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I. INTRODUCTION

A code was made for a line follower car in MPLAB assembly language, which consists of 5 sensors to identify the line where the car is going to travel, 3 LEDs, two yellow ones that indicate the direction where it is turning (left right) and a red one that indicates that the car is stopped.

II. THEORETICAL FRAMEWORK

In order to carry out the code we have to make a truth table for each sensor of the car and for each led. With this truth table made, we proceed to make a Karnaugh diagram and thus extract the function of each sensor and LED, and with this make the code in assembly language.

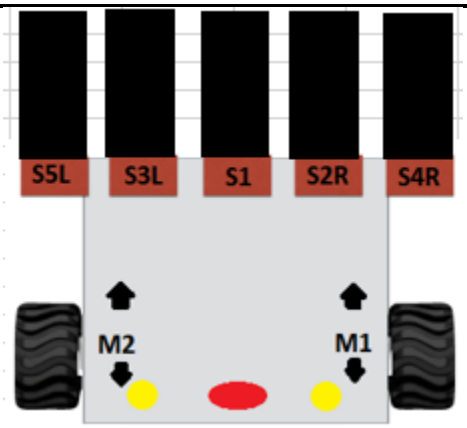


Fig. 1: Line follower trolley model

III. RESULTS

A truth table was made for each sensor and each led, taking into account what logical values we would assign to each sensor depending on the position of the line.

	S1	S2R	S3L	S4R	S5L	M1 Forward
0	0	0	0	0	0	0
1	0	0	0	0	1	1
2	0	0	0	1	0	0
3	0	0	0	1	1	X
4	0	0	1	0	0	1
5	0	0	1	0	1	1
6	0	0	1	1	0	X
7	0	0	1	1	1	X
8	0	1	0	0	0	0
9	0	1	0	0	1	X
10	0	1	0	1	0	0
11	0	1	0	1	1	X
12	0	1	1	0	0	X
13	0	1	1	0	1	X
14	0	1	1	1	0	X
15	0	1	1	1	1	X
16	1	0	0	0	0	1
17	1	0	0	0	1	X
18	1	0	0	1	0	X
19	1	0	0	1	1	X
20	1	0	1	0	0	1
21	1	0	1	0	1	X
22	1	0	1	1	0	X
23	1	0	1	1	1	X
24	1	1	0	0	0	0
25	1	1	0	0	1	X
26	1	1	0	1	0	X
27	1	1	0	1	1	X
28	1	1	1	0	0	X
29	1	1	1	0	1	1
30	1	1	1	1	0	0
31	1	1	1	1	1	0

Date table 1: Truth table engine 1 forward

Taking into account the truth table, we do the Karnaugh map for engine 1 forward.

MOTOR 1 FORWARD								
S1,S2R\S3L,S4R,S5L	000.	001.	011.	010.	110	111	101	100
00.	0	1	X	0	X	X	1	1
01.	0	X	X	0	X	X	X	X
11.	0	X	X	X	0	0	1	X
10.	1	X	X	X	X	X	X	1

F1= S1*S2R+ S3L*S5L + S3L*S4R

Fig 2 Karnaugh Map of Engine 1 Forward

	S1	S2R	S3L	S4R	S5L	M2 Forward
0	0	0	0	0	0	0
1	0	0	0	0	1	0
2	0	0	0	1	0	1
3	0	0	0	1	1	X
4	0	0	1	0	0	0
5	0	0	1	0	1	0
6	0	0	1	1	0	X
7	0	0	1	1	1	X
8	0	1	0	0	0	1
9	0	1	0	0	1	X
10	0	1	0	1	0	1
11	0	1	0	1	1	X
12	0	1	1	0	0	X
13	0	1	1	0	1	X
14	0	1	1	1	0	X
15	0	1	1	1	1	X
16	1	0	0	0	0	1
17	1	0	0	0	1	X
18	1	0	0	1	0	X
19	1	0	0	1	1	X
20	1	0	1	0	0	0
21	1	0	1	0	1	X
22	1	0	1	1	0	X
23	1	0	1	1	1	X
24	1	1	0	0	0	1
25	1	1	0	0	1	X
26	1	1	0	1	0	X
27	1	1	0	1	1	X
28	1	1	1	0	0	X
29	1	1	1	0	1	0
30	1	1	1	1	0	1
31	1	1	1	1	1	0

Date table 2:Truth table engine 2 Forward

Taking into account the truth table, we do the Karnaugh map for engine 2 forward.

