

Assignment - Report

by Zandr Badger

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1. Introduce and explain the overall problem to be solved.

We have been tasked with creating a robot that has to follow a set course, however it has to be able to do this autonomously.

The course can be split into two separate sections, the first is to make it follow a black line along the floor, until it comes to a roadblock, then it should be able to navigate around it and rejoin the line, and finally it will stop at the start of section two, which is indicated by a green line across the floor.

The second section is a maze, which will include dead ends and an end point, which is indicated by the colour red across the floor. The robot should be able to go through the course autonomously, which means without any human intervention once started.

2. Conduct research into the tools and techniques that you will use to solve the challenges of the problem. **This section especially should be sourced.** You should have more detail on the section that you were the leader for, and an overview of the other sections.

To begin, we needed to decide on what sensors we were going to use and eventually decided on using the light colour sensor, facing the floor, as it could track the black line. We also decided on using the ultrasonic sensor (distance sensor), as it could detect how close the robot was to objects, such as the walls in the maze and the obstacle in the line following.

We searched two main sources for the design of the car we chose, our first choice was the Lego Prime Spike App/Website [1], as it had premade designs that were guaranteed to use the parts provided in the set. We chose the Advanced Driving Base, as was easily modifiable and could house both the distance sensor and colour light sensor, as well as others if we deemed it necessary.

Our second point of research was YouTube.com [2], as we could use it to see what others had created and used that we may not have thought of, as well as other robotics projects outside of Lego Prime Spike that might have given us inspiration.

We used Jeremy Wuitschick's [3] designs as our base, as it met all our criteria of: needing a light colour sensor, a distance sensor and to have an advanced driving car model as the base, meaning we could complete all tasks that have been set.

3. Illustrate a plan of how you intend to solve the problem (again, more detail on the section you led with an overview of the other sections). You should develop a plan with respect to the literature you have read. You need to include a plan of how you will allocate your time in completion of the project.  2

For the first section, we intended to have the robot follow the black line using the light colour sensor, as this would be able to detect if it was going outside of the line. We decided to do this as when it would detect anything other than the colour black, it would circle back around until it found and rejoined the line, and when it found the line, it would simply move forward again. We gained inspiration from a YouTube Channel called Spratronics Learning Lab [4], as he also tackled a similar problem, and gave us the idea of making the robot follow the line autonomously. We decided that we would allocate two hours of time for this section, as we would need to code it to use the light colour sensor and autonomously follow the line.  3

We decided to use the distance sensor to detect the obstacle in this section, as this would allow us to stop and move around it, without touching it directly. We did consider using the pressure sensor, but found that it would often move the object, or that it was not sensitive enough compared to the distance sensor. We also found this out from a blog post by LEGO Education, which outlined the basics of the distance and pressure sensor [5]. We allocated an hour for this, as the code was fairly simple, we used a 20m slot to test the pressure sensor and 40m for the distance sensor.

The maze section proved to be most difficult to execute, as it needed to be autonomously able to go through it without issue. We decided to allocate 8 hours of our time to this part, so we could test multiple different solutions. Our first solution was to use the distance sensor, and when it detected a wall, the distance sensor would look left, right, and behind until it found a distance further than 10cm, which it would then turn that direction and move forward. This was inspired by Aram Perez [6], who used the same idea to create a Lego EV3 Robot to solve a maze autonomously.

However, when trying to implement this, we found that the code blocks provided by Lego were very restricting and made it hard to implement this more complex solution, and due to not being allowed to use python for this, we ultimately decided to search for a different method.

Instead, we decided to have a fixed position for the distance sensor, and to turn the car, as this removed the issue of the distance sensor not returning to its forward-facing position, or it turning too far and getting the cable tangled. We found that this has worked much better and completed the test run of the maze very well.

4. Describe the design of your robot. You should consider both the hardware and software elements of the construction and development process.

We used a design very similar to the "Training Camp 2" premade robot from the Lego Spike Prime App.

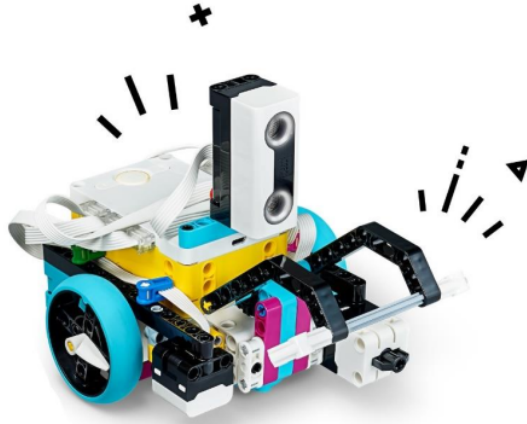


Figure 1: Training Camp 2 Robot. [7]

However, we removed the grabbing claws and pressure sensor as they weren't necessary and took up slots that we could potentially use. The light colour sensor was in a desirable position, so we left that as it, but we did attach a motor to the front of the robot, and mounted the distance sensor horizontally on it, this was so that it could turn independently of the robot itself, which was used primarily in our first iteration of the robot. We chose to mount it horizontally, as opposed to vertically in Figure 1, as it could detect a wider surface and stop.

