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by Daniel Algie

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Integrating project

Assignment on:
Lego Mindstorm

Submitted to
Gaynor Thomas

Daniel Algie 1706977

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Introduction

During this assignment we will be using the Lego mind storm to build a robot and using the Lego software to program a robot. While using the robot to control itself through a course consisting of line following obstacle avoidance and completion of a maze.

We will be going in depth into each of the stages we had to cover for this challenge to complete the course successfully and explain the challenges we had while trying to complete the course. Even though we did this assignment as a team we still have to complete certain tasks individually to make sure our robot would complete the course. In this task I had the part of making sure the robot could find and pass around an object blocking the robots path using ultrasonic, while Karl had the task of programing the robot to follow a line to find its way to the maze, while Ryan had the task of completing the maze also using ultrasonic. We will also explain how we built the robot and looking deeper in to the design we chose and the parts we used to help us to complete the task.

[1]Robot design

This was the first step of completing the task when the group searched on the internet for some inspiration. The decision was made to go for an upright design so that the power back was facing upwards. This design was selected because we had an idea that it was smaller in width so that we could manoeuvre around the maze and could turn smoother. However, with this design came problems. One of the first and main problems that occurred with the build was the design chosen at the beginning, which was the standing robot design, although easier to manoeuvre, became top heavy and would tip over when moving. We corrected this by putting more weight at the front and also added two castor wheels to help balance and manoeuvre the robot. Once the problem was solved, it was decided to move on to the sensors we would implement in to the design of the robot. In the first design it was decided to use a colour sensor to track the line, a touch sensor for the block and a touch sensor for the maze also. Later, however, when the maze was presented to the group it was decided to get rid of the touch sensor because there were concerns that the maze wouldn't be strong enough for the robot to stop when the touch sensor touched the wall of the maze. Instead it would just knock down the maze and keep going forward, with this idea in plan the decision was taken to change the touch sensor for an ultrasonic sensor and decided this would be a better design. During testing this was found to be a better solution than using the touch sensor.

