

Lego Mindstorm Project John Hughes 1708241

by John Hughes

FILE	11990_JOHN_HUGHES_LEGO_MINDSTORM_PROJECT_JOHN_HUGHES_1708241_173939_872443579.DOCX (975.48K)		
TIME SUBMITTED	04-MAY-2019 01:00PM (UTC+0100)	WORD COUNT	1853
SUBMISSION ID	106310754	CHARACTER COUNT	8407

Lego Mindstorm Project

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Integrating Project

April 2019

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Introduction

The purpose of this assignment is to build and program a Lego Mindstorm robot with the ability to carry out three specific tasks.

Firstly, the robot will need to follow a guidance line taped to the floor. This line will be blocked by an obstacle at some point of its path. The second requirement for the robot is to be able to move or unblock the obstacle from its line of path. The line will lead the robot into a maze section, which is the third requirement, to successfully navigate its way through the maze from entry point to a specifically marked exit. The layout for the route looked similar to the picture below. [1]

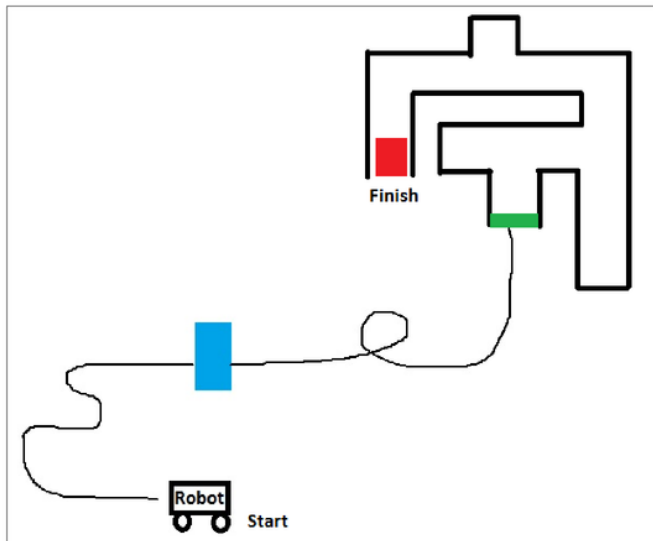


Figure 1 from moodle.

The assignment was a group project involving three people, each person led one specific part of the overall project. The first role of the project was for the robot to follow the guidance line, which was conducted by Jack Rout. I was in charge of the second part, to move an obstacle blocking the line. The third part was the maze, which Kai Bentley was in charge of.

Background Research

When considering how to negotiate the obstacle, we decided to keep it relatively simple. We had to consider what exact obstacle could be moved. Rather than a heavy block, it was decided to move a water bottle that would be easier to negotiate.

There was a number of methods to consider. Some methods considered were designs that could scoop the bottle or a claw of some sort that could grab it and place it out of the way. These ideas were challenging in both construction and programming.

On the construction side we did have limited sensors and components to build a more elaborate design. A scooper was considered to have the potential for a low success rate as it could be less accurate in successfully scooping the object and then transporting it out of the way. A grabber would likely be more successful but would be more complex and also require more components such as multiple motors for both grabbing and lifting.

On the programming side, a scoop or grabber would require lifting, then moving the obstacle out of its path and dropping/releasing it elsewhere. It would then need to re-join the line. A simpler method was to have a swinging arm attached to a motor that could knock the obstacle out of the way. A sensor would be required to detect the block in its path.

The swinging arm was chosen for project for a number of reasons. On the design/construction, it required less components and just one motor and sensor for detecting and then tackling the object. On the programming side, knocking the object from its path allowed the robot to stay on its path without having to re-join. This seemed the most practical option with the limited components available.

Project Plan

In terms of the timeline, we worked together on the maze first. We thought this would be the most time consuming as it would seem to have the largest amount of programming. Also it would be good to have the main body of the robot built and ready to tackle the maze so that we could add the other features later.

The guidance line would be the next choice, which took several hours of work. It was necessary for the obstacle to be last in the timeline as that could be added into the path of the guidance line. This was also the least time consuming as the robot design was kept simple and the programming side was much shorter than the other sections.

