Design and Implementation of an Educational Prototype for the Analysis of Mobile Robot Path Planning

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Summary
In universities where they teach knowledge of digital electronics there are not educational materials that allow students to reinforce the knowledge acquired in the theory. That is why this report presents and proposes a solution for the implementation of an educational prototype that shows the algorithm for the trajectories of space robots, and this educational material will greatly help to implement the knowledge in analysis and design of digital circuits.

SOLUTION APPROACH
The problem proposed is like a robot in this case, represented by 0 seek a certain goal and it encounter obstacles or other objects in this case Knowing that can jump or avoid (in this case it advances a box in any direction).

A limitation of the project is that it needs to know the starting location of the robot. In CONSEQUENCES, if a robot is in a random position our solution would not be appropriate.

INTRODUCTION
The motivation of this project is to prevent damage of space robots, missions like finding and approaching a satellite to drift to effect his capture, removal and handling without damage; and thus avoid the constant increase in satellites and space debris present in the cosmos, which increases the risk of collisions.

Space robots are used to more accurately study the rocks, soil and atmosphere that are in space precisely where man is constrained by their physical and emotional characteristics. Thus the various space robots that have been made will be displayed: The Deep Space (See Fig 1), the Mars Polar Lander (See Fig 2), the Mars Pathfinder (View Fig3), I Spirit and Opportunity (see Fig4.) the Curiosity (see fig5.).

The Deep Space Robot belonging to the first space mission that relies primarily on solar electric propulsion (ion) to reach its destination. The real goal of this mission was to demonstrate the feasibility of technological advances in space, which may subsequently be employed.

Mars Polar Lander mission was to study the state of the Martian weather, climate and levels of carbon dioxide and water.

The Mars Pathfinder mission was conducted to demonstrate the technologically and avoid lander with instruments and autonomous robotic rover on the surface of Mars, which is capable of returning a huge amount of data on Mars.

Spirit and Opportunity, are twin American-made robots. Where each on opposite sides of Mars, managed to perform research work of a different nature to find evidence that on the surface of Mars had liquid water for thousands of years.

Curiosity is part of the Mars Science Laboratory, a space mission is led by NASA whose mission is to explore in detail the Martian surface. With a radius greater than the vehicles previously sent exploration, investigate the past and present ability of Mars to host life.

Fig1. Deep Space
This project will demonstrate an algorithm as a basis for understanding the logic of a trajectory and obstacle avoidance in two-dimensional motion of a terrestrial robot for planetary exploration.

This report describes the functions of each group of gates used in the project will be explained.

PRESENTATION OF THE PROBLEM

You should implement a board with 9 squares each having two possible states: X or 0; where 0 represents part of the trajectory of the robot on Mars and X an obstacle.
The X and 0 will be represented by a set of LEDs and activation are 9 switches

The project is divided into 2 parts:

FIRST PART

In this part of the data (the X or 0) of the robot and the obstacle in the panel shown in Figure 6, each data (X or 0) is represented on a “cracker” with a set of LEDs will be entered (see Figure 7) and each enabled state should be saved and continue the path.
SECOND PART

Here should be displayed on the top of the board may continue to advance on the path or just the obstacle prevents it, for this we have the top and bottom of the board spaces.

The limitation of the project is given by obstacles because here one records the obstacle pressing the switch, which actually does not happen thereby robots have sensors and detectors to perform this function.

GOALS

GENERAL GOAL
Implement a prototype for training algorithms Path space robots

SPECIFIC GOALS

Use in digital design the D type flip-flops in the prototype trajectories.

Determine under what conditions the robot may continue its path and when not, thereby preventing damage.

Demonstrate the feasibility of only using combinational and sequential logic is possible to predict the operation of the robot.

DESCRIPTION OF THE SOLUTION

It is part of the logic for the "winning" function which would be given when 3 crosses are completed (see Figure 8) either in horizontal, vertical or diagonal.

\[
\begin{array}{ccc}
A & B & C \\
D & E & F \\
G & H & I \\
\end{array}
\]

Fig 9. Representation of the data by assigning each a letter box

\[
F = ABC + DEF + GHI + ADG + BEH + CFI + AEI + CEG
\]

The F Boolean function that would represent progress can continue and this is needed to use three-input AND gates 7411, and then OR gates; together they will give us the winning feature. Thus the following flow chart shown in Figure 10 is developed.

![Flowchart](image)

To solve the first part of the problem is needed 9 switches "pull down" (see Figure 11) that when pressed enter the 0 (part of the path) and X the obstacle , also you must have flip type D (see Figure 12 ) that will save this data , which clock signal will be simulated by the button which gives a pulse of 1 for a time and releasing
gives 0, that is to say it will give us pulse to activate our positive edge flip-flop.

These data are 2 entrances of the 3 flip flops needed to store a data, that is to say the data of the flip flop is 1 and the other flip flops will have on your data 0, waiting for the positive edge that let you pass these and activate one state either X or 0.

