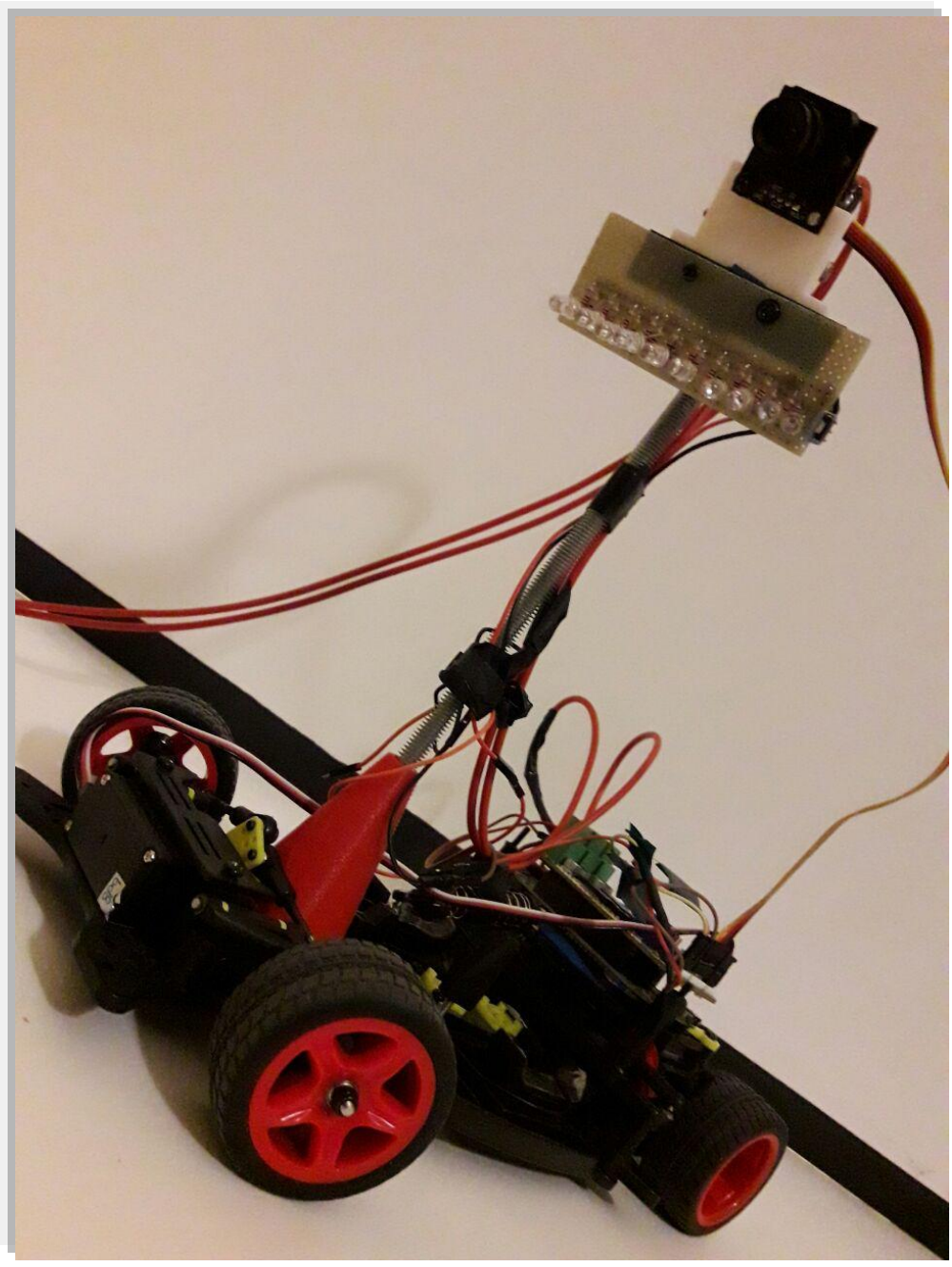


UNI.getName() Technical Report

NXP CUP

Mohammad Zobeer | Andrea Rossi | Mazzola Gabriele | Francesco Maestri

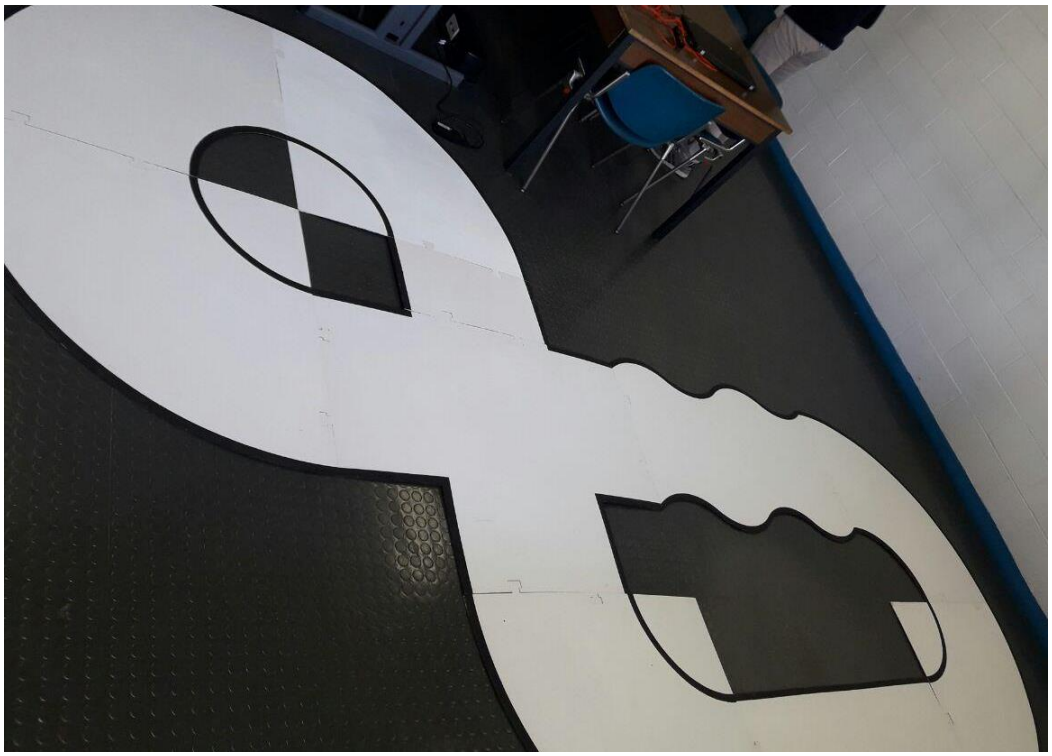
Introduction

With the following is presented the design and development of the team uni.getname().

The team has decided to enrol to this competition using a starter kit bought by University of Pavia in 2015.

