CMPE 443 PRINCIPLES OF EMBEDDED SYSTEMS DESIGN

Final Project - Phase 3

"Autonomous Car"

1) Problem Description

In this last phase of the Final project, you will add the ESP8266 WiFi module to the car. Previously, you had added 1 Motor Controller, 4 LEDs, 2 LDRs and 1 Ultrasonic Sensors, and in this phase you will also use these components.

This phase consists of two different scenarios and the demos of these scenarios will be graded separately, but the bonus part is combination of the scenarios and for the bonus part, the Half Letter Grade increment will be reward.

Your robot will start the Demo with the Power Down mode and with the External Interrupt (You can use the push button on the board), your robot will start with the rest state. When you press a Joystick button, your robot will start the complete the tasks which are listed below:

- ➢ When Joystick Center button is pressed, your robot should stop and board should go to Power Down State.
- ➢ When Joystick Left button is pressed, your robot should start executing the first scenario.
- ➢ When Joystick Right button is pressed, your robot should start executing the second scenario.
- ➢ When Joystick Down button is pressed, your robot should start executing the bonus scenario.

Also, your robot should have an ability to change its speed. The speed of the robot will be determined by the Trimpot which is located on the Experiment Base Board (You can see the Trimpot in the green circle). The speed scale of the robot should be between 50% - 100% Duty Cycle.

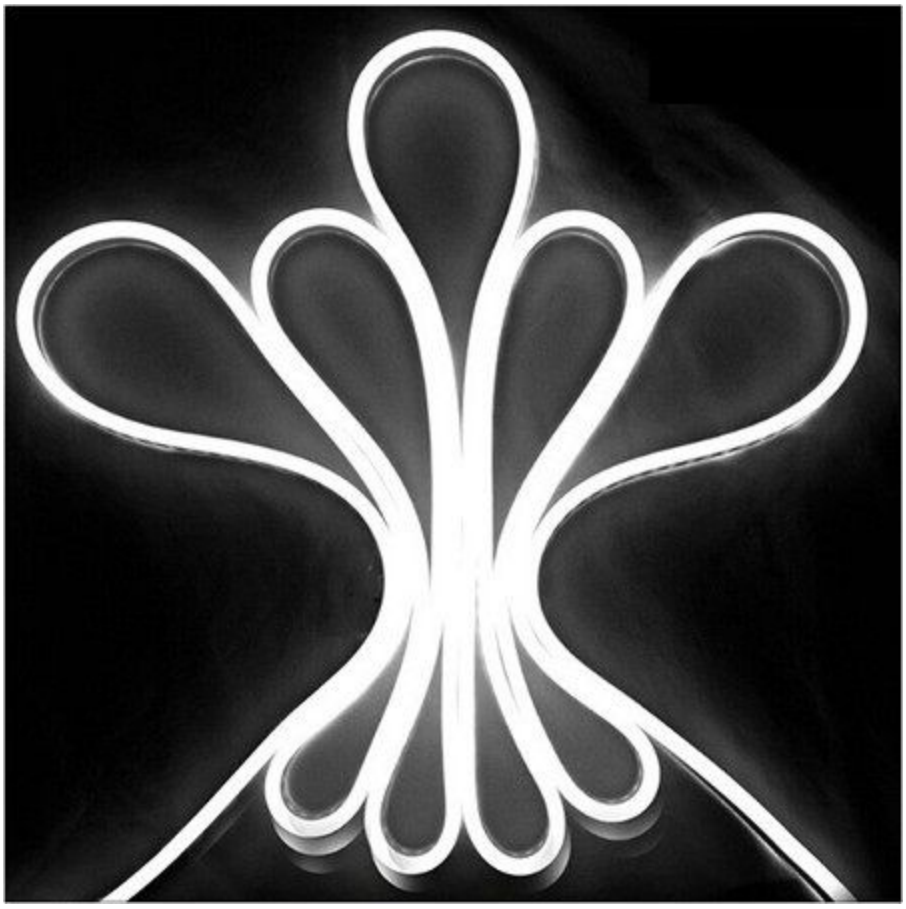
There are 4 LEDs on the Quickstart Board and in order to understand the scenario is finished or not. *At the start of scenario, these LEDs should be turned off. However at the end of each scenario, your robot should stop and turn on these 4 LED.*

Your robot car has 4 LEDs which are located to the Front-Left, Front-Right, Back-Left and Back-Right The state of the LED is changed according the action which robot performs:

- ➢ When robot stops, all the LEDs should be turned off.
- ➢ When robot drives in forward direction, Front-Left and Front-Right LEDs should be turned on and the other LEDs should be turned off.
- ➢ When robot drives in backward direction, Back-Left and Back-Right LEDs should be turned on and the other LEDs should be turned off.
- ➢ When robot drives counter-clockwise direction, Front-Left and Back-Left LEDs should blink (2 times in a second) and the other LEDs should be turned off.
- ➢ When robot drives clockwise direction, Front-Right and Back-Right LEDs should blink (2 times in a second) and the other LEDs should be turned off.

