Maze Solving Robot in C Language

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Abstract - This report presents the analysis, development and assembly of Gamma; a maze robot that has the ability to get out of a maze in C language for the Digital Electronics II course. It is a robot with 3 ultrasonic distance sensors that uses a PIC16F15244 microcontroller, a L298N driver for its operation and in addition, its operation must comply with some parameters in which two geared motors and 3 LEDs are used. Gamma was made with the help of MPLABX software for its programming. Link del GitHub

I. INTRODUCTION

Digital electronics works with programmable integrated circuits, better known as microcontrollers, capable of executing commands in different programming languages. In this project we will work with this device to control a robot capable of detecting and dodging obstacles to cross a maze, being programmed in C language. This robot is an introduction to robotics and with some improvements in its design and programming specifications it can be used in robotics competitions. This project aims to apply the knowledge acquired in the Digital Electronics II course and to have a real sample of what can be done with programming and the advantages and ease of use of microcontrollers.

II. OBJECTIVES

GENERAL OBJECTIVE

- Propose and analyze logic solutions with microcontrollers and C language for the development of a robot that solves a maze with ultrasonic sensors.

SPECIFIC OBJECTIVES

- Design a circuit with the ability to solve a maze with obstacles through distance sensors.
- Identify logical problems and indicate solutions through the use of programming.
- Experimentally evaluate the operation of the robot.

III. MATERIALS

- 1 PIC16F15244 curiosity nano microcontroller.
- 1 Driver L298N.
- 3 HY-SRF05.
- 1 Battery Li-Po 1100 mAh - 7.4 V.
- 1 Charger TITAN B3 Li-Po 2-3s.
- 2 DC Motors with wheels.
- 1 LM7805.
- 1 red LED.
- 2 yellow LEDs.
- 5 NPN y 3 PNP transistors.
- Resistors.
- Chasis.
- MPLAB X Integrated Development Environment.
- MPLAB XC8 C Compiler.

IV. DEVELOPMENT

A. Problematic situation

It is desired to participate in a robotics tournament in the maze robot category. To do so, you need to program in C language the "Gamma" robot, which works with 3 digital sensors and two motors. The robot must make a track and stop at the end of the maze in the shortest possible time.

B. Methodology:

1. Identify the necessary electronic components to be used as inputs, control media and outputs. For this project, 3 HY-SFR05 ultrasonic sensors are used as inputs, 2 DC motors, 2 yellow LEDs and 1 red LED are used as outputs and both are controlled from the PIC16F15244 microcontroller.
2. Perform a logical analysis to determine the behaviour of the outputs in relation to the data obtained from the inputs.
3. The functioning of the devices used is investigated in order to connect them correctly and avoid damage.
4. The circuits to be designed and assembled for coupling the sensors to the microcontroller and the microcontroller to the motors are proposed. The sensors are conditioned with transistors because the sensors and the microcontroller work with different voltages, so it is not advisable to make a direct connection between them because they could be damaged. Remember that a microcontroller is the means to control the robot and it is not recommended to be used to provide power, therefore, a L298N controller is used between the motors and the microcontroller.
5. Implement the code in C language to program it in the microcontroller, it is done in parts, the sensors are

programmed, then the LEDs and finally the motors, it is checked separately that the code of each device works correctly and the necessary corrections are made. (All the tests are done with the necessary conditioning circuits).

6. The codes produced are put together, checked and corrected to finally have a single functional code.
7. The robot is assembled and experimental tests are carried out on the proposed maze, it is verified that it works as it should and the correct measurements are taken for the pulse width modulation and delay times, which are finally implemented in the code.

C. *System parameters*

The robot must solve a maze using 3 distance sensors. The digital sensors output a 5V level when they detect an obstacle at less than 3 cm and a 0 V level when they detect no obstacle. The robot must have the following motion actions:

Go forward: Both motors in the same clockwise direction.
Stop: Both motors off.
Left turn: The left motor goes in reverse and the right motor goes forward.
Right turn: The right motor goes in reverse and the left motor goes forward.

The robot uses a PIC16F15244, a red LED and two yellow LEDs. In addition, it drives two motors with an L298N controller. The LEDs should light up as follows:

- The left yellow LED lights up only when the robot turns left.
- The right yellow LED lights up only when the robot turns to the right.
- The red LED lights up only when the robot stops.

