UNIVERSIDAD AUTONOMA DE GUADALAJARA

CoppsKiano Móvil

Ing. de Software

Diseño de Sistemas con microprocesadores

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Introduction

This document describes the design and implementation of a remotely controlled vehicle through a mobile device. It will be formed by two large blocks: hardware and software. The vehicle prototype, built on a scale using a structure containing a microcontroller, can be moved with the commands that the user sends, thanks to the creation of an algorithm that avoids collisions with frontal objects. In this document, the entire process is detailed.

Scope of work

Currently mobile technology is constantly evolving; the utilities that a mobile device can offer are increasing, from basic utilities such as making calls to more complex utilities.

From this arises the motivation for which this project is going to be carried out, which consists of applying radio control technology to mobile technology. The remote-controlled cars were a great technological revolution; Being able to drive a car with a wireless control aroused great interest in the world of leisure. At present, there are more complex remote-controlled structures, such as ships, planes, helicopters or the innovative "drones".

Justification

The impact that the rise of mobile technology generates in society can be reflected in the number of terminals sold per year among people of all ages; this arouses an interest both in the users and in the developers of applications, since every time there is a greater number of applications destined to the leisure or to facilitate certain tasks to the user.

By joining the concept of radio control with mobile technology, is the main objective of this project, which will consist of a car prototype that can be addressed through a smartphone.

Theoretical framework

If we want to develop a good project, it is necessary to have knowledge of the modules and the architecture of the microcontrollers, since they can do many applications. Therefore, it requires an open mind and good logic to think about the solution of the project and how to achieve the proposed objectives.

Functional description

To define the functional description, it will be classified into two categories:

- User requirements: describes a project functionality.
- Use case diagrams: describe the activities that must be done by someone or something to carry out a process.