Design Process

Hardware

The first requirement was to negotiate the guidance line. The robot had two parallel lines to follow, one red and the other blue. A colour sensor was used to detect the line, as shown in the picture below.



The next stage was to negotiate the obstacle. A plastic bottle was placed on the guidance line path. A swinging arm was built, as shown in the picture, and connected to a motor that would be activated when the robot detects the obstacle in its path. The robot uses the ultrasonic sensor to detect the object.

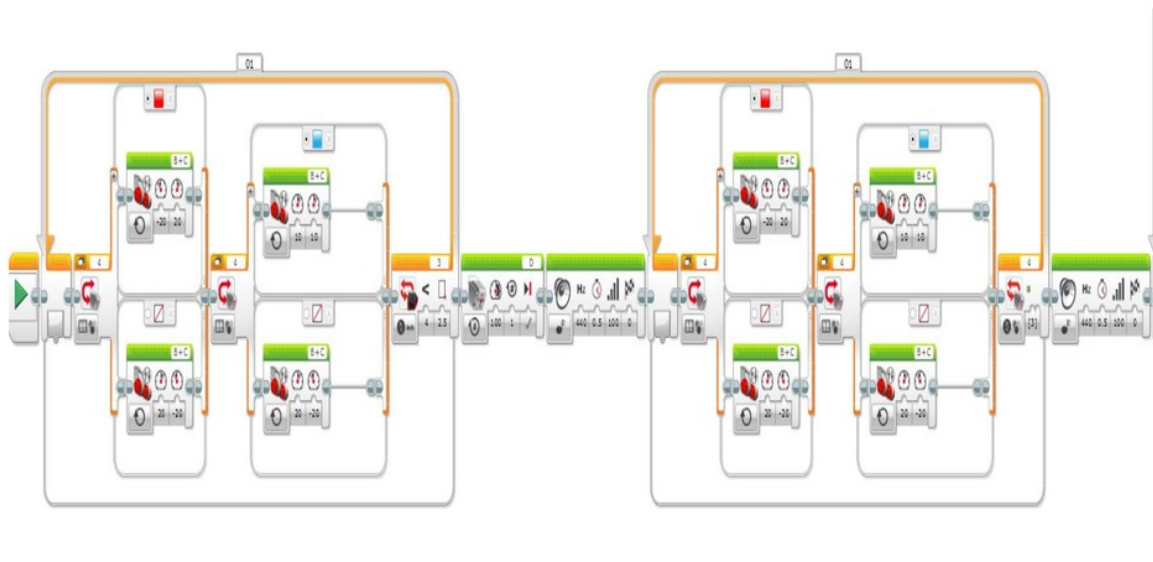
The final stage was to negotiate the maze which Kai was in charge of. The robot had two ultrasonic sensors, the one at the front that was also used for the swinging arm and one on the side, as pictured.

Software

The robot was programmed to enter a loop which starts with a switch using a colour sensor. If the sensor detects red, it turns the wheel motors left, if it does not detect red it turns the wheel motors right. The program then uses another switch with colour sensor, this time looking for blue. If it detects blue, it moves the wheels forward rotation of 10, if it does not detect blue, it turns the wheels back to the right, which points the robot back in the direction of the red line. This gives the robot a shimmy effect that gradually navigates it along the guidance line. This part of the project was done by Jack.

