ELEC330
Assignment Two
Robot Moving in its World and Face Detection

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Abstract

This assignment has a weight of 30% of the total grade. The assignment is issued on the fourth week and is due on Friday of week twelve of the first semester. This assignment is very important as it represents a stepping stone to enable you to complete the third and final assignment.

1 Assignment requirements and marking criteria.

Table 1 summarises the assignment requirements.

Module	ELEC330
Coursework title	Assignment 2
Component weight	30%
Semester	1
HE level	6
Lab location	lab sessions and private study
Work	Individually
Timetabled time	24 hours (3 hours per week)
Suggested private study	16 hours including report writing
Assessment method	Individual, formal word–processed reports in addition to video and code.
Submission format	On–line via CANVAS
Submission deadline	23:59 on Friday 16^{th} December 2022
Late submission	Standard university penalty applies.
Resit opportunity	August resit period (if total module failed)
Marking policy	Marked and moderated independently
Anonymous marking	No
Feedback	via annotated copy corrections.
Learning Outcomes	LO4: Define & implement a system for navigation & manipulation of a robotic system. LO5: Describe and implement sensing in a robotic system. LO6: Define and implement a system for navigation of a robotic system. LO7: Explain how machine vision, machine learning and human machine interfaces augment capability of robotic systems.

Table 1: Assignment Requirements

Table 2 summarises the marking criteria of the second assignment.

Section	Marks available	Indicative Characteristics	
		Adequate/pass (40%)	Very good/Excellent
Clarity of presentation (including succinctness) of main report	20%	2–page executive summary. Comprehensible language with adequate grammar and punctuation. Documented code and Gazebo .world files in appendices	Appropriate use of technical language. All sections clearly signposted. Correct cross referencing to appendices. Annotated Gazebo .world and code files including readme files.
Methodology and testing scenarios	40%	Adequate Gazebo .world file; Rviz, minimum testing scenarios of the robot designed in assignment 1 navigating autonomously to target.	Well thought through .world file and testing scenarios foreseeing requirements of the exploration mission and detecting face of at least one human avatar in the indoor environment. Video showing the detail of the testing of various navigating scenarios and face detection schema.
Quality of discussion, reflection and conclusion	40%	Critical assessment of the efficacy of the robot in navigating the world and identifying the target. Discussion on what worked and what did not.	Discussion how the robot successfully navigated its world, detected the face of the human avatar and how the model was fully assessed/tested.

Table 2: Marking Criteria

2 Assignment Outline

In this module you will

- create a .world file in which the robot you designed in the first assignment will navigate.
- add a sensor suitable for creating a map of the world.
- use gmapping to create a .map file of the world.
- test different navigation scenarios.
- create/include a human avatar and spawn in the indoor environment.
- Using the navigation stack to implement autonomous navigation.
- Drive the robot autonomously to a human model.
- Detect the face of the human and take a photo using a camera.

In the second assignment, you shall start by creating and launching a world file in Gazebo. The world file will represent an indoor space that has at least four walls, one door and one window and has the following objects on its floor:

1. at least one chair,
2. at least one coffee table,
3. one book shelf,
4. at least one sphere,
5. at least one cube,

You can use objects from the Gazebo database.

There are **no** requirements on

- the dimensions of the indoor space but should be large enough to enable the navigation of your robot within it.
- the position of the various objects and the distances among them.
- the starting position of the robot.

After creating the .world file, you will choose an appropriate sensor to add to your robot to enable it to generate a map of the world using gmapping (SLAM) and use YAML to load it.

You should be able to use both Rviz for visualisation and Gazebo for simulation.

Refer to the following tutorials for help:

- `http://wiki.ros.org/rviz` to refresh your knowledge in Rviz (ROS visualisation tool)
- `http://gazebosim.org/tutorials?cat=build_world`. to build a world.
- `http://wiki.ros.org/Robots/TIAGo/Tutorials/Navigation/Mapping`.
- `http://wiki.ros.org/map_server`.
  make sure you are using the correct distribution e.g. Melodic or Noetic version.
- `https://emanual.robotis.com/docs/en/platform/turtlebot3/slam/#ros-1-slam`.
- `http://wiki.ros.org/amcl` to localise the robot within the indoor space.
- `http://gazebosim.org/tutorials?tut=ros_gzplugins`.

You should be able to simulate the model in Gazebo and visualise it in Rviz. You need to SLAM/map the Gazebo world to make its robot perception equivalent available in Rviz. So the robot needs to "scan" the Gazebo world, translate it into map format, and publish it (via map server)

3 Submission

3.1 Submission Deadline

The submission deadline for the assignment is **Friday** 16^{th} **December 2022** at *23:59*. You will submit your report and code on–line using the dedicated link in the module page on CANVAS.

3.2 What to submit

You will submit an executive summary, a detailed report, code and a video as follows. Use appropriate names for all files and zip them in one file to submit.

3.2.1 Executive Summary

You will submit a 2–page executive summary with a maximum of two figures (excluding any appendices) in 10 point font with no less 2cm margins. Note that this summary is very important and will be the only part that is completely read by the marker. It should include all what is needed to get the reader acquainted of what you have achieved and how. The reader should not have to refer to any other material. The executive summary should include

- Summary of the world you designed with a bird's eye view of the world.
- Selection of the sensor and any modifications to the initial robot design.
- Autonomous navigation and face detection.
- Discussion and reflection on (1) map generation, (2) testing scenarios to generate an accurate map, (3) accuracy of the map generated with respect to the robot starting position.(4) localisation and navigation, (5) testing scenarios to generate an accurate map and reach the target position, (6) image of the human face.
- Conclusion with a view on what requirements are needed for a mobile robot to accurately detect objects including human faces.

3.2.2 Appendices

You should use appendices where you include the detail of all the steps you have gone through to complete the creation of the world and generate the map. The appendices should include a detailed section for each of requirement specification of the world, launch file, the map, the testing scenarios, how you achieved the an accurate map. A reflection section on what worked, what did not work, what are the lessons learnt and skills acquired.

3.2.3 code

This will include any code you have written or used to complete the assignment. This will also include all the .world, .yaml and any other files. All code and files should be appropriately documented and annotated.

3.2.4 video

Submit a video showing the robot in Gazebo and Rviz navigating and identifying the human avatar. Figures will also be accepted.

4 How to tackle the assignment?

To help you tackle the assignment, a series of laboratory sheets are published weekly to help you work on your assignment *step-by-step*. The first laboratory sheet associated with the second assignment is Lab Sheet 04. It is your responsibility to complete the tasks in the laboratory sheets which will help you successfully complete the assignment.

5 Difficulties

If you have difficulty

- designing and implementing an indoor environment in Gazebo, you can use an existing .world file and modify it. If you are unable to do that, you can use .world file without modification.
- using Makehuman to create human models, you can use an existing person model in Gazebo object database.
- in autonomously driving the robot, then you can use keyboard control to drive it to target.
- to detect a face using a camera, take a photo of another object in the room.

Taking any of these *easy* solutions will affect your grade.