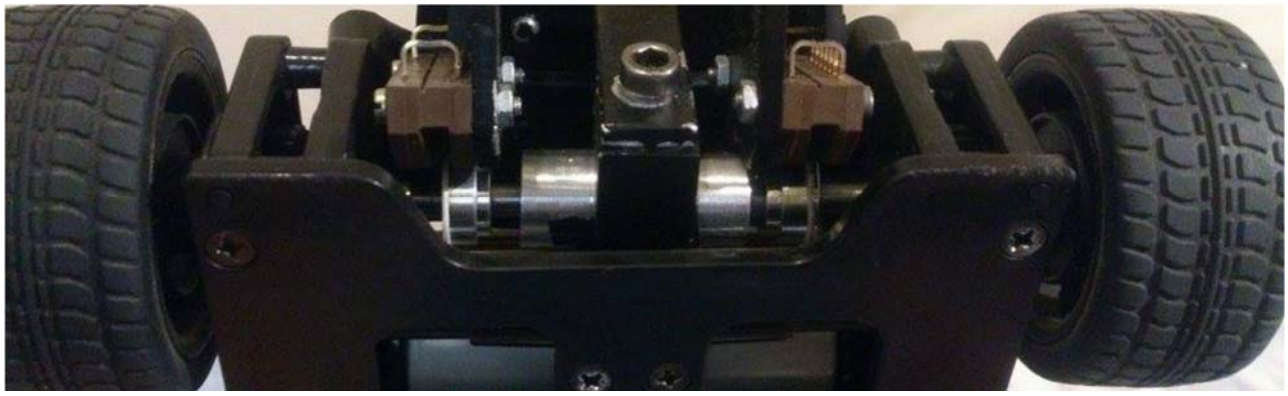
References

Galeano, G. (2009). *Programación de SISTEMAS EMBEBIDOS en C.* México: Alfaomega.

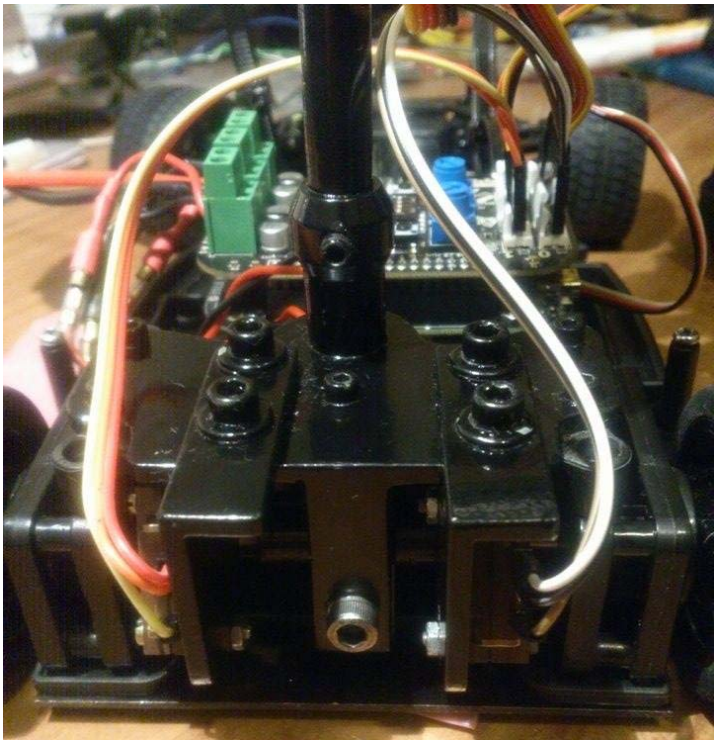
Ogata, K. (1998). *Ingeniería de Control Moderna*. México: Pearson Educación.

For this competition we made some modifications about the hardware of the car, we used two line scan cameras with different angle with the purpose to predict the curve faster than before.

Another important change that we made, was the usage of incremental encoders in the back wheels for sensing the speed, giving us a better speed control. As you can see in the next image we implemented a different mechanism that the regular, this mechanism allow the back wheels rotate independently.



In the next image you can see that the base of the encoders is the same that supports the pole of the cameras.



Finally in the next photo you can get a general view of the car and its changes…