For the software development, a low-level approach has been preferred, due to this fact CodeWarrior is the software IDE that has been chosen, because it offered the best tools to program and debug with the board.

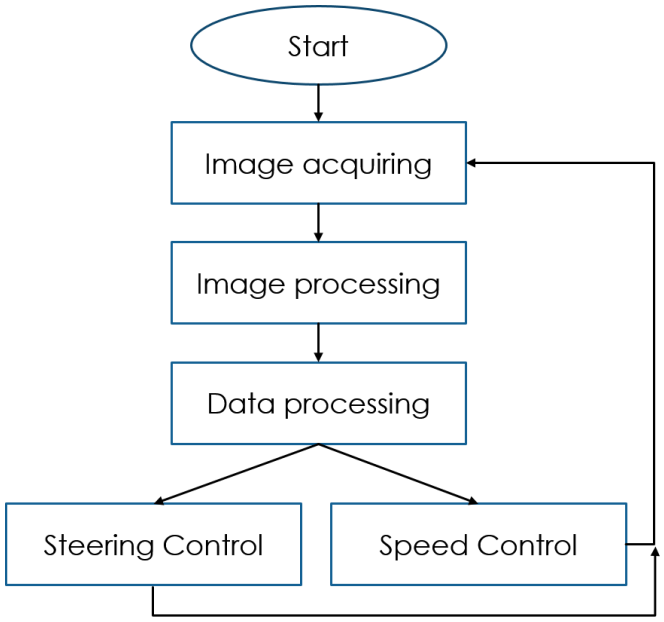
To test the performance of the car, the team has designed a race track. It has been done following the parameters on the official NXT Cup website. The cad drawings made have been laser-cut on wood and then painted.