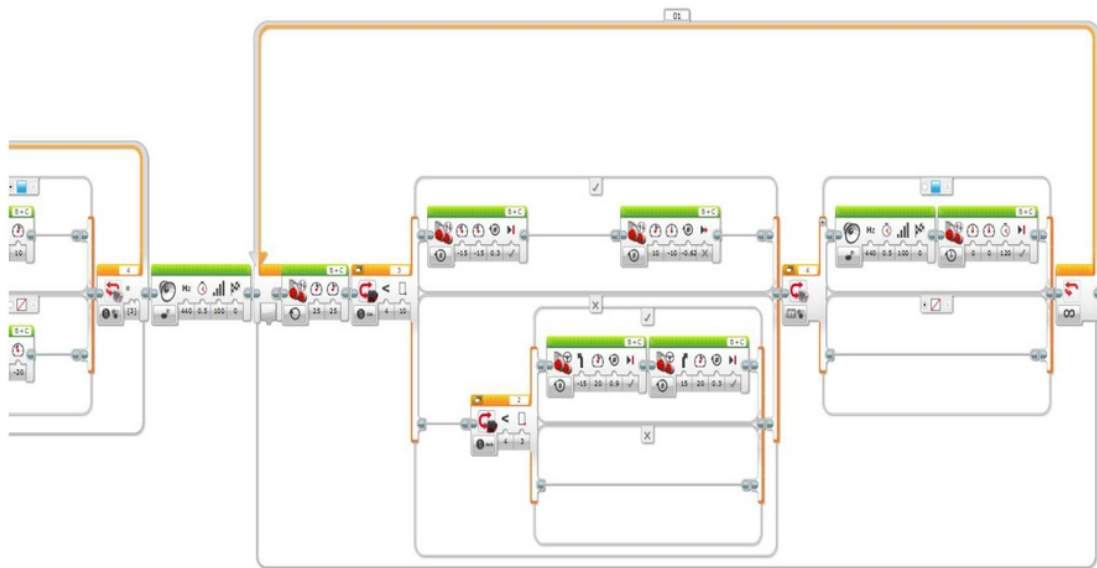
In the program, at the end of the loop for the guidance line, the ultrasonic sensor detects any obstacle in its path between a range of 2.5 and 4 inches. This was a sufficient distance to go through the loop until it finds the object without crashing into it, at which point it activates a medium motor, to a power of 100 and rotation of 1. This knocks the obstacle out of the way. It then plays a sound, a bleeping noise and returns on its course of negotiating the path. In order to return to its path, another loop was added after the medium motor and sound. The second loop started the same as the first, but ended with a colour sensor. If it detects green, it plays a sound and enters the maze section. Otherwise, it loops back through to continue shimmying along the line. This stage of the project was conducted by myself.

This picture shows the code for the first and second sections.

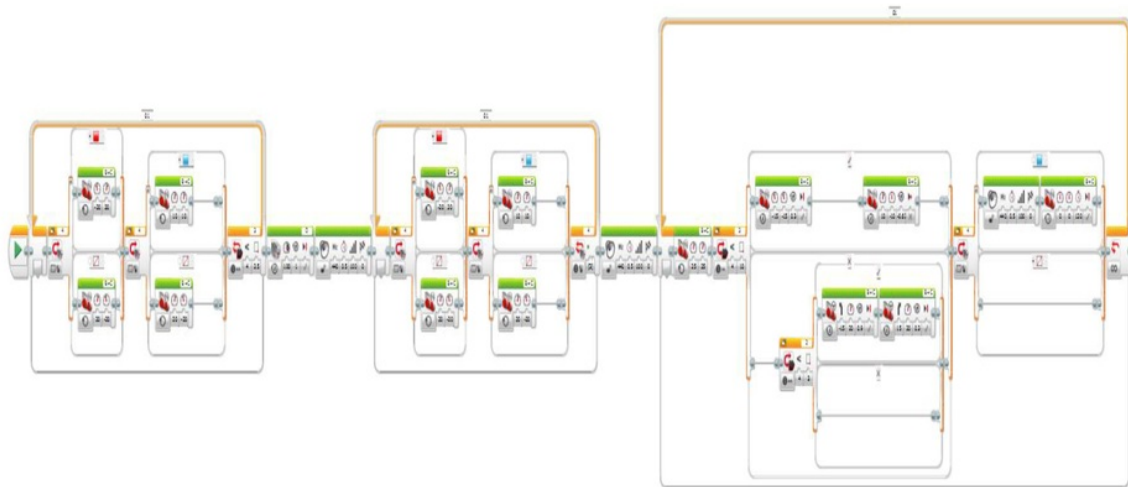


The final stage was to negotiate the maze which Kai was in charge of. The robot had two ultrasonic sensors, the one at the front that was also used for the swinging arm and one on the side.