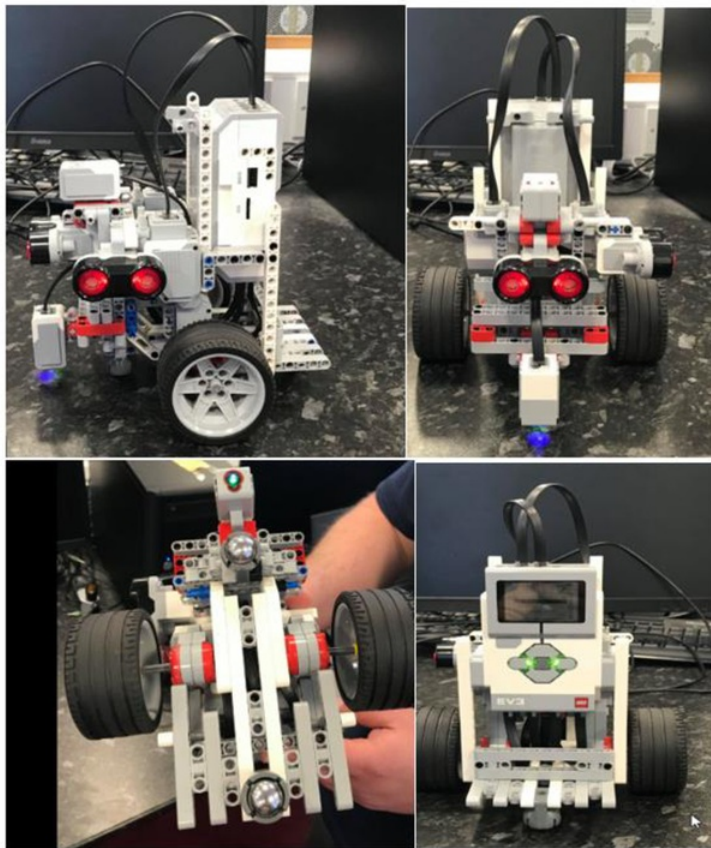


Fig 1 building
of the robot

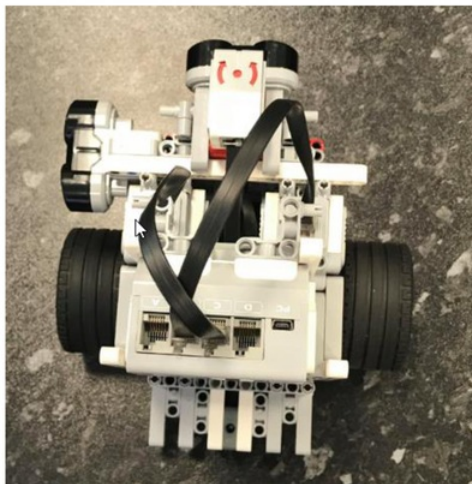


fig 2 robot building

The program

The program being used for the Lego Mindstorms ev3 robot was the Lego home edition. This is where we designed the program to run our robot through the course.

[2]Sensors

Colour sensor

The colour sensor was used to complete the line follow and the maze. The colour sensor can detect up to 8 colours; Blue, Black, Brown, Red, Green, Yellow, White and no colour. It can be used for a range of purposes. Including line follow, it can check ball colours and read out colours it sees, or can start and stop the robot.

Ultrasonic

The ultrasonic sensor will be used for the obstacle avoidance and the maze. The ultrasonic sensor is used to measure the distance of an object in front of it. It does this by sending soundwaves out and measuring how long it takes for the waves to get back to the sensor in order to work out how far away the obstacle is from the sensor. The measurement is calculated in cm and inches.

Line follow

This was the first part of the course which was Karl's task to control the robot to follow the coloured line using the colour sensor on the robot. First he made sure the colour sensor was working by checking it was picking up colours then he made sure he was happy with the placement of the sensor on the robot. Once he was happy with everything he moved on to programming the robot to follow the line using the Lego Mindstorms software. The first task was to join the line and follow towards the obstacle. When he was happy with that he moved on to the harder part of his challenge and connecting back to the line once going around the obstacle. There will be more detailed information of the obstacle avoidance in the assignment later. Once he had joined the line successfully he had to program the robot to realise when it has reached the end of the line, using the colour sensor to know when it sees a different colour on the floor to stop and make a noise to let you know that it had completed the line follow and had moved on to the next stage of the course.

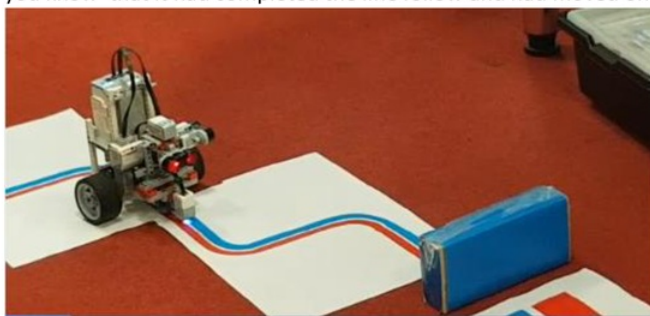


fig 3,4 line follow

Obstacle avoidance

While completing this part of the course the first task was making sure that everything was fine with the robot and the sensor was in the correct place and height to pick up the block on approach. Once they was happy with the robot they started to look at the code and decide how to program the robot to avoid the obstacle. The first problem to arise was when using the program it didn't have an ultrasonic choice but this was quickly rectified by downloading the correct addon for the program to be able to use all the functions needed for completing the task. With the program now fully functional the author started to program the robot. They made the robot go forward till it found an obstacle and stop to make sure the sensor was working. Once the sensor was working correctly they could move on to programming the robot to avoid the obstacle. The first step in the program was to program the robot to turn 160 degrees once the front sensor had picked up the obstacle blocking its path. It wasn't that simple as a there was a big problem had occurred. It was becoming a challenge to get the robot to turn because it was too close to the block and would clip or more correctly clatter into the obstacle. A solution to remedying this problem was necessary and with this in mind a second sensor was added to the robot build for completing the maze. The author decided to implement this into the block avoidance.