2) First Scenario

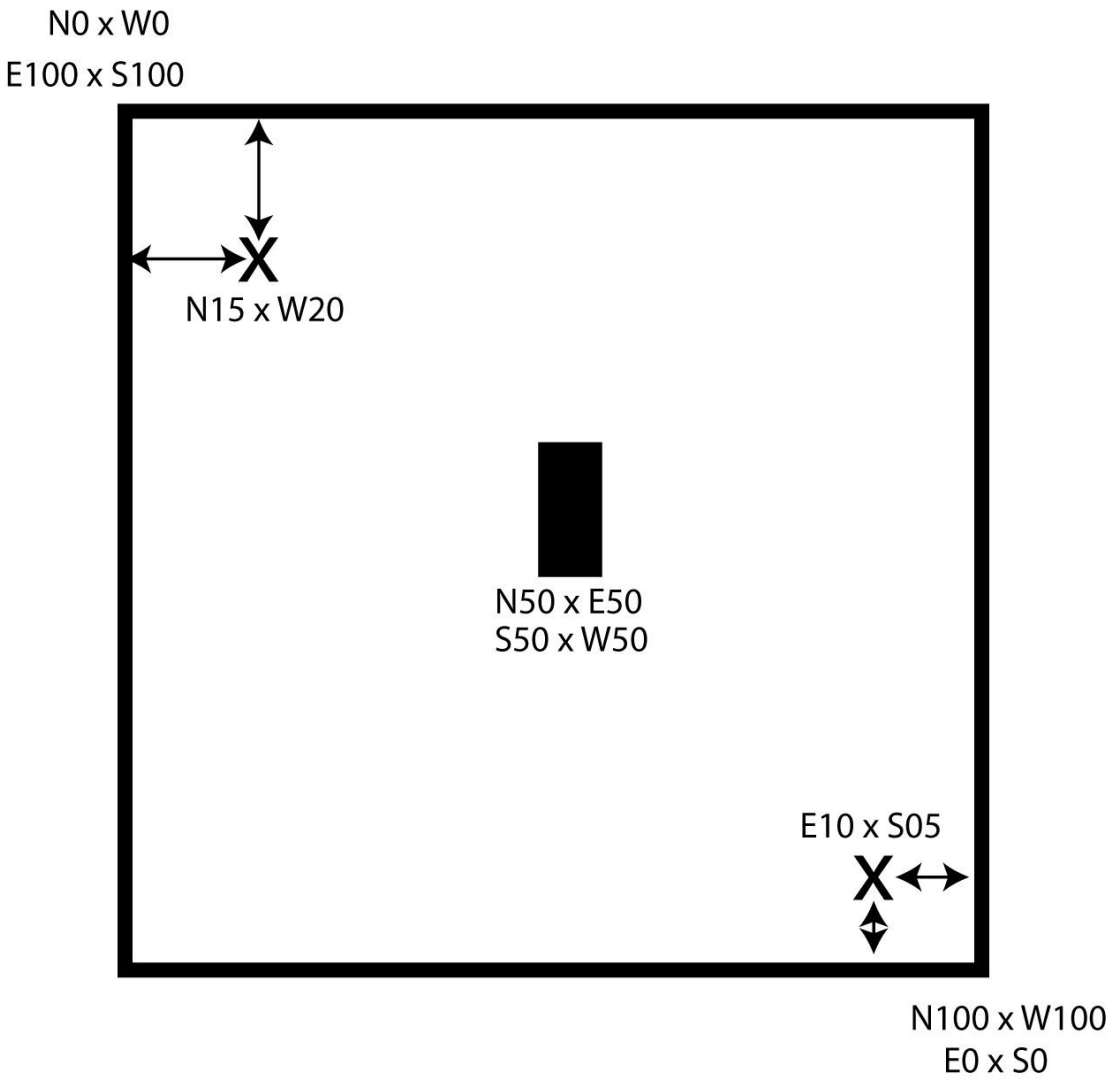
In this scenario, we will put two LED strips on the left and right of the robot.