D. *Process*

TABLE 1
ROBOT INPUTS AND INPUTS

INPUTS	Sensor 2 (S2), Sensor 1 (S1), Sensor 0 (S0).
OUTPUTS	Left motor forward (MI), left motor reverse (MIR), right motor forward (MD), right motor reverse (MDR), left yellow LED (LAI), right yellow LED (LAD), center red LED (LR).

TABLE 2
TRUTH TABLE

Sizq	Scen	Sder	MI - V	MD - V	MIR - A	MDR - A	LAI	LR	LAD	Function
0	0	0	0	0	0	0	0	1	0	Stop
0	0	1	0	1	1	0	1	0	0	Left turn
0	1	0	1	0	0	1	0	0	1	Right turn
0	1	1	0	1	1	0	1	0	0	Left turn
1	0	0	1	1	0	0	0	0	0	Forward
1	0	1	1	1	0	0	0	0	0	Forward
1	1	0	1	0	0	1	0	0	1	Right turn
1	1	1	1	0	0	1	0	0	1	Right turn x2

V. RESULTS

Due to its functions with the different combinations between the sensors it can be identified that the robot is able to solve some types of mazes. Gamma is able to detect obstacles through the 3 ultrasonic sensors and perform appropriate movements in the motors to avoid them.

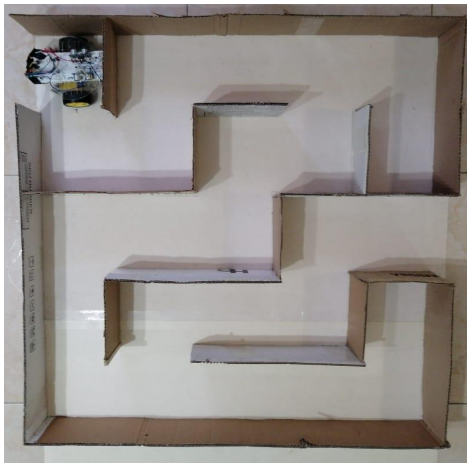

Fig. 2. Robot and the maze to cross.

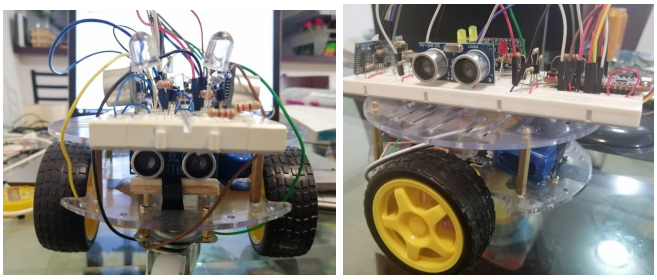

Fig. 3. Robot maze.

CIRCUIT DIAGRAM OF THE ROBOT:

SCHEMATIC

VIDEO

Maze Solving Robot.mp4

VI. CONCLUSIONS

The result was as expected since it was possible to build a labyrinth robot with 3 ultrasonic sensors. It is recommended to carry out this project with some measurement adjustments for greater precision and speed, for example, with PWM, and also to use smaller Mouse-type materials for high-level competition. Programming is fundamental in these projects because it works the functionality of the project. It is important to take into account the specifications of the materials to be used with the microcontroller because if they work differently an adjustment must be made.

The use of microcontrollers programmed in C language, allows efficient, easy, fast, cheap and comfortable systems, which allow them to be used in the industry for diverse uses.

REFERENCES

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[3] Microchip. *MPLAB XC8 C Compiler User's Guide.* Microchip Technology Inc. U.S.A.. 2003. Available MPLAB XC8 C Compiler

[4] SRF05 - Ultrasonic Ranger. *Technical Specification*. Available SRF05 Data Sheet.

ANNEXES

TABLE 3
PROJECT MATERIALS

Materials	Units	Price
PIC16F15244 Cruisity Nano	1	$70.000
L298N	1	$6.900
HY-SRF05	3	$15.000
Battery Li-Po 1100mAh - 7.4 V	1	$30.000
Charger TITAN B3 Li-Po 2-3c	1	$19.000
LM7805	1	$800
LEDs	3	$1000
BJT transistors	9	$4500
Chassis and engines	1	$24.000
Protoboard	1	$6.000
Total		$177.200