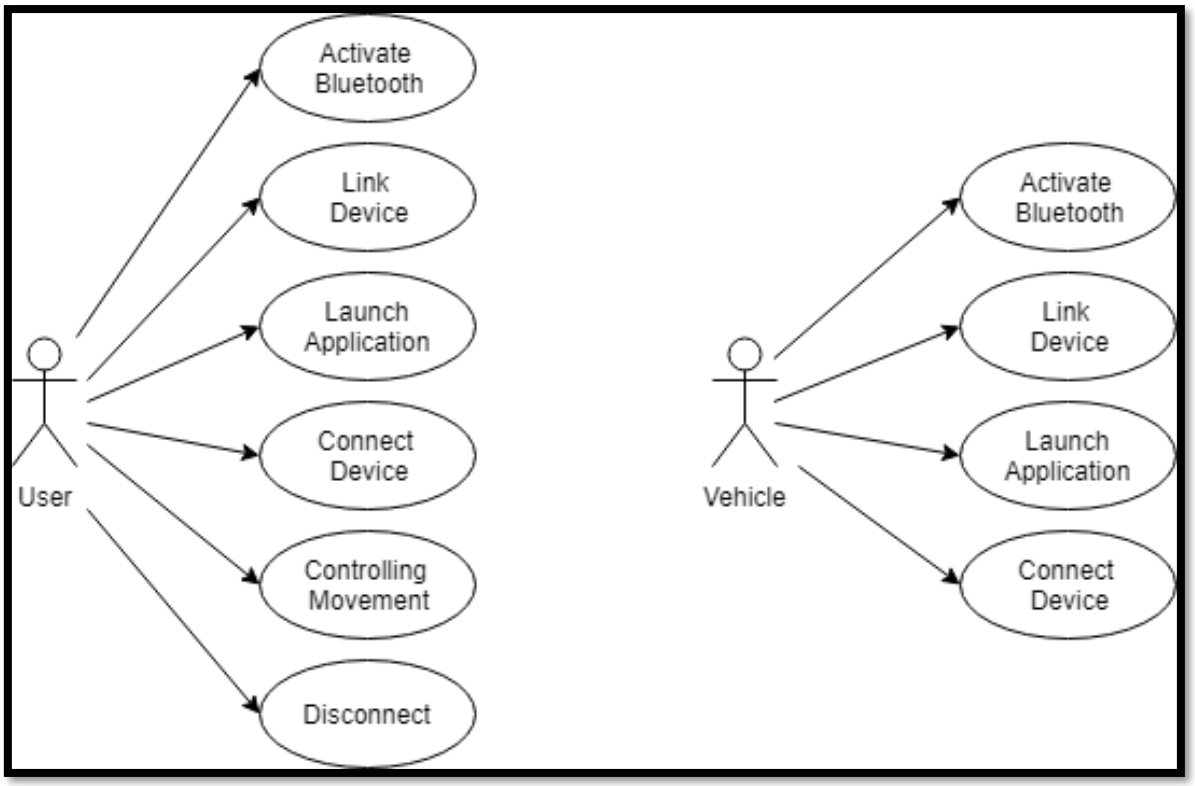
User requirements

- The user must have a wireless connection enabled on the mobile device.
- You must be able to select the device with which to establish the wireless connection.
- There must be a connection between the vehicle and the mobile device.
- At the start of the application, the following interface will be presented: 5 buttons to operate the vehicle, a button for connecting via Bluetooth and two buttons for switching the front lights on and off.
- The user must be able to drive the vehicle (move forward, backward, turn left and right and stop).
- The user must be able to turn the front lights on and off using the on and off buttons.
- The user must be able to connect the device using the Bluetooth button.
- The user interface application design must be simple and intuitive.
- The application must notify the user if any type of error occurs.
- The vehicle must have a device to make wireless connections.
- The vehicle's wireless device must be on and visible to the user.
- The vehicle must be equipped with an anti-collision system to prevent frontal collisions.
- The vehicle must have its own power source.
- The vehicle must have a mechanism to generate traction on two wheels.
- The software loaded in the microprocessor must receive and correctly process the orders sent from the mobile application.

Use cases diagrams

Once the user requirements are established, they will be divided into two main scenarios:

- User use cases: the use cases for the control of the vehicle by a user from the Android application will be defined.
- Vehicle use cases: these will be the cases of use that the vehicle can make as the main actor.



Requirements

To define the requirements of the project, these will be classified into two main categories:

- Functional requirements: refers to a capacity user requirement.
- Non-functional requirements: refers to a restriction user requirement.

Functional requirements

- The vehicle's device, once properly linked to the phone, will appear in the phone's paired list.
- If a connection cannot be established, the user will be notified.
- The user can try to connect again until the connection is achieved.
- he user will operate the vehicle in manual mode using the buttons that will appear in the application (move forward, backward, turn, stop and turn on and off the headlights).
- All buttons will appear on the application's operation screen: connect device, turn on / off front lights and vehicle change buttons.
- The vehicle will have a Bluetooth module to transmit the data between the application and the microcontroller.
- The Bluetooth module of the vehicle can be linked to one or more mobile devices.

- The Bluetooth module of the vehicle may only be connected to a mobile device.
- The LED of the Bluetooth module will flash rapidly if there is no connection with a device.
- Once the connection with a device has been established, the LED of the Bluetooth module will blink slowly.
- The Bluetooth module must be on to appear as an available device.
- The vehicle will be equipped with a sensor that calculates the distance between the vehicle and the obstacle with which it is facing.
- If the sensor detects an obstacle at a certain distance, the vehicle will stop automatically.
- A 9V battery will be used as the external power source for the vehicle.
- The vehicle will have two DC electric motors to move the wheels.
- The vehicle will also possess a "crazy wheel" without traction to generate stability in the structure.
- The microcontroller will receive the data sent from the Bluetooth module, which will act as a slave.
- The software must compile without errors or warnings before loading it into the microcontroller.

Non-functional requirements

- The application must work in the Android operating system.
- The application is not designed for tablets or Smartphones larger than 5.5 inches.
- The C language will be used for embedding.
- A development environment will be used at the code level, compatible for the Windows 10 operating system.
- Both software and hardware connections will be made using only a single microcontroller.
- The model of the card used will be "FRDM-KL25Z".