MOTOR 2 FORWARD								
S1,S2R\S3L,S4R,S5L	000.	001.	011.	010.	110	111	101	100
00.	0	0	X	1	X	X	0	0
01.	1	X	X	1	X	X	X	X
11.	1	X	X	X	1	0	0	X
10.	1	X	X	X	X	X	X	0

F2 = S4R*S5L+ S1*S2R + S1*S3L

Fig. 3 Karnaugh Map of Engine 2 Forward

	S1	S2R	S3L	S4R	S5L	M1 Reverse
0	0	0	0	0	0	1
1	0	0	0	0	1	0
2	0	0	0	1	0	1
3	0	0	0	1	1	X
4	0	0	1	0	0	0
5	0	0	1	0	1	0
6	0	0	1	1	0	X
7	0	0	1	1	1	X
8	0	1	0	0	0	0
9	0	1	0	0	1	X
10	0	1	0	1	0	1
11	0	1	0	1	1	X
12	0	1	1	0	0	X
13	0	1	1	0	1	X
14	0	1	1	1	0	X
15	0	1	1	1	1	X
16	1	0	0	0	0	0
17	1	0	0	0	1	X
18	1	0	0	1	0	X
19	1	0	0	1	1	X
20	1	0	1	0	0	0
21	1	0	1	0	1	X
22	1	0	1	1	0	X
23	1	0	1	1	1	X
24	1	1	0	0	0	0
25	1	1	0	0	1	X
26	1	1	0	1	0	X
27	1	1	0	1	1	X
28	1	1	1	0	0	X
29	1	1	1	0	1	0
30	1	1	1	1	0	0
31	1	1	1	1	1	0

Date table 3: Truth table engine 1 Reverse

Taking into account the truth table, we do the Karnaugh map for engine 1 reverse.

MOTOR 1 REVERSE								
S1,S2R\S3L,S4R,S5L	000.	001.	011.	010.	110	111	101	100
00.	1	0	X	1	X	X	0	0
01.	0	X	X	1	X	X	X	X
11.	0	X	X	X	0	0	0	X
10.	0	X	X	X	X	X	X	0

F3=S3L*S4R + S1*S2R*S3L*S4R*S5L

Fig. 4 Karnaugh Map of Engine 1 Reverse

	S1	S2R	S3L	S4R	S5L	M2 Reverse
0	0	0	0	0	0	1
1	0	0	0	0	1	1
2	0	0	0	1	0	0
3	0	0	0	1	1	X
4	0	0	1	0	0	0
5	0	0	1	0	1	1
6	0	0	1	1	0	X
7	0	0	1	1	1	X
8	0	1	0	0	0	0
9	0	1	0	0	1	X
10	0	1	0	1	0	0
11	0	1	0	1	1	X
12	0	1	1	0	0	X
13	0	1	1	0	1	X
14	0	1	1	1	0	X
15	0	1	1	1	1	X
16	1	0	0	0	0	0
17	1	0	0	0	1	X
18	1	0	0	1	0	X
19	1	0	0	1	1	X
20	1	0	1	0	0	0
21	1	0	1	0	1	X
22	1	0	1	1	0	X
23	1	0	1	1	1	X
24	1	1	0	0	0	0
25	1	1	0	0	1	X
26	1	1	0	1	0	X
27	1	1	0	1	1	X
28	1	1	1	0	0	X
29	1	1	1	0	1	0
30	1	1	1	1	0	0
31	1	1	1	1	1	0

Date table 4: Truth table engine 2 Reverse

Taking into account the truth table, we do the Karnaugh map for engine 2 Reverse.

