Project Outline

Marking scheme

RECOMMENDED REPORT STRUCTURE AND MARKS BREAKDOWN		Percentage of project mark	Percentage of module mark
Introduction to report (max 200 words)	5	4.4	3.5
Challenge 1 - description of work and results	15	13.1	10.5
Challenge 2 - description of work and results	15	13.1	10.5
Challenge 3 - description of work and results	25	21.9	17.5
Challenge 4 - description of work and results	35	30.6	24.5
Conclusion - achievements and learning outcomes (max 200 words)	5	4.4	3.5
Total	**100**	87.5	70

Project Demonstration (recorded video) • Not demonstrated: 0% • Partial success: 50%Max • Successful: 70%Max • Outstanding: 100%Max	**Max**	**Percentage of project mark**	**Percentage of module mark**
Challenge 1: Follow simple track	15	1.9	1.5
Challenge 2: Follow complex track	15	1.9	1.5
Challenge 3: Keep inside a box and avoid obstacles	30	3.7	3
Challenge 4: Follow track and corridor	40	5	4
Total	**100**	12.5	10

Report and Code Submission

You will need to submit a single program file with all project code, organised in separate functions. This file should be uploaded to **Canvas → Project Code Submission** by the submission deadline at **4pm on Monday 16 May 2022**. Everything described in the report should be included here, so that your work can be reproduced when marking. For every function, you should make it clear in both your report and your program file whether it:

- Works well.
- Is only partially successful.
- Does not work as expected.
- Is incomplete or not tested properly on the robot as you ran out of time.

What to include in your report

When you explain your program code and your solutions to the problems in the project, it is essential to demonstrate your knowledge and understanding of embedded systems principles and techniques. If you do not have the robot, please mention it in the introduction.

You may find the following structure useful for explaining a project challenge:

- Briefly describe the problem and the issues involved.
- Show your **main code (only)** and explain what you did to solve the problem and address the issues (this is the main part). When you explain the programs, you can include any diagrams (e.g. your finite state machines), flow charts or photos in this section. If you use someone else's diagrams or photos, make sure to reference your sources correctly.
- Comment on your code.
- Comment on how successful your solution was, and/or on how it might be improved.

Your individual report must be uploaded to **E-Submission** – **Project Report Submission** by the same deadline: **4pm on Monday 16 May 2022**.

Deadline for returning your robot (Room 3A03 Richmond) is **4pm on Tuesday 17 May 2022.**

Programming notes

- Code should be well laid out, and you should use a consistent style of indentation.
- All functions should be explained with comments
- Redundant variables and logic should be removed.
- Small is beautiful! Over-complicated code and duplicated code will be penalised.
- The use of global variables should be kept to a minimum.
- Apart from index variables, it is good to give variables and functions descriptive names.

Demonstrating your programs

Project demonstration will be organised at **11:00am Tuesday 26 April 2021** at **Future Technology Laboratory** (FTL, Chichester 1 CI027).

Each group will have only 5 minutes to demonstrate all four challenges and the schedule is very tight. If you are not ready to demonstrate on time, you will lose marks.

Try to test your programs in advance in the place where you will demonstrate. Due to the sensitivity of the sensors, a program which works well in one room will not always work well in another.

You **MUST NOT** use code from someone else. Questions on the code you developed might be asked during your project demonstration.