Schedule

The start date of the project was the first week of September 2018, and the end date of the last week of November. Approximately the project consists of approximately 3 months.

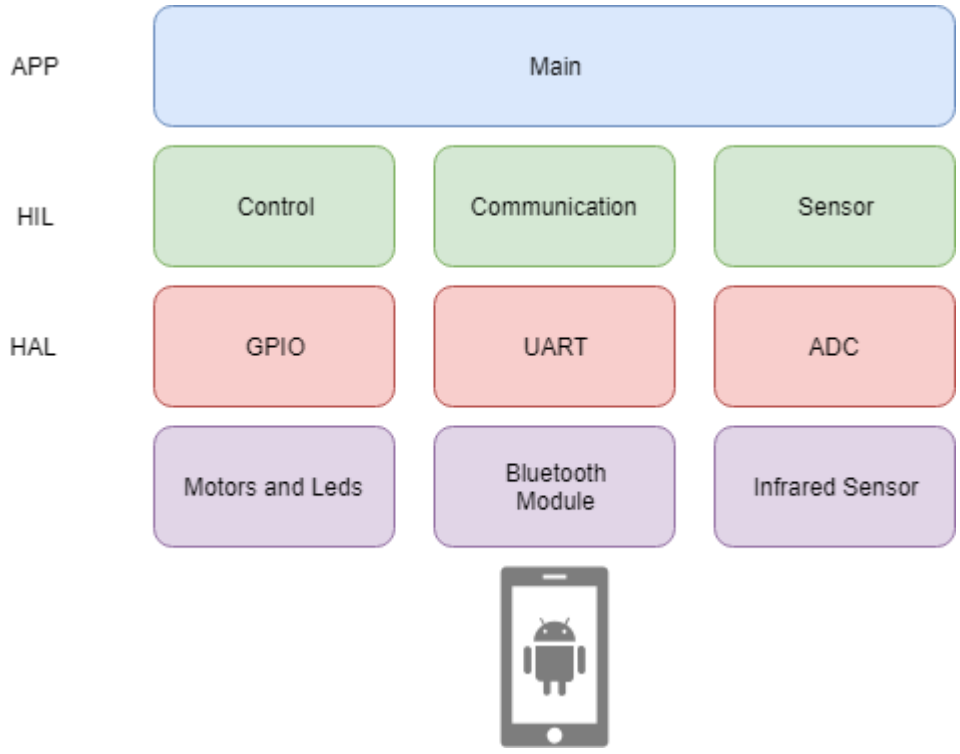
The following Gantt chart shows the breakdown of the planning of the activities throughout the duration of the project.

		September				October				November					
No.	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	Weeks
1	Project planning														
2	Initial design and ordering components														
3	Vehicle assembling														
4	Basic movement coding														
5	Front lights														
6	Bluetooth configuration														
7	Mobile application development														
8	Sensor configuration														
9	Sensor iteration with the vehicle														
10	Fixing details														
11	Documentation														
12	Project delivery														

Modules

- GPIO: module to control the movement of the motors and front lights.
- UART: communication module to receive the commands.
- ADC: module to control the anti-collision system that the vehicle will have.

Architecture



Description

- **APP**

Main: Program to administrate and control the movements.

- **HIL**

Control: Program to control the movement of the motors and front lights.

Communication: Program to receive the commands from the application.

Sensor: Program to control the anti-collision system that the vehicle will have.