Software Development

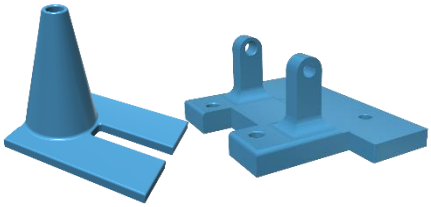
The following software modules have been developed:

- **Image acquiring:** the program checks if a new image is available from the camera, if so, the image processing routine is called;
- **Image processing:** different filter technics are applied to the linear image to reduce noises and prepare it for the line detection;
- **Data Processing**: the content of the filtered image is now ready to be processed by the decision tree, here the system decides how to respond, depending on the information captured by the camera. If the end of the track is detected the program is stopped. A memory system is used to keep record of the track and help the decision process.
- **Steering Control and Speed Control**: The state of the machine chosen by the Data Processing algorithm selects what to input to the Steering and Speed Control. These two subprograms implement some Autonomous Control Methods to regulate the steering servo and the motors. To obtain a closed-loop control of the speed a speed sensor has been used.



Hardware Development

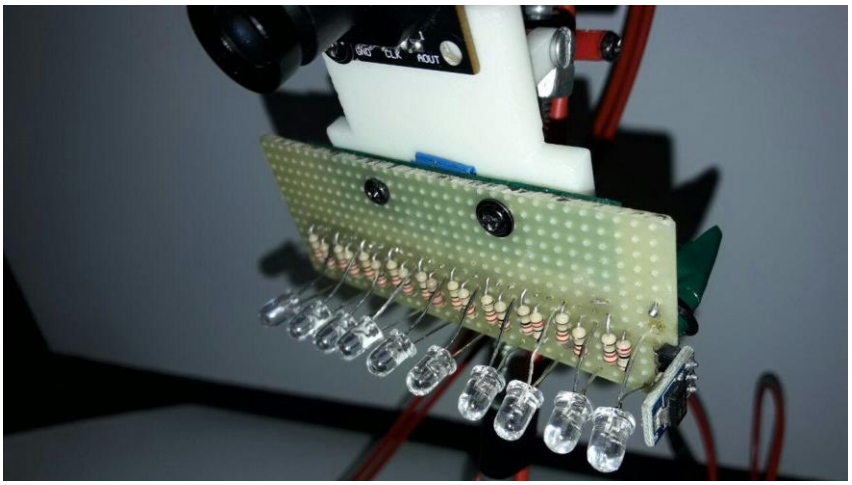
Structure



Some parts have been added to extends the car chassis, this has been done to install the camera, the led support and the speed sensor. The team components have designed and 3D-printed these extensions specifically for this hardware.

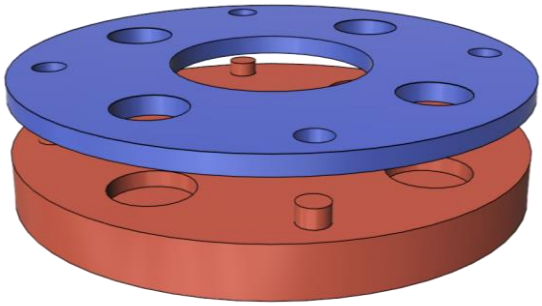
Illumination

To increase the camera definition an external circuit has been added, it hosts nine super-bright red led. The circuit is mounted on the camera holder to point the same direction. The circuit board is powered by a voltage regulator connected to the battery.