The robot should follow the road and always be at the center of the road. Also, there can be more than one robot on the road. Therefore, the robot should not hit the car which is in front of the car. (approximately 10 cm away)

3) Second Scenario

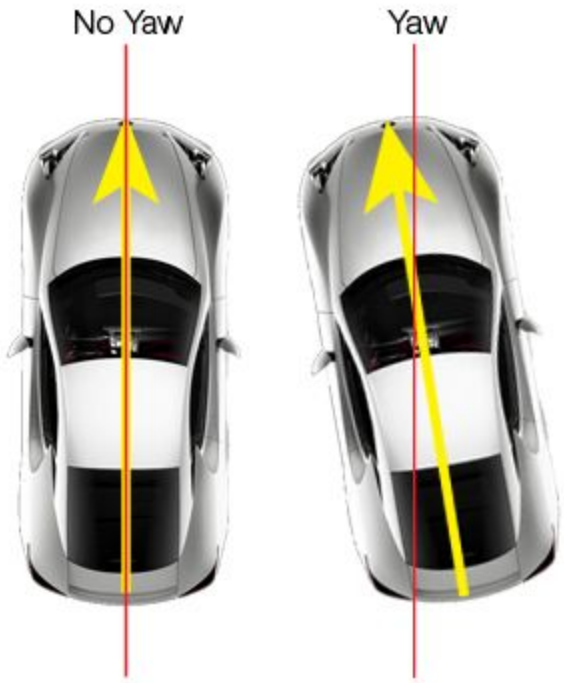
In this scenario, your robot will be placed on a square which is 100cm x 100cm and according to the coordinates which will be sent via the WiFi, the robot will change its position.



The coordinates will have the same structure as LAB8 (ID02N15W20). For the second senario, the robot will start at the center of the square which can be represented as N50E50, S50W50 etc. N20 means that the distance between the North Wall and the robot should be 20cm away from the wall. E30 means that the distance between the East Wall and the robot should be 30cm away from the wall. In this square, N20 and S80 represent the same meaning.

For the rotations, you can use additional sensors and the added sensors will be rewarded as bonus.

The car will rotate around the yaw axis and in order to detect the rotation of the car, you can use the sensors which can return the yaw angle value. The most commonly used sensors for this problem are **Gyroscope, IMU and Compass.**



Gyroscope: is a sensor for measuring the orientation and angular velocity.

IMU (Inertial measurement unit): is a device that contains **gyroscope, accelerometer** and sometimes **magnetometer.** Because of these devices, it can be used for applications which require precise measurement.

Compass (Magnetometer): is a device that measures the relative change of a magnetic field at a particular location. By using the Earth's magnetic field, it can measure the yaw angle movement.

These sensors generally uses the I2C communication interface. However, there are sensors which uses different type of communication. While buying these sensors, you should consider the communication interface.

4) Bonus Scenario

In bonus scenario, the first and the second scenarios will be merged. The robot placed between the LED strips and when the command is sent the robot, the robot will go through the LED strips and when it enters the square, the robot will go to the position sent via the WiFi. (The robot will enter the square from the W50S00 position.)

You need to **complete the previous two scenarios correctly** in order to be selected for the Bonus Scenario. In other words, the groups who have some problems in the previous scenarios, will not be eligible for the Bonus Scenario.

We will measure the completion time of this scenario. The fastest group will be rewarded by the Half Letter Grade increment (All the group members will be rewarded). For example, if a student in the winning group is about to get BB, then her grade will be BA.

For this phase, we allow groups to bring their own batteries. In the lab, we use Samsung ICR18650-26JM. Therefore if you bring your battery for the demo, this battery should be an 18650 type battery and the max allowable capacity for this battery is 2600mAh. (Warning: Some of the Chinese batteries even if they say they have 6800mAh capacity, the actual capacity of these batteries is around 250mAh)

5) Group Report

Your report has to be genuine. It should include all necessary details such as Block Diagram(s), System-Level Functional Diagram, Sequence Diagram(s), Connection Table(s) and Circuit Schematic(s), Expense List. In addition, you should write the pseudocodes for each function in your code.

Some Important Notes

- The total cost of the components that you buy for this experiment should not exceed the 100 TL. If the total cost exceeds this budget, your group will not be eligible for the bonus scenario. In addition, we will reduce points from Phase 003. The amount of reduction will be proportional to the excess amount.
- We will not allow coding during Demo. You will be given ten minutes to prepare the car for the demo. Hence, we suggest you to finish all kinds of settings before the demo day of Phase 003.