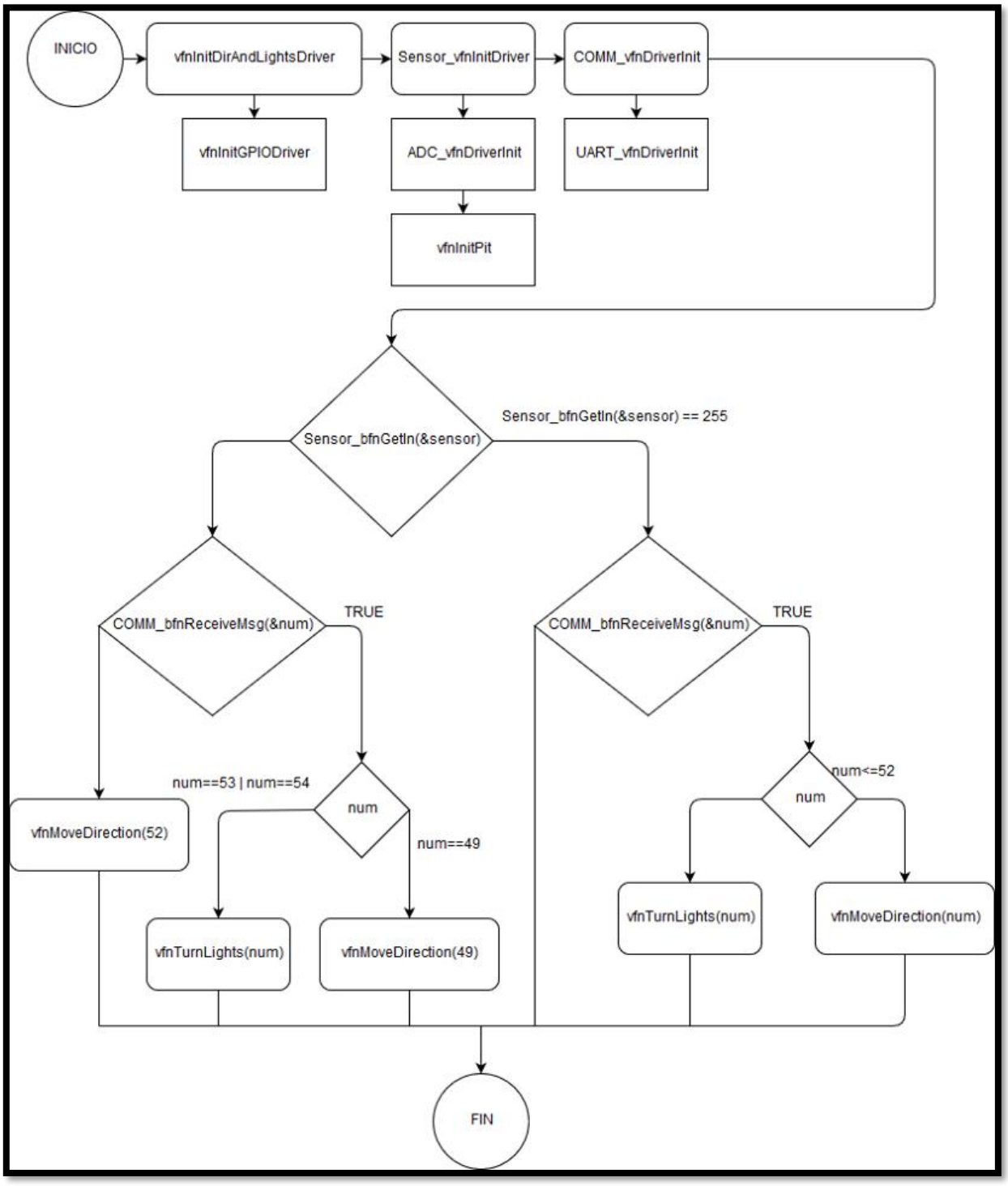
- **HAL**

GPIO: Module that contains initialized drivers to control the movement of the motors and front lights.

UART: Module that contains initialized drivers to receive the commands.

ADC: Module that contains initialized drivers to control the anti-collision system that the vehicle will have.

Flow chart


INICIO
vfnInitDirAndLightsDriver
Sensor_vfnInitDriver
COMM_vfnDriverInit
vfnInitGPIODriver
ADC_vfnDriverInit
UART_vfnDriverInit
vfnInitPit
Sensor_bfnGetIn(&sensor)
Sensor_bfnGetIn(&sensor) == 255
COMM_bfnReceiveMsg(&num)
TRUE
COMM_bfnReceiveMsg(&num)
TRUE
num==53 | num==54
num
num==49
vfnMoveDirection(52)
vfnTurnLights(num)
vfnMoveDirection(49)
num<=52
num
vfnTurnLights(num)
vfnMoveDirection(num)
FIN

Materials

Hardware

- ***FRDM-KL25Z***

To carry out this project, the Freedom-KL25Z microcontroller will be used; it is one of Freedom's basic models and is the one commonly used for projects of this magnitude.

