University of Essex
School of Computer Science & Electronic Engineering

Module CE315 - Mobile Robotics
Assignment 1 – C/C++ Programming with Linux
Autumn 2022

1. Objectives

1) To describe four types 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.

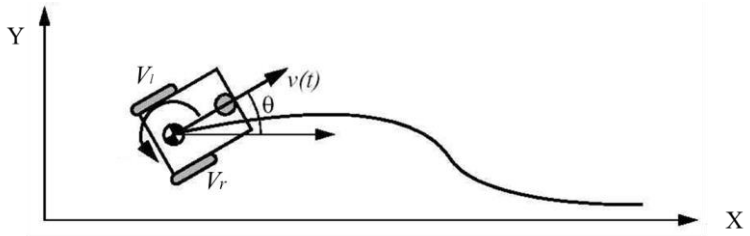

Figure 1 A differentially driven robot

The discrete form of its kinematic equations is shown below:

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

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

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

where W is the wheelbase of the robot, i.e., the distance between two rear wheels.
V_l and V_r are the velocities of the left and right wheels, respectively.
Δt is the cycle time.

Suppose you have been given the following parameters:

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

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 and to be plotted in a graph.

3. Task 2: 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.
- Write your code to create a square robot without wheels. Each edge is 0.25m.

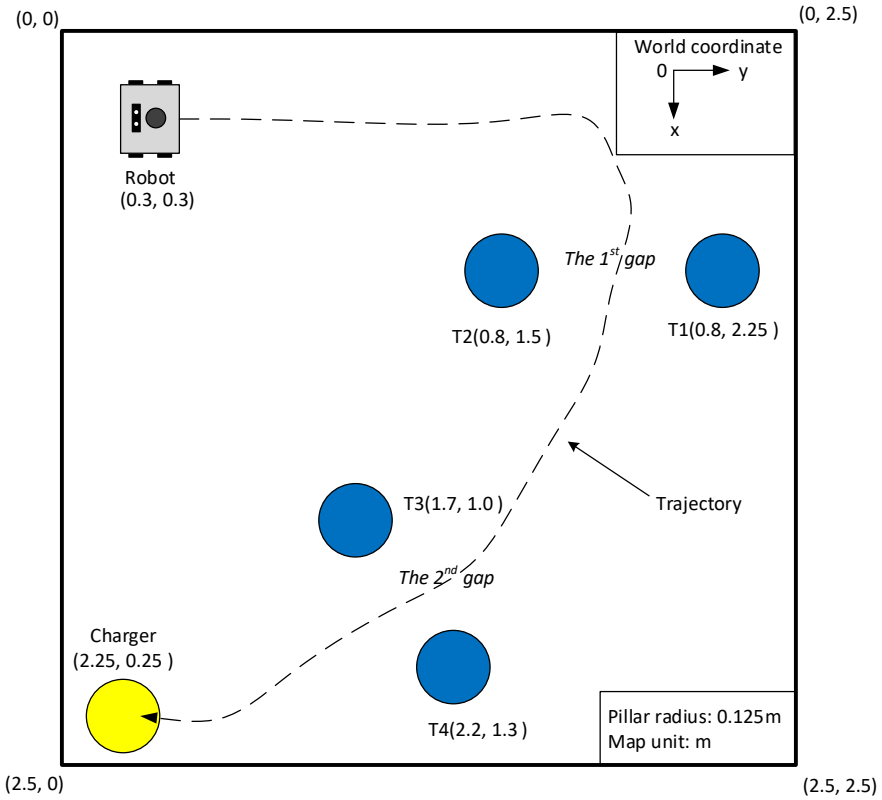

Figure 2 The robot in an indoor environment

4. Deadline & submission requirements

The deadline for the electric submission of your report is given in FASER. Your report should be about 2000 words (no more than 12 pages in total), More specifically,

- Write your registration number 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 four types of mobile robots being taught in this course so far, i.e., why we need them and how they differ (3 pages).
- Implementation of **Task 1**: Present a flowchart for your code and explain it briefly. To run your code at two different velocities, i.e., one is ($V_l = 10cm/s; V_r = 8cm/s;$) and another is (V_l = *5cm/s*, V_r = *7cm/s*) to generate two robot trajectories (x_k, y_k) when k=0,1,2,3, …200. Save the results into files and plot trajectory graphs using the recorded data and explain how and why they are different (2 pages).
- Implementation of **Task 2**: 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 two tasks, with some clear comments for easy reading and understanding (3 – 4 pages).

5. Assessment criteria

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

- The presentation quality and readability of your introduction (25%).
- The understanding of the tasks and conducting an efficient implementation (25%).
- The quality of your code, i.e., optimize the code provided in lab notes. (25%).
- The writing quality of your report, including the structure & presentation style (25%).

6. Note

- You should work independently on your coding and implementation.
- Late penalty is **zero mark** unless special circumstances are approved.