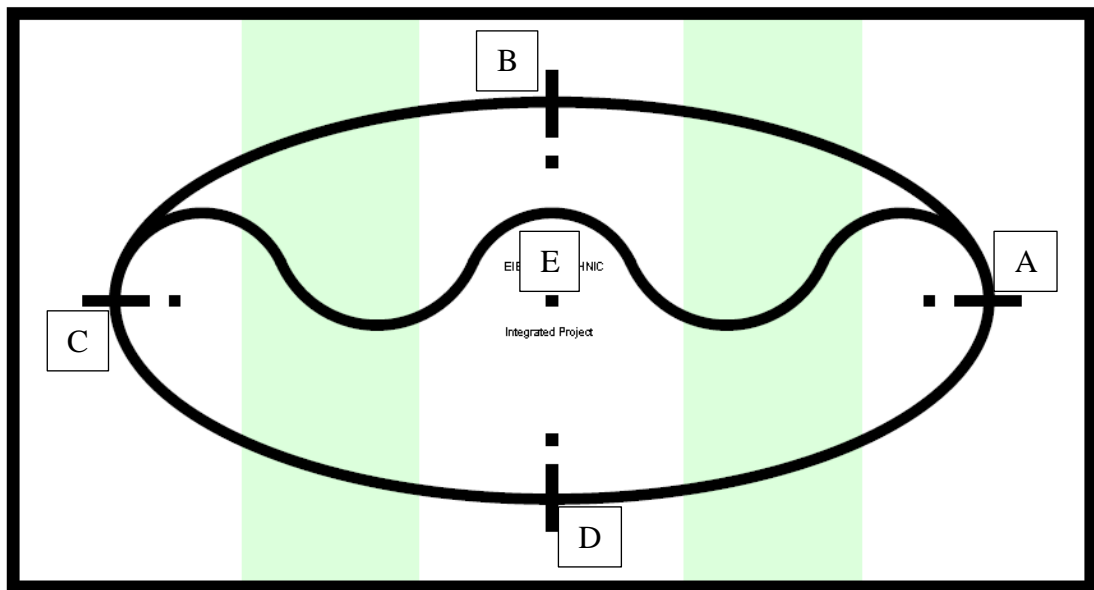


## 1. Introduction

In EIE3105 we are given a robot car with two DC-motor-driven wheels and chargeable pair of batteries as power source. I have to program STM32F103RB Cortex-M3 microcontroller with specific circuit connections to track given floor path. To complete the task, speed and direction control system will be implemented so that the robot car can trace the black line and move along it automatically by analyzing the information collected from Infra-Red (IR) sensing transistors. The floor path given is as follows:

A-B-C-D-A-E



## 2. Design Methodology

### a. Line tracking algorithm

To be able to trace the path automatically, the robot car should be able to detect the track. Specifically, after getting the reading from IR floor sensor, it should be able to decide if the car is moving along the track or not, and accordingly, adjust the speed in wheels. Setting the right wheel at high speed and left wheel at lower speed will make the car turn right direction. Setting the left wheel at high speed and right wheel at lower speed will make car turn left. The difference in speed values will affect how big or small turn will be. If the speed is equal in both wheels, it will move straight. In general, the program logic is shown in Figure 1 below.

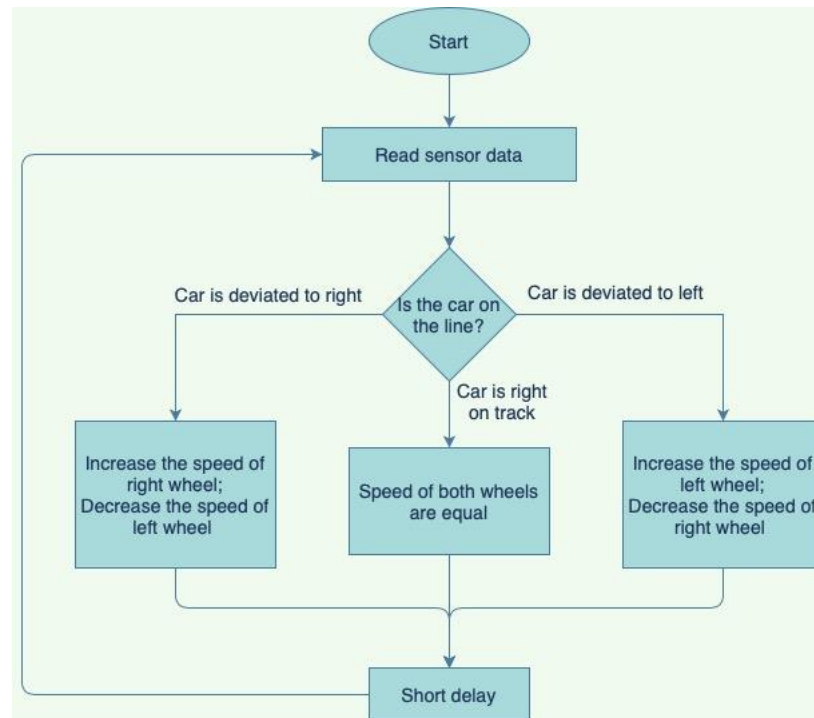


Figure 1

#### b. Reading the data

SPI communication is used to read the data from the floor sensor. When the floor is white, the IR ray is absorbed and the photo transistors remain in OFF state, which generates signal '0'. When the ground is black, the IR ray is reflected back and photo transistor change state to ON, generating signal '1'. Therefore, the position of the car relative to the line can be determined by knowing which photo transistor gives '1' signal.

There are 8 photo transistors with IR lighting board and 8-bit shift register 74HC299. Using the shift register, the generated signals from the sensor array are shifted to MCU through SPI serial port.

We can read the sensor information by checking the register value bit by bit and sending the '1' or '0' corresponding characters at a time through USART. I have used Tera Term to access the information and read the bits in reverse order for convenience.

This is an example data with different car position relative to the black line.

index	7	6	5	4	3	2	1	0
Straight on track	0	0	1	1	1	0	0	0

Turned left	0	1	1	1	0	0	1	1
Turned right	1	0	0	1	1	1	0	0

It can be noticed that shift of 1 or 2 bits to the right or left corresponds to the car's relative location. Hence, if 1<sup>st</sup> or 6<sup>th</sup> bit is set to '1', the car is turned right or left correspondingly. By only checking these specific bits and adjusting the speed we can make the car to accurately trace the line.

However, there are range of possible cases that need to be considered separately because of straight lines added at the corners of the path.

The program code used hexadecimal number system for comparing data values for convenience.

### c. Getting to inner circle

According to the track, the car should be able to change the track to inner part after making a complete anticlockwise circle. To detect the time when it should switch, I have counted the number of vertical lines passed. These cases can be simply separated as special cases when all 8 or 7 bits straight are '1'. After making a whole circle, it will pass 4 lines like that. Hence, when the counter is equal to 4, the car makes stronger turn toward inside of circle to detect the inner line and follow it as it did the outside path.

## 3. Conclusion

I have accomplished the task with average accuracy. The list of completed areas include: while making the turn, the car doesn't deviate too far from the line, it is prepared for handling specific scenarios at corners and it can make stronger turns and pass the inside part of the path.

However, there are still number of limitations of my algorithm. There are cases when the car doesn't recognize FF (or EF) pattern while passing the corner. This affects car's ability to time the turn. It can be improved by making the car deviate less from the main line while circling. This way it will have time and more possibilities of getting FF cases.