MTRN4110 22T2 Phase D Task Description (Week 10-12)

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Updated 1/8/2022: Adjusted weighting of Task 1, Task 2, and Task 3

1. Overview of the Course Project:

The main project of MTRN4110 22T2 is a simulation-based project adapted from the Micromouse competition. Webots will be used as the simulation platform throughout the project. You will design a mobile robot and implement a controller and a vision program to negotiate a maze autonomously in Webots. The project will contribute 60% to your final mark in this course.

The project consists of four sequential phases which are connected, but attempting one phase is not dependent on the completion of another:

- Phase A: Driving and Perception (Week 1-3, 14%, individual)
- Phase B: Path Planning (Week 4-6, 14%, individual)
- Phase C: Computer Vision (Week 7-9, 14%, individual)
- Phase D: Integration and Improvement (Week 10-12, 18%, group)

This document will describe the tasks of Phase D.

2. Overview of Phase D – Integration and Improvement:

Phase D aims to integrate the three modules developed in the previous phases (Driving and Perception, Path Planning, and Computer Vision) into an integral project. You will form a group of three (in a small number of cases, a group of four) to work on the project. Your group is required to complete the tasks of this phase by Friday, Week 12 (with a possible extension, see Section 5.4).

2.1. Expectations:

By the end of Phase D, your group is expected to have been able to:

- collect, compare, and analyse the solutions to the previous three assignments developed by all the team members, improve the solutions, and combine them into an integral project;
- devise and attempt more tasks to endow the program of your group with more capabilities;
- prepare a video presentation for the final demonstration showing all the elements above.

2.2. Learning Outcomes Associated with this Assignment:

- **LO1**: Apply relevant theoretical knowledge pertaining to mobile robots, including locomotion, perception and localisation using onboard sensors, navigation and path planning, for practical problem-solving
- **LO2**: Apply computer vision techniques for feature/object detection and tracking in complicated environments
- **LO3**: Demonstrate practical skills in mechatronics design, fabrication, and implementation
- **LO4**: Demonstrate teamwork skills relevant to team-based projects

3. Phase D Task Description:

The completion of this phase's tasks will be a group effort. You will be randomly assigned to a group of three (in a small number of cases, a group of four) before the start of this phase. You should work collaboratively to address all the tasks of this phase.

Your group should complete the following tasks.

3.1. Collect, compare, and analyse the solutions to the previous assignments, improve the solutions, and combine them into an integral project:

Your group should collect the solutions developed by all the team members for the previous three modules (Driving and Perception, Path Planning, and Computer Vision).

There could be different approaches to addressing the same tasks. By comparing the solutions of your group members, you should recognise alternative possibilities, analyse the pros and cons of each method, and determine the best solution to be integrated into the final demonstration.

Even if your group members have come up with similar solutions, you could discuss the best implementations in aspects such as time complexity, space complexity, robustness, modularity, etc. You may also brainstorm different possible approaches even if none of you has implemented them in the previous phases.

Your group should integrate the best/improved solutions from the three modules into one project. The project should be able to:

- 3.2.1. read in an image of a maze with a robot and a target, and extract a map from it
- 3.2.2. generate an optimal path plan from the map using a planning algorithm implemented in Webots
- 3.2.3. execute the path plan in Webots, and demonstrate the robot moving from its initial state to the target position

Task 3.2.1 should be completed in Python, and Tasks 3.2.2 and 3.2.3 should be run in Webots. The input images for Task 3.2.1 can be manually prepared. However, once the program reads in the image(s), automatic execution of all three tasks is expected. Refer to Section 6 for resources that may help with this.

You should demonstrate the comparison, improvement, and integration process in your final video presentation (you could show the program's execution at a higher speed than in real-time to save time for other parts).

3.2. Develop more capabilities for the robot:

Your group is encouraged to expand/extend the capabilities of the robot by attempting more tasks beyond what was defined in the previous phases.

This task is open-ended, and your group should discuss the most appropriate improvement to be developed based on the circumstances of your group.

