University of Essex
School of Computer Science & Electronic Engineering

Module CE315 - Mobile Robotics
Assignment 1 – C/C++ Programming with Linux
Spring 2021

1. Objectives

1) To describe a variety of autonomous mobile robots you have learnt in this course.
2) To design, program and evaluate mobile robots for specific tasks.
3) To produce a report on your design and implementation.

2. Task 1: Figure 1 describes a differentially driven robot in a 2D space. The robot position is (x, y) and its heading is θ. V_l is its left wheel velocity and V_r is its right wheel velocity.

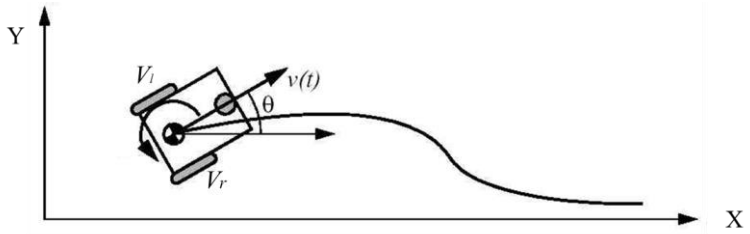

Figure 1 A differentially driven robot

The odometry calculation of the differentially driven robot are based on equations below:

$$x(k+1) = x(k) + \frac{V_r + V_L}{2}\cos\theta * \Delta t$$

$$y(k+1) = y(k) + \frac{V_r + V_L}{2}\sin\theta * \Delta t$$

$$\theta(k+1) = \theta(k) + \frac{V_r - V_L}{W} * \Delta t$$

You should create a function to implement the odometry calculation above. Note that Δt and W are constant. V_l and V_r are input parameters to the function being created.

3. Task 2: Suppose you have been given the following parameters:

$$V_l = 10cm/s; \quad V_r = 8cm/s; \quad W = 30\ cm; \quad \Delta t = 1;$$
$$x(0) = 30cm; \quad y(0) = 30cm; \quad \theta(0) = \pi/4$$

- Using the C/C++ function code you have created above to generate the robot trajectory (x_k, y_k) when k=0,1,2,3,4,5,6,7…200. All the results should be saved into a file to be displayed in Excel.
- By using different velocities, $V_l = 5cm/s$, $Vr = 7cm/s$, repeat the process above.

4. Task 3: Figure 2 shows the robot and its environment (1 square room with 4 pillars and 1 charge station), which is used for your assignment.

Based on it, you should write C/C++ code to generate this environment map without the robot, and save the data into a file for its display in Excel.

More specifically, when you are writing the code, you should follow the steps below.

- Initialization of all the parameters in your code, which are shown in Figure 2.
- Write your code to create four walls using the dimensions shown in Figure 2.
- Write your code to create 4 pillars and 1 charger based on their centre and radius.
- The robot should be missed out in this task.

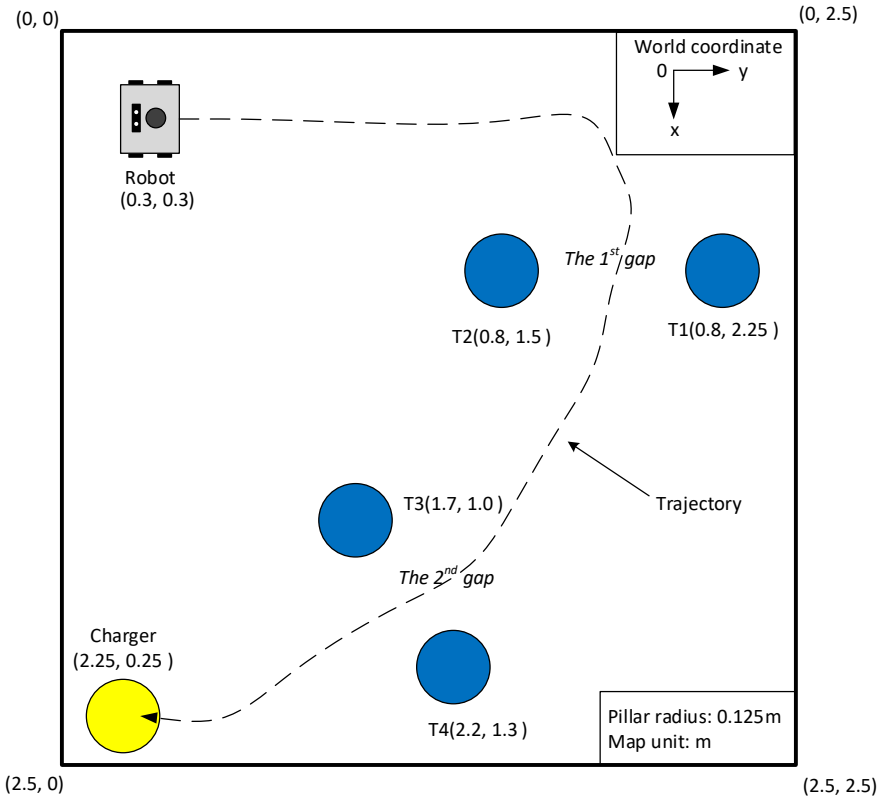

Figure 2 The robot in an indoor environment

5. Deadline & submission requirements

The deadline for the electric submission of your report is informed by the School Office. Your report should be about 2000 words (about 10 - 12 pages), More specifically,

- Write your name and the code of the course module clearly on the cover page of your assignment; include a table of contents for easy to navigate (1 page).
- Introduction: you should describe a variety of mobile robots in real-world applications learnt in this course so far, i.e. why we need them and how they differ (2 - 3 pages).
- Implementation of **Task 1**: To complete a modular function of C/C++ code for odometry calculation. Present a flowchart for the code and explain it briefly (1 page).
- Implementation of **Task 2**: To generate the robot trajectories (x_k, y_k) when k=0,1,2,3, …200, at different velocities. Save the results into files and plot two data graphs. Only include data graphs into your report and explain why they are different (1 - 2 pages).
- Implementation of **Task 3**: you should present a flowchart of your code for generating the robot environment, explain how it works and plot the environment map (2 pages).
- Appendix: list the C/C++ programs you have written for three tasks, with some clear comments for easy reading and understanding. All words here are counted (2-3 pages).

6. Assessment criteria

This reassessment is accounted for 15% of total module credit and based on the criteria:

- A list of mobile robots in real-world applications you have learnt in this course (25%).
- The understanding of the tasks and conducting an efficient implementation (25%).
- The quality of your code (compactness & modularity). Note the short is better (25%).
- The writing quality of your report, including the structure & presentation style (25%).

7. Note

- You should work independently.
- Late penalty is **zero mark** unless special circumstances are approved.