	S1	S2R	S3L	S4R	S5L	Led 1(RIGT)
0	0	0	0	0	0	0
1	0	0	0	0	1	0
2	0	0	0	1	0	1
3	0	0	0	1	1	X
4	0	0	1	0	0	0
5	0	0	1	0	1	0
6	0	0	1	1	0	X
7	0	0	1	1	1	X
8	0	1	0	0	0	1
9	0	1	0	0	1	X
10	0	1	0	1	0	1
11	0	1	0	1	1	X
12	0	1	1	0	0	X
13	0	1	1	0	1	X
14	0	1	1	1	0	X
15	0	1	1	1	1	X
16	1	0	0	0	0	0
17	1	0	0	0	1	X
18	1	0	0	1	0	X
19	1	0	0	1	1	X
20	1	0	1	0	0	0
21	1	0	1	0	1	X
22	1	0	1	1	0	X
23	1	0	1	1	1	X
24	1	1	0	0	0	1
25	1	1	0	0	1	X
26	1	1	0	1	0	X
27	1	1	0	1	1	X
28	1	1	1	0	0	X
29	1	1	1	0	1	0
30	1	1	1	1	0	1
31	1	1	1	1	1	0

Date table 5: Truth table Led1 RIGT(Yellow)

Taking into account the truth table, we do the Karnaugh map for Led1 RIGT (Yellow).

MOTOR 2 REVERSE

S1,S2R\S3L,S4R,S5L	000.	001.	011.	010.	110	111	101	100
00.	1	1	X	0	X	X	1	0
01.	0	X	X	0	X	X	X	X
11.	0	X	X	X	0	0	0	X
10.	0	X	X	X	X	X	X	0

F4=S1*S5L + S1*S2R*S3L*S4R

Fig 5 Karnaugh Map of Engine 2 Reverse

LED 1 RIGHT

S1,S2R\S3L,S4R,S5L	000.	001.	011.	010.	110	111	101	100
00.	0	0	X	1	X	X	0	0
01.	1	X	X	1	X	X	X	X
11.	1	X	X	X	1	0	0	X
10.	0	X	X	X	X	X	X	0

F5= S4R*S5L + S2R *S3L

Fig 6: Karnaugh map for Led1 RIGT(Yellow)

	S1	S2R	S3L	S4R	S5L	Led 2(LEFT)
0	0	0	0	0	0	0
1	0	0	0	0	1	1
2	0	0	0	1	0	0
3	0	0	0	1	1	X
4	0	0	1	0	0	1
5	0	0	1	0	1	1
6	0	0	1	1	0	X
7	0	0	1	1	1	X
8	0	1	0	0	0	0
9	0	1	0	0	1	X
10	0	1	0	1	0	0
11	0	1	0	1	1	X
12	0	1	1	0	0	X
13	0	1	1	0	1	X
14	0	1	1	1	0	X
15	0	1	1	1	1	X
16	1	0	0	0	0	0
17	1	0	0	0	1	X
18	1	0	0	1	0	X
19	1	0	0	1	1	X
20	1	0	1	0	0	1
21	1	0	1	0	1	X
22	1	0	1	1	0	X
23	1	0	1	1	1	X
24	1	1	0	0	0	0
25	1	1	0	0	1	X
26	1	1	0	1	0	X
27	1	1	0	1	1	X
28	1	1	1	0	0	X
29	1	1	1	0	1	1
30	1	1	1	1	0	0
31	1	1	1	1	1	0

Date table 6: Truth table Led2 LEFT(Yellow)

	S1	S2R	S3L	S4R	S5L	L-STOP
0	0	0	0	0	0	1
1	0	0	0	0	1	0
2	0	0	0	1	0	0
3	0	0	0	1	1	X
4	0	0	1	0	0	0
5	0	0	1	0	1	0
6	0	0	1	1	0	X
7	0	0	1	1	1	X
8	0	1	0	0	0	0
9	0	1	0	0	1	X
10	0	1	0	1	0	0
11	0	1	0	1	1	X
12	0	1	1	0	0	X
13	0	1	1	0	1	X
14	0	1	1	1	0	X
15	0	1	1	1	1	X
16	1	0	0	0	0	0
17	1	0	0	0	1	X
18	1	0	0	1	0	X
19	1	0	0	1	1	X
20	1	0	1	0	0	0
21	1	0	1	0	1	X
22	1	0	1	1	0	X
23	1	0	1	1	1	X
24	1	1	0	0	0	0
25	1	1	0	0	1	X
26	1	1	0	1	0	X
27	1	1	0	1	1	X
28	1	1	1	0	0	X
29	1	1	1	0	1	0
30	1	1	1	1	0	0
31	1	1	1	1	1	1

Date table 6: Truth table Led-STOP(Red)

Taking into account the truth table, we do the Karnaugh map for Led2 LEFT (Yellow).