Now with the second sensor in place the author then programmed the robot to still detect the obstacle using the front sensor and turn, but when it was turning then the second sensor on the left hand side would come in to account and would pick up the side of the obstacle and would keep going forward till the sensor didn't pick up the obstacle and would turn to go back on to the path it was going. The problem that kept occurring is that the side sensor wouldn't pick up the obstacle. There were a few tries at adjusting the distance of the side sensor ranging from 10cm to 20 cm. Each attempt was unsuccessful and the same problem occurred in that it would not pick up the obstacle. Initially it was thought that the problem was the sensor was faulty so the sensor was replaced with a different sensor but the same problem kept occurring. Once it was realised it wasn't the sensor the next thing tried was shortening the sensor instead of going to a higher scale of distance and moved down from 10cm to 8 cm and the sensor did recognise the side of the obstacle, but the problem occurred again on the second try so they lowered the range to 5cm and finally after several attempts it did keep recognising the side of the obstacle. With the robot completing the obstacle avoidance this meant the author had completed their part of the task and would now need to be implemented in to the full program which was completed as a team.

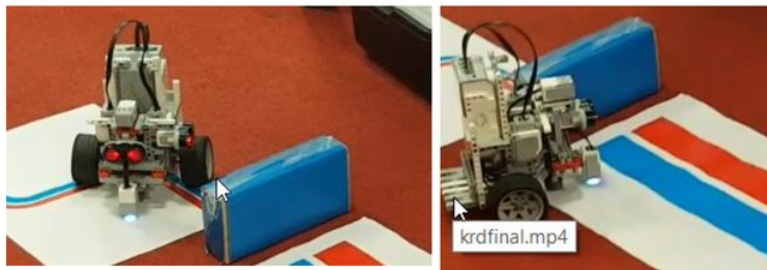


Fig 5, 6 block avoidance

The maze

This was the final part of the course and this was the task was allocated to Ryan. He was using 2 ultrasonic sensors to help guide the robot around the maze. The first task he did was program the robot to use the side ultrasonic to read the wall and help guide the robot. If there was a wall on the side the robot would continue to go straight, while if there was no wall the robot would recognize this and see this as a turn and turn the robot in to the space to try to recognise the wall again. Once picking up the wall the robot would continue straight with the second ultrasonic being used to stop the robot. If the front ultrasonic picked up the wall in front of it the robot would realise it couldn't keep going forward and turn until there was no wall blocking its path and continue to use the side ultrasonic to follow the wall and get to the end of the maze. Once the robot had reached the end of the maze Ryan programmed the robot using the colour sensor to recognise the colour on the floor of the maze and programmed it to realise this was the end of the maze and stop. Upon stopping the robot would make a noise to signal it had completed the maze and stopped.