The function of this microcontroller will be to receive and process the orders that the user sends from the mobile phone to control the vehicle.

- ***Bluetooth module HC-05***

This component is used to make the connection between the mobile phone and the KL25Z via Bluetooth, and thus be able to transfer the data that the user sends.

- ***Proximity sensor LM393***

This sensor will be part of the anti-collision system that the vehicle will have, since it will be able to detect obstacles at a certain distance.

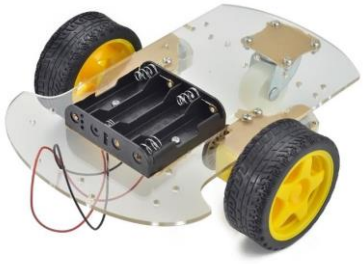
- ***Vehicle structure***

The vehicle that will be used for this project consists of the following components:

Methacrylate table: it is a table on which the circuitry of the system will rest: KL25Z board, connections with the test plate, batteries, sensors ...

Wheels: the vehicle will consist of two wheels with traction, connected to two electric motors, and a crazy wheel, which is a wheel that rotates in all directions without having traction.

Motors: two electric motors will be used to generate rotation in the wheels.



- ***Protoboard***

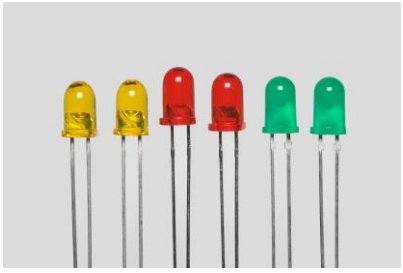
It is a test plate in which you can insert electronic elements and cables with which circuits are assembled without the need to weld any of the components.

- ***L298N Module***

This module will serve to generate movement in the two direct current motors that the vehicle will possess and thus the possible turns of the engine will be controlled: to turn forward and to turn backwards.

- ***Led lights***

The led lights will simulate the headlights of the vehicle.

