Line Follower in Assembly Language

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***Abstract*--** **The main purpose of this laboratory is to develop the simulation of a continuous line tracker using pic 16F877A in assembly language and the L293B driver. In addition, it has five-line sensors where s1 works as a strong left turn and s5 right, s2 works as a smooth left turn and s4 right, thus leaving s3 working in central advance. Finally, this tracker has the implementation of two gear motors and 3 LEDs where two work as directional and the other as stationary.**

I. INTRODUCTION

Line follower robots are very simple robots that fulfill a single mission: to follow a line marked on the ground, usually black on a white board. They are the "Hello world" looks of robotics [1]

For this laboratory we work with the Microchip Technology Pic16f877a microcontroller manufactured in CMOS technology, highlighting this low power consumption and the ability to perform various activities where data and digital communication between various devices are required. On the other hand, we find the l293 driver, which is made by means of H bridges for the motors. This driver contains two logic inputs for each motor, thus defining the motor's action. In relation to simulation, the "logic state" element is used to check the 32 possible logical combinations. Finally, the microcontroller has 5 digital inputs corresponding to the sensors, the MCLR pin connected to VCC and 4 digital outputs connected to the motor driver.

SYSTEM PARAMETERS

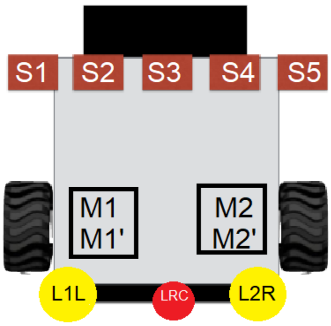

Fig. 1. Line follower model.

The robot must follow a 20mm black line on a flat white surface. The distance between sensors is 15mm. The digital sensors show a level of 5v when detecting the line and a level of 0v when detecting the white background.

The robot can have the following movement actions:

1. **Advance**: both motors clockwise
2. **Back**: both motors counterclockwise
3. **Stop**: both engines stopped
4. **Smooth twist**: one of the motors is off and the other active
5. **Strong spin**: both motors active one in a clockwise direction, and the other in an anti-clockwise direction

When the above parameters are clear, the corresponding truth table is carried out because with it the corresponding analysis for the motors and LEDs can be carried out in order to arrive at the realization of the line follower.

II. DEVELOPING

For a good realization of the truth table, previous knowledge of Digital Electronics 1 is required, since from there the corresponding Karnaugh maps that are necessary for the analysis of the line follower come out.

TABLE 1
TABLE OF TRUTH

S1	S2	S3	S4	S5
A	B	C	D	E
0	0	0	0	0
0	0	0	0	1
0	0	0	1	0
0	0	0	1	1
0	0	1	0	0
0	0	1	0	1
0	0	1	1	0
0	0	1	1	1
0	1	0	0	0
0	1	0	0	1
0	1	0	1	0
0	1	0	1	1
0	1	1	0	0
0	1	1	0	1
0	1	1	1	0
0	1	1	1	1
1	0	0	0	0
1	0	0	0	1
1	0	0	1	0
1	0	0	1	1
1	0	1	0	0
1	0	1	0	1
1	0	1	1	0
1	0	1	1	1
1	1	0	0	0

1	1	0	0	1
1	1	0	1	0
1	1	0	1	1
1	1	1	0	0
1	1	1	0	1
1	1	1	1	0
1	1	1	1	1

Once the truth table has been made, each column is given the value of S1, S2, S3, S4, S5 where the respective sensors are, taking into account the meaning of each one as shown in table 2 for this start performing the analysis for the motors and LEDs.

TABLE 2
MEANINGS OF THE SENSORS

S1	TURN STRONG LEFT.
S2	GENTLE LEFT TURN.
S3	CENTRAL.
S4	SMOOTH TURN RIGHT.
S5	TURN STRONG RIGHT.

❖ KARNAUGH ANALYSIS FOR MOTORS AND LEDs

TABLE 3
ENGINE FUNCTIONS REGARDING THE TABLE OF TRUTH.