Project Challenges

Rotary switch program selection

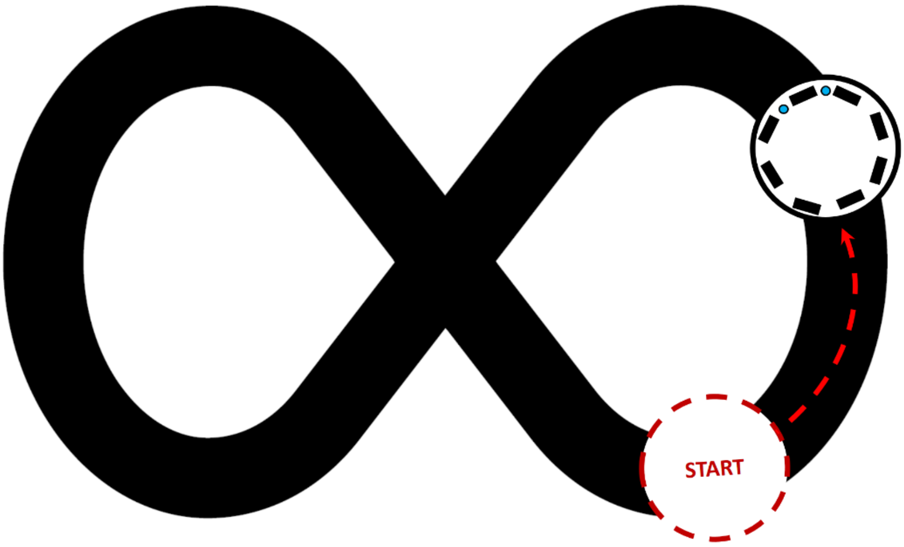
Programming requirements:

Reading from the rotary selector switch.
Using either the "Switch… case" or the "If-else if" structure to select which robot control function to run.

Task

You will only have 5 minutes to demonstrate all of your programs, so the code for all project challenges must be loaded on to the robot before your demonstration starts. Assign each of the functions you wish to demonstrate to a different position on the rotary sector switch, and in the loop() function, read from the rotary switch and use the reading in a logical structure which will select the correct function to run.

Please note that the robot tracks will be printed on A4 papers for Challenges 1&2 and on A3 papers for Challenges 3 &4.



Challenge 1 - Line follower, Part 1

Programming requirements:

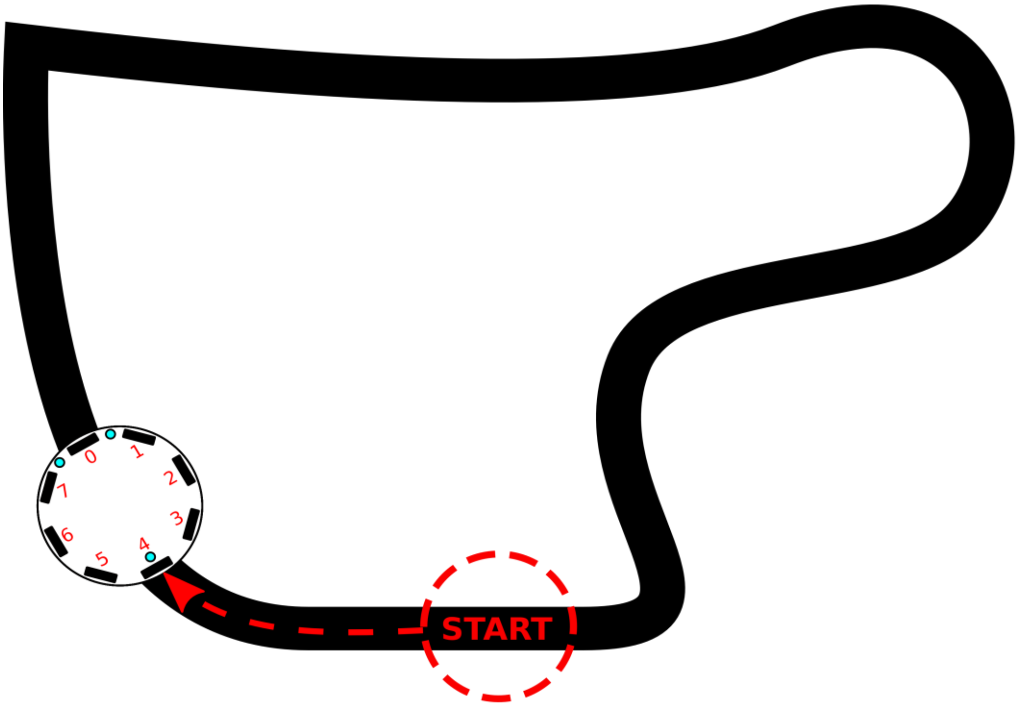
- Controlling motors with PWM.
- Reading from ground sensors and thresholding measurements to distinguish between black border and white floor.
- A number of approaches can be taken to controlling the robot, including:
  - Setting motor speeds appropriately for all possible sensor patterns
  - Finite state machine
  - PID control

Task

- Use the image file for Challenge 1. This thick track can be detected by at least one sensor at any time.
- The robot is started on track, already facing in the right direction.
- The robot should complete a single circuit of the track.