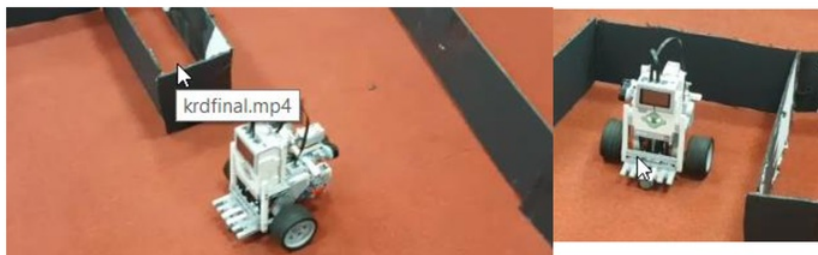
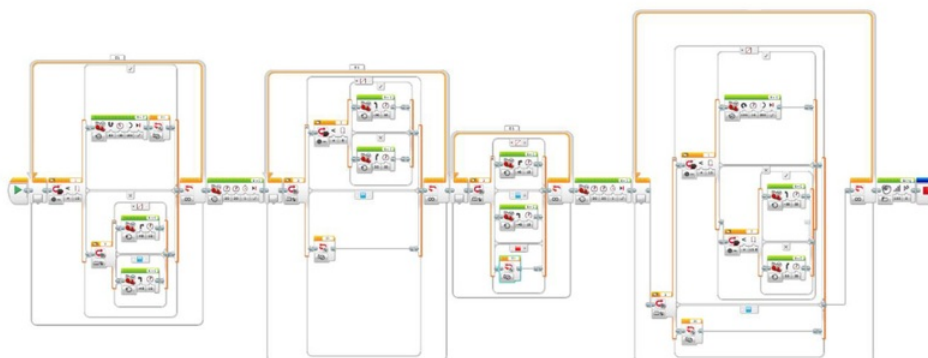


Fig 7,8 maze completion

Complete program



This is the complete program for the course. This includes the line follow, block avoidance and completion of maze. The objective was that the robot be completely adaptable and could function the whole course on its own and could run even if the circumstances changed. Changes such as the line was longer, or had a different route or loop to follow, or the obstacle was wider or longer or that the maze dimensions or route had changed. It was also decided that the robot had to be in total control and after completing the program and running the robot on the course several times in a practice run the course was adapted to include some of the different circumstances needed to make sure that the robot was capable of plotting its own course and the robot did pass all of the challenges. With this being the case it proved able to show and demonstrate the evidence to prove that the robot was completely reliable by itself and could complete the task ahead.

Conclusion

In conclusion honestly I couldn't have asked for a better team to work with. Everyone gave 100 percent and we all went in with the mind set of making this robot completely adaptable and one which could function without any flaws. There were some problems with the program and the build of the robot along the way, but each time a problem occurred the other person was there to help their team mate out. This was a team effort to complete this task and even though we had our own sections to complete, I knew I could trust that each member would have some helpful advice and would help reach a solution with the combined aim of successfully completing the task.

References

- [1] R. Kwok, "youtube," [Online]. Available: <https://youtu.be/fJxSK9zNPWg>. [Accessed 26 april 2018].
- [2] T. Griffin, "the art of lego mindstorm ev3 programming," in *the art of lego mindstorm ev3 programming*, 2014.

FINAL GRADE

84/100

GENERAL COMMENTS

Instructor

Assessment Component 1 (Report):

Introduction: Quite well stated, but try avoid use of We or I in academic reports! Use a picture to clearly illustrate what the assignment is about (you could use the picture from the assignment brief if you like!)

4/5

Background Research: Sensors considered quite well, don't forget to reference any material you might have read. Some good discussion of the sensors problems and alternatives considered
10/15

Project Plan: There doesn't seem to be one? You should provide a list of tasks/timescales as stated in the assignment brief, "You need to include a plan of how you will allocate your time in completion of the project."
0/10

Design Process: Design of robot clearly shown with justifications for decisions taking. Good illustrations showing robot from all sides
34/40

Evaluation and results: Some good screenshots shown. I think you could be even more positive in this section as the implementation was excellent (see below) 25/30

Assessment 1 Total: 73%

Assessment Component 2 (Demo):

Technical knowledge/skill 20/20

Analytical and Problem-solving skills 20/20

Quality of result 60/60

Can't fault the implementation - robot completes all tasks, transitions/ending are excellent, maze negotiation very good and efficient. If I was going to nitpick you were a tiny bit close to the wall on the last corner, but you

successfully negotiated it. An excellent group effort.

Assessment 2 Total: 100%

OVERALL MARK FOR MODULE: 84%

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