M1 A	**M2 A**	**M1 R**	**M 2 R**	**TROLLEY ACTIONS**
0	0	1	1	REVERSE
1	0	0	1	TURN STRONG RIGHT.
1	0	0	0	RIGHT GENTLE TURN
1	0	0	1	TURN STRONG RIGHT.
1	1	0	0	GET MOVING
1	0	0	1	TURN STRONG RIGHT.
1	0	0	0	RIGHT GENTLE TURN
1	0	0	1	TURN STRONG RIGHT.
0	1	0	0	SMOOTH TURN LEFT
X	X	X	X	
X	X	X	X	
X	X	X	X	
0	1	0	0	SMOOTH TURN LEFT
X	X	X	X	
X	X	X	X	
X	X	X	X	
0	1	1	0	TURN STRONG LEFT
X	X	X	X	
X	X	X	X	
X	X	X	X	
0	1	1	0	TURN STRONG LEFT
X	X	X	X	
X	X	X	X	
X	X	X	X	
0	1	1	0	TURN STRONG LEFT
X	X	X	X	
X	X	X	X	
X	X	X	X	
0	1	1	0	TURN STRONG LEFT
X	X	X	X	
X	X	X	X	
0	0	0	0	STOP

TABLE 4
FUNCTIONS OF THE LEDs REGARDING THE TABLE OF TRUTH

L 1	L 2	L 3
0	0	0
0	0	1
0	0	1
0	0	1
0	0	0
0	0	1
0	0	1
0	0	1
1	0	0
0	0	0
0	0	0
0	0	0
1	0	0
0	0	0
0	0	0
0	0	0
1	0	0
0	0	0
0	0	0
0	0	0
1	0	0
0	0	0
0	0	0
0	0	0
1	0	0
0	0	0
0	0	0
0	0	0
1	0	0
0	0	0
0	0	0
0	1	0

III. RESULTS

Once the truth table is completed, we proceed to make the corresponding 7 Karnaugh where four are from the motors (M1, M2, M1 'and M2') and the other two are from the LEDs (LAI, LRC and LAD).

KARNAUGH MAPS

M1 function: DA'+EA'+CA'B'

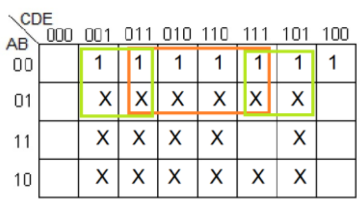

Fig. 2. Karnaugh corresponding to motor 1 advancing.

M2 function: C’B+AB’+CD’E’

AB \ CDE	000	001	011	010	110	111	101	100
00								1
01	1	x	x	x	x	x	x	1
11	1	x	x	x	x		x	1
10	1	x	x	x	x	x	x	1

Fig. 3. Karnaugh corresponding to motor 2 advancing.

M1’ function: D’A+C’D’E’B’

AB \ CDE	000	001	011	010	110	111	101	100
00	1							
01		X	X	X	X	X	X	
11	1	X	X	X	X		X	1
10	1	x	x	x	x	x	x	1

Fig. 4. Karnaugh corresponding to motor 1 backing up.

M2’ function: EA’+C’D’A’B’

AB \ CDE	000	001	011	010	110	111	101	100
00	1	1	1			1	1	
01		x	x	x	x	x	x	
11		x	x	x	x		x	
10		x	x	x	x	x	x	1

Fig. 5. Karnaugh corresponding to motor 2 backing up.

Función del LAI; BD'E' + AD'E'

AB \ CDE	000	001	011	010	110	111	101	100
00								
01	1							1
11	1							1
10	1							1

Fig. 6. Karnaugh corresponding to the left yellow Led.

LRC function: ABCDE

AB \ CDE	000	001	011	010	110	111	101	100
00								
01								
11						1		
10								

Fig. 7. Karnaugh corresponding to the central red Led.

LAD function: A'B'E + A'B'D

AB \ CDE	000	001	011	010	110	111	101	100
00		1	1	1	1	1	1	
01								
11								
10								

Fig. 8. Karnaugh corresponding to the right Yellow Led.

Once the Karnaugh of the motors and LEDs are finished, the simulation of each one is carried out using the logic gates in order to check that the 32 possible combinations agree with what is shown in the truth table.

SIMULATIONS

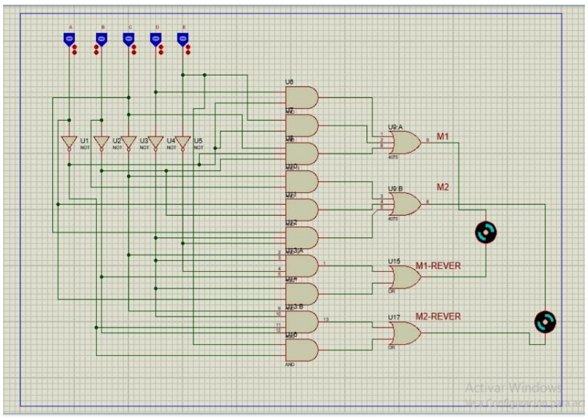

Fig. 9. Corresponding simulation applying logic gates on motors.