Test criteria

- The robot will need to be tested in both directions of travel - CW and CCW.
- It is most important for the robot to successfully navigate the course, but some small credit is also assigned to how fast the robot is travelling and how smoothly it follows the track.



Challenge 2 - Line follower, Part 2

Programming requirements:

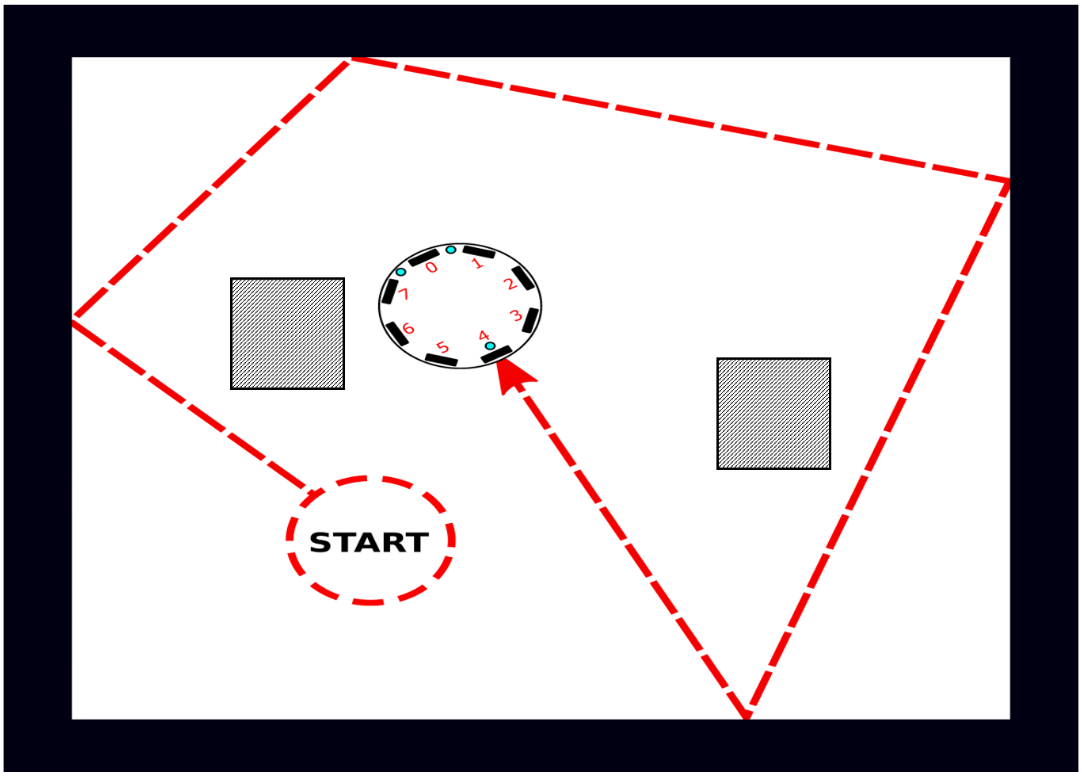
- Controlling motors with PWM.
- Reading from ground sensors and thresholding measurements to distinguish between black border and white floor.
- A number of approaches can be taken to controlling the robot, including:
  - Setting motor speeds appropriately for all possible sensor patterns
  - Finite state machine
  - PID control

Task

- Use the image file for Challenge 2. This thin track is narrow enough to fit between the front two sensors.
- The robot is started on track, already facing in the right direction.
- The robot should complete a single circuit of the track.

Test criteria

- The robot will need to be tested in both directions of travel - CW and CCW.
- It is most important for the robot to successfully navigate the course, but some small credit is also assigned to how fast the robot is travelling and how smoothly it follows the track.