Taking into account the truth table, we do the Karnaugh map for Led-STOP (Red)

LED 2 LEFT

S1,S2R\S3L,S4R,S5L	000.	001.	011.	010.	110	111	101	100
00.	0	1	X	0	X	X	1	1
01.	0	X	X	0	X	X	X	X
11.	0	X	X	X	0	0	1	X
10.	0	X	X	X	X	X	X	1

F6=S3L*S5L + S3L*S4R

Fig 7: Karnaugh map for Led2 LEFT(Yellow)

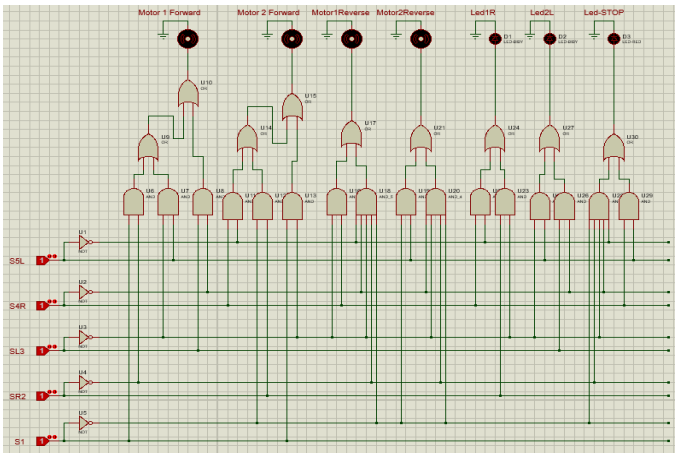
LED- STOP

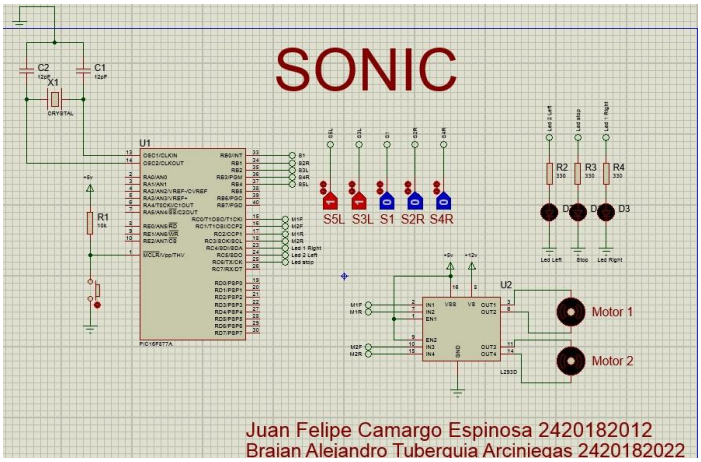
S1,S2R\S3L,S4R,S5L	000.	001.	011.	010.	110	111	101	100
00.	1	0	X	0	X	X	0	0
01.	0	X	X	0	X	X	X	X
11.	0	X	X	X	0	1	0	X
10.	0	X	X	X	X	X	X	0

F7= S1*S2R*S3L*S4R*S5L+ S4R*S5L

Fig 7: Karnaugh map for Led-STOP(Red)

To make sure that the maps were left correctly, we made the circuit with gates





Taking into account that we were able to verify the operation through the gates, we continue to create the code having the data from the PIC16F877A and the L293D driver. we can start the code.

We also create the simulation in proteus in order to confirm the operation of our code.

IV. ANALYSIS AND RESULTS

With the Karnaugh diagrams, the functions were taken as simplified as possible by the no-matter conditions that help to simplify the final function further.

The flow diagram was made according to the PIC16F877A datasheet for when doing the final simulation in the proteus, make better connection of the components and greater order.

V. CONCLUSIONS

A good handling of assembly language was learned for the line follower solution, a good analysis for the sensors and values that we gave to them and to perform Karnaugh diagrams again for their solution to these sensor analyzes.

VI. REFERENCES

[1] https://ww1.microchip.com/downloads/en/devicedoc/39582b.pdf

[2] https://www.ti.com/lit/ds/symlink/l293.pdf