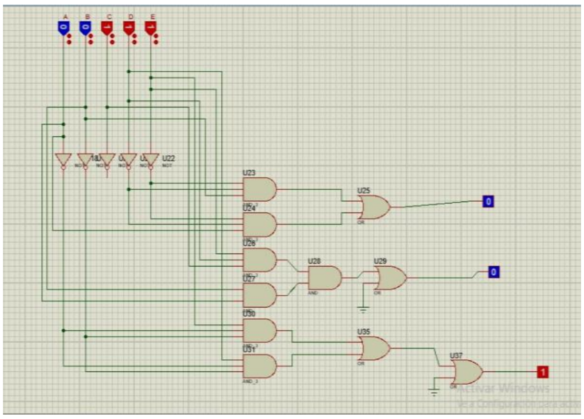

Fig. 10. Corresponding simulation applying the logic gates on the LEDs

By performing the simulation in Proteus it can be verified that each possible combination gives correctly. That is, you can proceed to the realization of the fluid map to be able to start the digital part of the laboratory, the code in Mplabx.

FLUID MAP

The fluid map can be seen at the following link: https://lucid.app/lucidchart/8a8f1eee-116d-42a3-8043-9d503dc890ad/edit?shared=true&page=0_0#

In the following link you can see the flow diagram more clearly. SEGUIDOR DE LINEA .pdf

CÓDIGO EN MPLABX

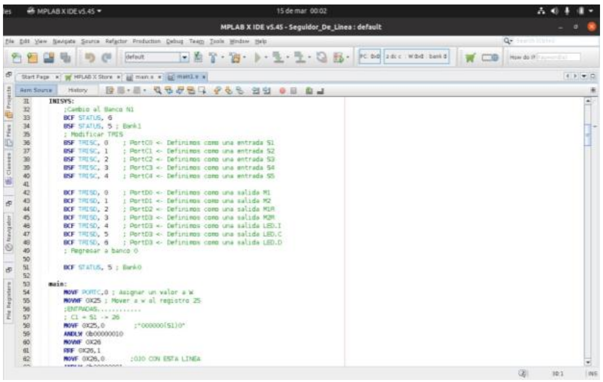

Fig. 11. Code in Mplabx.

In figure 11 a fragment of the code can be detailed, however it is located in "https://drive.google.com/drive/folders/15RUCGFQQVfaGe4g19NbmftXW1udFJd3M?usp=sharing" now, to initialize the code that is entered in the PIC16F877 analysis of functions, for this the members of the conformed group shared and questioned his hypotheses presented and in this way to be able to apply the knowledge prior to the subject in assembly language programming, adjusting the inputs that in this case are taken as sensors (5 in total), continuing with the code, the Karnaugh map implementation was necessary to grant the reading functions that will reach the outputs, with 2 motors and 3 LEDs that fulfill their function in the vehicle's circuit.

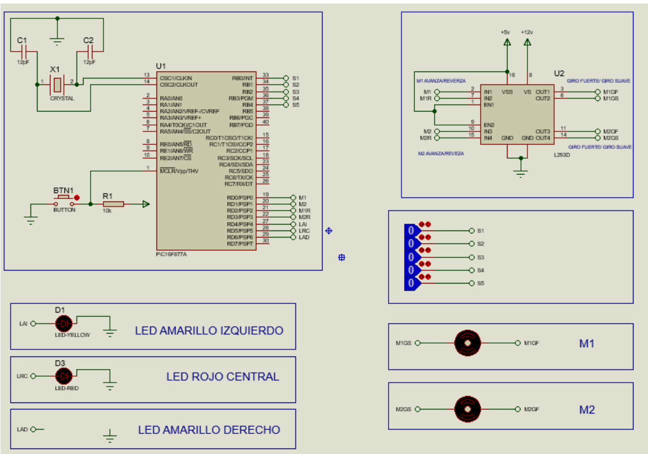

Fig. 12. Final circuit in Proteus.

IV. CONCLUSIONS

- For the realization of a line follower there is a great variety to do it, that is, there may be different ways of reaching it through the code.
- • It is necessary to have previous knowledge such as knowing how to perform a Karnaugh.

V. ANNEXES

- TABLES: TABLASDEDIGITALES2Libro1.xlsx
- FLOW MAP: SEGUIDOR DE LINEA .pdf
- PROTEUS: LAB1DIGITALES2New Project.pdsprj
- MPLABX:https://drive.google.com/drive/folders/15RUCGFQQVfaGe4g19NbmftXW1udFJd3M?usp=sharing

VI. BIBLIOGRAPHIC REFERENCES

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[3] H. Murcia. (2021, marzo). Clases Sincrónicas Vía Meet. Avalibre: https://drive.google.com/file/d/1j7ARZ8GaTJ1iXa8QohoXS8qT8knO7kkX/view