The first sensor, was set on a switch to detect a wall between 3 and 4 inches. If it finds a wall, it will travel backwards slightly, at a speed of -15 and rotation of 0.3, then it will turn 90 degrees left by turning one wheel -10, the other 10 and rotation of 0.63. If the front sensor does not find a wall, then it will continue forward until the side sensor finds a wall between 3 and 4 inches. The robot will then turn left then right in another loop in order to prevent the robot from side swiping the maze walls. This looped process will continue unless the colour sensor detects the blue finish line for the maze exit, at which point the robot will play the sound again to indicate that it's reached its final and the program will end.



The full coding for the program is shown below.



The problem with my section of the project was the robots ability to knock objects out of its path. We had to ensure the arm was strong enough to knock the object out of its path and not be damaged in the process. This meant adding as many holding pieces as could possibly fit to the motor in order to reinforce it. The advantage of this design was that the robot could easily pick up where it left off, without any need to rejoin the line as it never leaves it.

Assessment

The object was successfully moved from its path but, it did have its limitations. The object had to be tall enough to activate the ultrasonic sensor, which is why a bottle was chosen. Also, there were some weight restrictions in its ability to successfully move it. If the bottle were full of water, the swinging arm would be strong enough to knock the object over, but there was no guarantee that the object would be moved out of the robots path. If the bottle was quarter full or less, this would be enough weight for the robot to deal with as the force of the impact would knock the bottle far enough out of the way for the robot to continue without any problem.

The robot re-joining the line was successful without any problem. As it hadn't deviated from its path, the robot entered another program loop to continue as before and shimmy its way to the end of the line.

Evaluation and Results

The robot was a success overall as it met its criteria. It successfully followed two parallel lines, one blue and one red by switching between them along its path.

Once it encountered the obstacle, it successfully knocked it away and then continued on its path.

At the end of its path, it detected the green start line and entered the third stage of programming to navigate the maze.

It then followed the wall to its right with the side sensor, keeping a distance between 3 and 4 inches. When it came to a wall head on, the front sensor was activated and the robot successfully turned left by moving backwards slightly, then rotation 90 degrees left. This program was enough for the robot to find its way to the finish line, activate its sound and come to a stop.

Conclusion

Even though the robot was a success, there were still some things that could be done differently. A different design to tackle the obstacle could have been used. Although this would require more components and more complex programming, a grabber could have been used instead of a swinging arm in order to give it a greater ability to move things. This could have been achieved by using one motor to activate a grabber or pincer, and another motor to both lift the grabber with the object and drop it elsewhere by lowering and releasing it.

The first section of the project would also need adjusting as the robot would need to rejoin the line but other than that, its design worked very well. I would also leave the maze section as it is. There could have been simpler designs using just one sensor but the existing design worked well and I'm confident it would successfully negotiate any other maze of different layout.

During the project, we have learnt how to work together as a team by assigning each other different tasks, whilst helping each other in a collective manner. We also successfully scheduled the sections well. We also learnt how to build and program a Lego Mindstorm robot.

References

Gaynor Thomas, Task Description, Moodle.

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GRADEMARK REPORT

FINAL GRADE

60/100

GENERAL COMMENTS

Instructor

Report (60%) overall: 40 %

Introduction - 2 /5

Introduction is very brief, it is a basic review of the task required.

Background research - 6/15

Very limited reference list. There is no in text citation. The research activity is limited with gaps in the knowledge.

Project plan - 6/10

The project plan in combined with the design process. Which made it harder to identify.

Design Process - 12/40

The design process is limited standard. The information provided about the software and the hardware is very limited. .

Evaluation and Results - 14/30

very brief evaluation and

There is no real result analysis or outcome evaluation of a qualitative or quantitative data, in order to develop lines of argument and make sound judgement in accordance with basic theories and concepts of the task. There is a summative statement in the form of conclusion.

Demo (40%) - Overall 91%

Technical knowledge/skill - 18/20

Analytical and problem-solving skills - 18/20

Quality of result - 55/60

An excellent implementation. Line is followed precisely, good speed, obstacles removed successfully - simple, but effective. Maze is particularly good because you have a side sensor to mitigate for any unexpected maze layouts or imprecision in angle of turn. Maintains good distance from the wall. To be really picky, make sure the cables at the back are tied in as occasionally they touch the maze wall and have an effect on the turn.

(We laughed at your robot encouragement comments during the demo)

Overall mark for module: 60%

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