Speed Sensor

To implements a speed-feedback the team has created a speed sensor installed on one of the rear wheels. A 3D printed support hold 4 magnets solid with the wheel. A Hall-Effect sensor is installed perpendicular the wheel, and so to the magnets. The sensor is near enough to be triggered when the wheel is turning and one of the magnet passes.



Hall-Effect Choice:

This sensor has been chosen instead of the Xtrinsic MAG3110 Three-Axis, Digital Magnetometer offered by the NXP because:

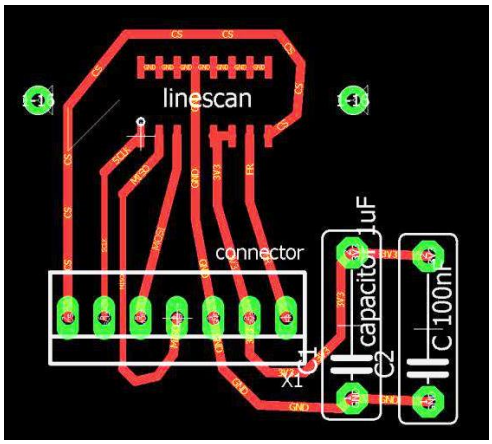
- We have found complicated to handle an SMD sensor with contacts that small.
- The NXP one was not specifically designed for a digital propose, like the one bought.
- The NXP sensor need a I2C communication protocol, it has been considered too much complicated for this application. Because the sensor is interrogated with a high frequency, the use of this protocol has been considered risky due to the delay it could introduce.

Different kind of technology have been kept in consideration to choose the battery that matched the perfect trade-off between weight and capacity. At the end the team opted for a Carson 500608132 - Battery NiMH, 7,2 V/1500 mAh.

Changes after qualification:

After the team gained the second place at the Grenoble Qualification, the development of the car has continued and some major chances have been made to the car: the camera sensor have been replaced with a different one, to use this new component at the best a specific new illumination circuit was made, to hold them was needed some new 3D-printed parts. In the following paragraphs, all these three improvements will be discussed.

New Camera:



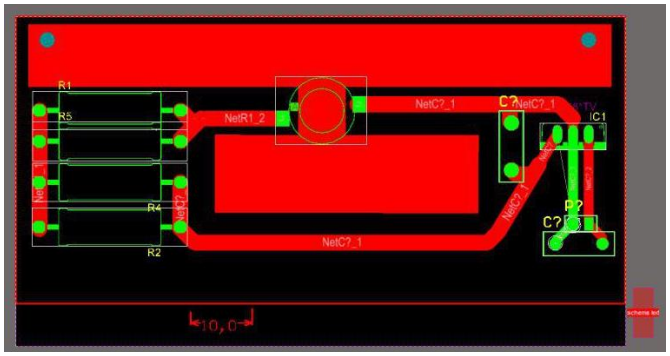
To avoid time delay introduced by the default camera in the NXP CUP starter kit, a new faster sensor has been chosen: the Melexis MLX75306. This camera appears in the list of the cameras approved for the NXPCUP: https://community.nxp.com/docs/DOC-103040 .

To install the camera the team has designed a PCB circuit. To interact with the MLX75306 the SPI protocol is used, so a new module has been added to handle the communication. Because the new camera has a different gain function, the old illumination circuit, based on super-bright red leds, was calibrated on the wrong wave-length.

After some testing, the team has decided to use white light to reduce camera noises and eliminate environment dependencies.