To implement this in the breadboard, each flip-flop D separately with this test to verify the correct functioning of these for this use in both output LEDs necessarily, because as it turned out, to leave an entry is not connected to the flip-flop, it will display any data, by mistakenly believe that is in poor condition.

Once the correct operation of the flip-flops are tested separately proceeds to check phased operation of each switch to be triggered with each group of three flip-flop.

Is implemented separately, the set of XOR gates 7486, just as with the flip-flops we check each gate obtained and thus verify correct operation of the circuit implements.

Once already implemented both circuits, we unite taking into account, verify functionality in stages, and now we see that seize the respective symbols X or 0 when pressing any of the switch, and the respective reset to reset the circuit for another possible path.

Finally we implement the winning function (see Figure 14), with the gates 7411, this is the laborious process due to the number of cables used in the process and which is attached to the above, complete this complex process and uniting these three logical parts have completed the prototype of paths and prevent damage due to collision with obstacles.
RESULTS

At the press of a switch, the rising edge is activated and start passing data, which were Player 1 = 0, Player 2 = 1. Figure 13 shows that these gates are XOR 7486 product. With this output data at the beginning were all equal and zero in the flip flop where the switch is pressed, will change its output data and will be different, with this now we have:
- Player 1 = 1
- Player 2 = 0

Following this logic, for example pressing the switch, the data in this flip-flop and will happen:
- Player 1 = 0
- Player 2 = 1

All Q outputs will be denied to the respective inputs of the LEDs.

Pressing the switch 1 (see Figure 15) comprising the respective Led (in the model will turn on 0), this indicates that the robot is moving forward in his career.

When implementing the circuit in breadboard, corresponding to the first flip flops part because it is the main part as loa flip flops store the 0 and X simultaneously obtained what is observed in Figure 17. In this case an X in the problem statement would hinder observed. How to take the first cookie depend greatly on the order in which the cookies as they are connected with four wires, the wire colored black anger grounded, the accompanying red cable must be connected to the voltage and finally any remaining red wires must be connected to voltage and this will depend on the form of 0 or X.

Fig. 17. Implementation of the D flip flops

Some of the cases obtained in which the robot can move are the one you can see in Figure 18 and Figure 19. In these cases obtained in the simulation the yellow LED represents the robot (0) and the red LED the obstacle (X).

Fig. 18. Case in which the robot can continue its path towards your objective.
Completed the implementation and development of the project analyzed the expenditure in achieving the project described above and notes that the project is economical compared to what would be done with real space robots, she explained above seen in the following table:

<table>
<thead>
<tr>
<th>Materials</th>
<th>List of gates</th>
<th>Number of gates</th>
<th>Number of integrated</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>XOR</td>
<td></td>
<td>17</td>
<td>5</td>
<td>S/. 5.00</td>
</tr>
<tr>
<td>Three-input AND</td>
<td></td>
<td>20</td>
<td>7</td>
<td>S/. 17.00</td>
</tr>
<tr>
<td>4-input OR</td>
<td></td>
<td>4</td>
<td>2</td>
<td>S/. 4.00</td>
</tr>
<tr>
<td>2-input OR</td>
<td></td>
<td>2</td>
<td>1</td>
<td>S/. 2.00</td>
</tr>
<tr>
<td>NOT</td>
<td></td>
<td>3</td>
<td>2</td>
<td>S/. 5.00</td>
</tr>
<tr>
<td>2-input AND</td>
<td></td>
<td>9</td>
<td>3</td>
<td>S/. 4.00</td>
</tr>
<tr>
<td>D-type flip flops</td>
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<td>27</td>
<td>14</td>
<td>S/. 14.00</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>switches pull down</td>
<td></td>
<td>10</td>
<td></td>
<td>S/. 14.00</td>
</tr>
<tr>
<td>Cable tinned</td>
<td></td>
<td>20 meters</td>
<td></td>
<td>S/. 2.00</td>
</tr>
<tr>
<td>Battery holder</td>
<td></td>
<td>2</td>
<td></td>
<td>S/. 5.00</td>
</tr>
<tr>
<td>Resistors 220</td>
<td></td>
<td>9</td>
<td></td>
<td>S/. 0.30</td>
</tr>
<tr>
<td>Set of LEDs</td>
<td></td>
<td>15</td>
<td></td>
<td>S/. 3.00</td>
</tr>
</tbody>
</table>

CONCLUSIONS

It concludes that there are different routes of travel of the robot in question. Which must find the optimum and necessary way to reach your destination.

It concludes that the basic algorithm behind the application is the famous game "Tic Tac Toe" also called "Michi" which was designed and implemented combinational logic required in addition to the integrated data storage called D-type flip flops.

It concludes that you can design a complex project using simple digital circuits. Digital circuits are the basis for programming circuits and systematization.

It concludes that the power to make the integrated circuit should be below what sets your datasheet because if you cannot burn or alter his established logic and not allow the project logic is correct.
BIBLIOGRAPHY