Challenge 3 - Stay inside box and obstacle avoidance

Programming requirements:

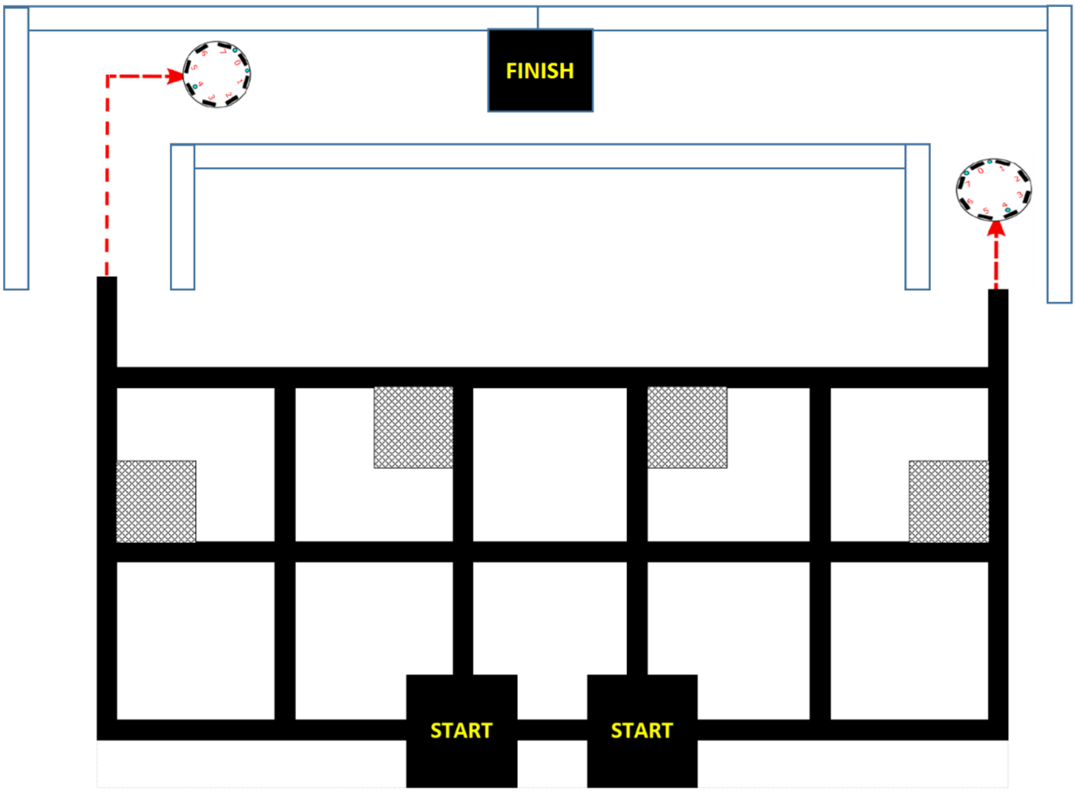
- Controlling motors with PWM.
- Reading from ground sensors and thresholding measurements to distinguish between black border and white floor.
- Use of random numbers to vary turn angle.
- Reading proximity sensors to avoid collision with obstacles.

Task

- Use the image file for Challenge 3.
- Robot is started off inside box.
- Robot drives forwards until it finds the black box edge. Every time it finds the edge, it turns and drives forwards again while avoiding two obstacles (made from wooden blocks - 40x40x40 mm) inside the box.

Test criteria

- This should be happened at least 3 times. A really good solution will turn left and right, and visit at least 3 edges during a single demonstration.



Challenge 4 - Line and corridor follower

Programming requirements:

- Reading from ground sensors and thresholding measurements to distinguish between black lines and white floor.
- Controlling motors with PWM.
- Setting motor speeds appropriately for all possible sensor patterns.
- Counting junctions and adjusting robot directions to avoid obstacles.
- Use of proximity sensors to detect walls, and navigate through a corridor made of plastic walls (you could use cardboards or other materials to build the corridor for your testing).

Task

- Use the image file for Challenge 4 for the track.
- This task combines line-following and wall-following behaviours. The robot is started from the 'Start' position, follow the black lines while avoiding obstacles (made from wooden blocks - 40x40x40 mm) until the robot reaches the corridor, at which point it should switch to wall following behavior until the robot reaches the 'Finish' position.

Test criteria

- The robot will need to be tested in both directions - CW and CCW.
- It is most important for the robot to successfully navigate the course, but some small credit is also assigned to how fast the robot is travelling.