As previously mentioned, we chose to use the distance sensor instead of the pressure sensor as it allowed us to stop before the object, otherwise we risk moving it, and it would also allow us to navigate the maze more efficiently, however, we still view the pressure sensor as a viable option. The colour light sensor was used to track the line following up to the maze, as it allowed us to easily follow the line without issue, and we could not find another solution to this problem.

We used the Lego Prime Spike app to code this as it gave us pre-created code blocks, which allowed us to save time, and they also had tutorials showing us how to use both the distance and colour light sensor, however, we found that eventually the code blocks became very complicated, and the ease of use dropped heavily when attempting to create more complex pieces of code i.e. making the robot go through the maze autonomously.

5. Outline how you will assess success of each stage of the problem. Include results, and an evaluation of the final overall outcome. Consider what you might have done differently.

The first section's success will be determined by three different points. The first point is whether the robot is able to follow the line automatically using the colour light sensor, until it reaches the object. The second point is if the robot detects the object using the distance sensor and leaves the black line and manoeuvres around the object without hitting/moving it. The third point is if the robot is able to rejoin the line and follow it until it reaches the start of the maze, where it will stop upon detecting the green tape along the floor, using the colour sensor.

When testing this, our robot was able to follow the black line perfectly to the object, on which it detected it and successfully moved around it, eventually rejoining the line and stopping at the green tape at the start of the maze. We consider this to be a massive success, the only point we believed we could have improved on was making the robot autonomously rejoin the line, instead of just moving a long distance away to ensure that it doesn't hit the object.

Upon reaching the maze it seemed to be going well, despite going down a dead end, however it did take a long time to manoeuvre the maze, and the possibility that it even went back to the start was still present. It did eventually reach the end where it stopped using the light colour sensor detecting red tape along the floor.

If we were able to make any further changes, we would have liked to add a code block where if it detected green, using the colour sensor, it turned around, to prevent it from leaving the maze through the start, and to speed up the process of going through the maze.

Overall, we are happy with our design and how it performed during both segments of the practical, however there was vast room for improvement and changes to be implemented, that we would have liked to accommodate, which ultimately came down to a misallocation of time.

References

- [1] Lego, "Lego Prime Spike," 01 09 2020. [Online]. Available: <https://education.lego.com/en-us/lessons/?products=SPIKE%E2%84%A2+Prime+Set>. [Accessed 31 02 2024].
- [2] "YouTube," Google, [Online]. Available: YouTube.com.
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- [4] S. L. Lab, "YouTube," Google, 2 09 2023. [Online]. Available: <https://www.youtube.com/watch?v=j9uYm6rwxAA>. [Accessed 01 04 2024].
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- [6] A. Perez, "YouTube.com," Google, 15 09 2017. [Online]. Available: <https://www.youtube.com/watch?v=Ro7T3q14uDY&t=19s>. [Accessed 10 04 2024].
- [7] "Lego Education," Lego, 2020. [Online]. Available: <https://education.lego.com/en-gb/lessons/prime-competition-ready/training-camp-2-playing-with-objects/>. [Accessed 15 04 2024].

Assignment - Report

GRADEMARK REPORT

FINAL GRADE

66/100

GENERAL COMMENTS

Zandr, good start demonstrating a comprehensive overview. Here's some feedback on your work. specific section comments can be found inside the document as well:

Positive aspects:

- Clear problem statement
- Thorough research into tools and techniques for solving challenges
- outlined criteria for assessing the success of each stage of the project and evaluates the final outcome,

Areas for improvement:

- Inclusion of Visuals, Robot's design and code snippets missing
- While the script mentions challenges encountered during the project, further reflection on how these challenges were addressed would provide more information into the problem-solving process.
- IEEE referencing style should be followed

Overall, the script demonstrates a strong understanding of the project requirements and a systematic approach to problem-solving, with opportunities to enhance clarity, detail, and reflection.

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Research skills- 10

Plan- 24

PAGE 1

PAGE 2



Comment 1

requirements of project clearly outlined

PAGE 3

PAGE 4



Comment 2

detailed plan for addressing each segment mentioned



Comment 3

no accompanying visuals

PAGE 5

PAGE 6



Comment 4

snippets of code would offer deeper insights

PAGE 7



Comment 5

IEEE referencing style to be followed