New Illumination Board:

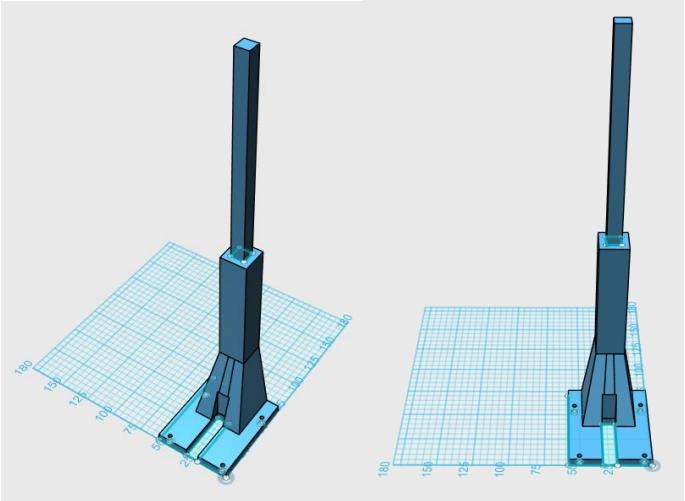
The core of the board is the ProLight PM2B-3LWE-SD, one single SMD led, that gives to the camera a strong and diffuse white light. This changing in the illumination board has allowed the elimination of different software noise cancellation routine used before the qualification.



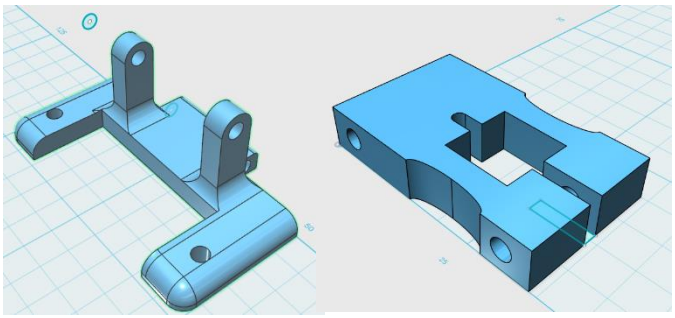
The LED is mounted one a PCB circuit too. To feed it with the right voltage, a voltage regulator is needed: the Texas Instrument 7805 Positive Voltage Regulator.

3D-Printed Hardware:

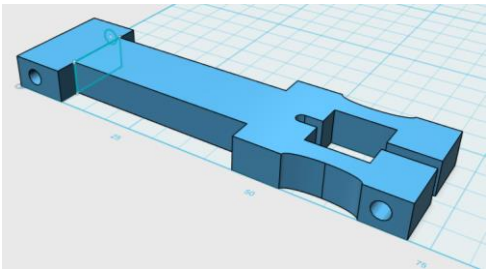
To increase the performance, the camera stick has been completely redesigned to eliminate every metallic part and reduce weight.



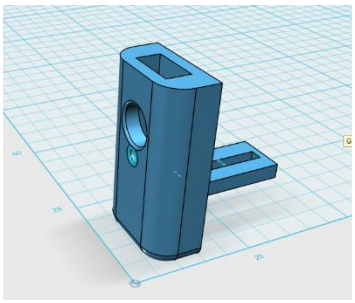
With it, a new camera holder, the piece that attach the camera board to the stick, was adapted and printed.



The led board has been detached from the camera board and installed with a different support to the stick. This was done to give more mobility to the led board and to have a better orientation of the light.



A new encoder-holder was also printed, to better fix the sensor and reduce the shifting during the race.



Bill of Material:

The details and specification of the components are available in the attachments. Here follows a resume of the costs.

Product	Code	Qty	Cost (€)
Adhesive magnet 5x1 mm	N837	50	10.89
Super bright Red LED	L53SRCJ4	25	12.50
Hall effect sensor	SS443A	5	10.55
NiMH Battery 7,2 V	500608132	1	14.99
Melexis Linear Optical Array	MLX75306	1	20
ProLight White LED	PM2B-3LWE-SD	5	13,82
Resistors 4,7k Ohm	2141636	9	7,55