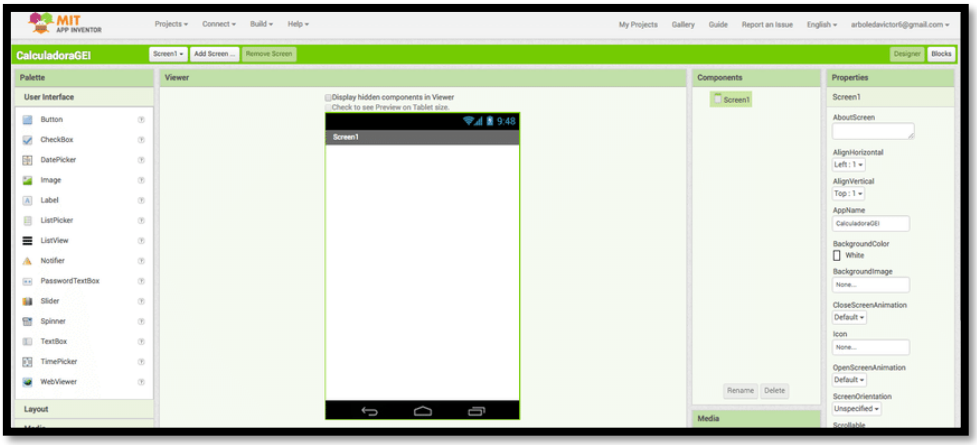


Software

- ***MIT App Inventor***

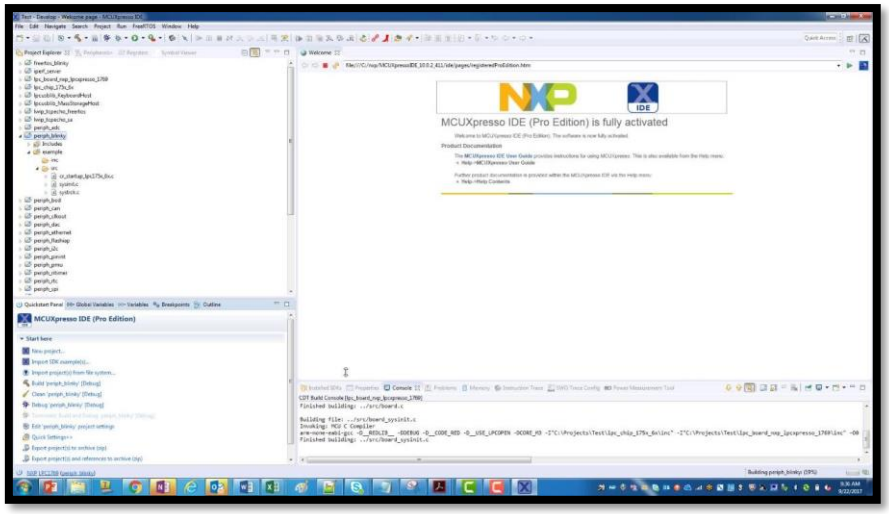
It is a Google platform that allows you to design and create applications for the Android operating system in a simple and visual way.

The main advantage of using this tool is the simplicity of use, since it offers the user both the ability to design the application interface and implement the logic in a very simple and intuitive way. Although it is not required to program as such, the user must have basic notions of programming and logic.



- ***MCUXpresso IDE***

MCUXpresso is an integrated development environment published by NXP Semiconductors for editing, compiling, and debugging software for several microcontrollers and microprocessors and digital signal controllers used in embedded systems.



Problems found

Throughout the realization of the project difficulties have arisen both in software and hardware, which have been able to modify the planning of tasks established from the beginning; In the case of software, the problems have been errors in the code, both in the microcontroller and the Android application. This is something very common in programming, so, thanks to the documentation provided by the internet and conducting numerous tests, the errors were solved.

The problems in hardware have been the most common in the implementation of the system, such as failures in some component due to a bad connection or wrong voltage, battery wear when carrying out numerous tests, loose parts in the structure of the vehicle or the replacement that It was made of two components when damaged (Bluetooth module and sensor).

The problems, both in software and hardware, originated during the realization of the project, could have been solved efficiently and the final delivery time of the project has not been altered, despite undergoing alterations the initial planning of the projects. chores.

Lessons learned

The realization of the project, from the beginning, has required a great personal effort due to the little experience in the environment of the system.

The easiest part, but at the same time has brought more problems, has been the construction of the vehicle; all the connections of the hardware components that constitute the structure could be made correctly thanks to the extensive documentation existing on the Internet. The problems were mainly to couple the circuitry to the structure of the vehicle and the construction of said structure.

The most complicated part, in which the greatest effort has been employed, has been in software programming, since it had little experience programming for embeds and none with the kl25z microcontroller.

Anyway, I learned a lot in this project, such as retake the basic foundations of programming in c, its logic and that embedded systems are very great since you can make products that can facilitate your daily life.

As a software engineer I have learned to organize myself better in the realization of projects in my job as a web developer because many of the problems that a project does not finish on time is due to the lack of organization.

YouTube Video

https://youtu.be/cAF6K8UbQuM

Source Code

https://github.com/Coppel26/ProyectoFinalMicros2

Bibliography

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  https://www.gme.cz/data/attachments/dsh.772-148.1.pdf
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- Proximity sensor LM393
  http://www.ti.com/lit/ds/symlink/lm2903-n.pdf
- Connection Example
  http://www.electrontools.com/Home/WP/2016/03/09/como-funciona-el-puente-h-l293b/
- HC-05 Functionality
  https://www.youtube.com/watch?v=9pMujGaZwZw
- L298N Functionality
  https://www.youtube.com/watch?v=c0L4gNKwjRw