Example tasks include but are not limited to (each task is indicated with a potential complexity level which does not necessarily reflect the actual difficulty: 1 (low - changes are relatively small

or non-technical); 2 (medium - changes require considerable effort in technical implementation); and 3 (high - changes entail significant and advanced design and implementation with sophisticated thoughts put in)):

- Replace the E-puck robot with a new one (either provided by Webots or developed by your own) that exhibits different features (closely or loosely) relevant to Task 3.2.1, 3.2.2, and/or 3.2.3 (1-3);
- Develop an exploration module in which the robot can automatically build a map of the maze using its onboard sensors, as an alternative to Task 3.2.1 (2-3);
- Include trajectory planning, e.g., Bang-Bang trajectory or Cubic Polynomial trajectory in Task 3.2.3 (1-2);
- Include obstacle avoidance in Task 3.2.3 (e.g., automatically bypass unknown obstacle blocks by rerouting to other cells or circumnavigating them within the same cell) (1-3);
- Remote control the motion of the robot using an external device such as a joystick/keyboard, as an alternative to Task 3.2.3 (1);
- Remote control the robot and build a map of the maze using its onboard sensors, as an alternative to Task 3.2.1 (2);
- Record a video of the robot navigating the maze and automatically track the motion of the robot using computer vision as an add-on to Task 3.2.3 (1-2);
- Implement probabilistic map-based localisation (2-3);
- Implement SLAM (2-3);
- …

You should show the new capabilities separately from demonstrating the primary tasks in 3.2 in the final video. You can try implementing one or more tasks (examples listed above or tasks proposed by your team); your mark for this part will be assessed based on the quantity and complexity of the features implemented and their completion quality, normalised by the performance of all the groups' submissions.

3.3. Prepare a video presentation to demonstrate your final group project:

Your group should prepare a video presentation to demonstrate your final group project.

The video presentation should be between 5 mins and 6 mins and have a title page showing the name of the team and information of all the members.

The presentation should cover:

- your comparison and analysis of the solutions to the first three phases from aLL the team members, the improvements finally made, and the execution of the three primary tasks which are combined;
- new capabilities, if any, developed by your group;
- explicit description of the contribution of each team member to the final project (e.g., one-page slide without narration).

3.4. Task summary:

Task	Description
1	Collect, compare, and analyse the solutions to the previous assignments, improve the solutions, and combine them into an integral project
2	Develop more capabilities of the robot and the vision program
3	Prepare a video presentation to demonstrate your final group project

4. Hints

1. Consult the lecturer/demonstrators if you are unclear about anything.
2. When preparing the video presentation, try to:
    a. be concise and to the point;
    b. balance between summary and details;
    c. hit all the points while highlighting the uniqueness;
    d. have a clear structure;
    e. avoid unnecessary animations;
    f. speed up playback where appropriate to save time for other parts;
    g. show confidence;
    h. show teamwork.
3. A professional presentation may make up the weakness of the technical aspects, and likewise a dull/disorganised presentation may downgrade the quality of the technical features.
4. When making comparisons, try using quantitive analysis wherever applicable.
5. Team collaboration means not only your contribution finally incorporated into the product, but also, and sometimes even more importantly, your attitude towards cooperation.
6. Contribution can be to the technical implementation but also the presentation preparation.
7. Start collaboration as early as possible.
8. Inform the lecturer/demonstrators about observed teamwork issues as early as possible.
9. Keep evidence of collaboration (e.g., meeting minutes, communication records, etc.).

5. Assessment:

5.1. Submission of your work

You should zip your project and name it as "TeamName_z*******_z*******_z*******.zip" where ******* is the zID of each team member of your group. Submit this zip file to Moodle. Only one submission is needed from each group.

In the folder, you should include both the source files of your project and the video presentation.

The video presentation should be in MP4 format. The overall zip file should be less than 200M.

5.2. Marking criteria:

This assignment will contribute 18% to your final mark.

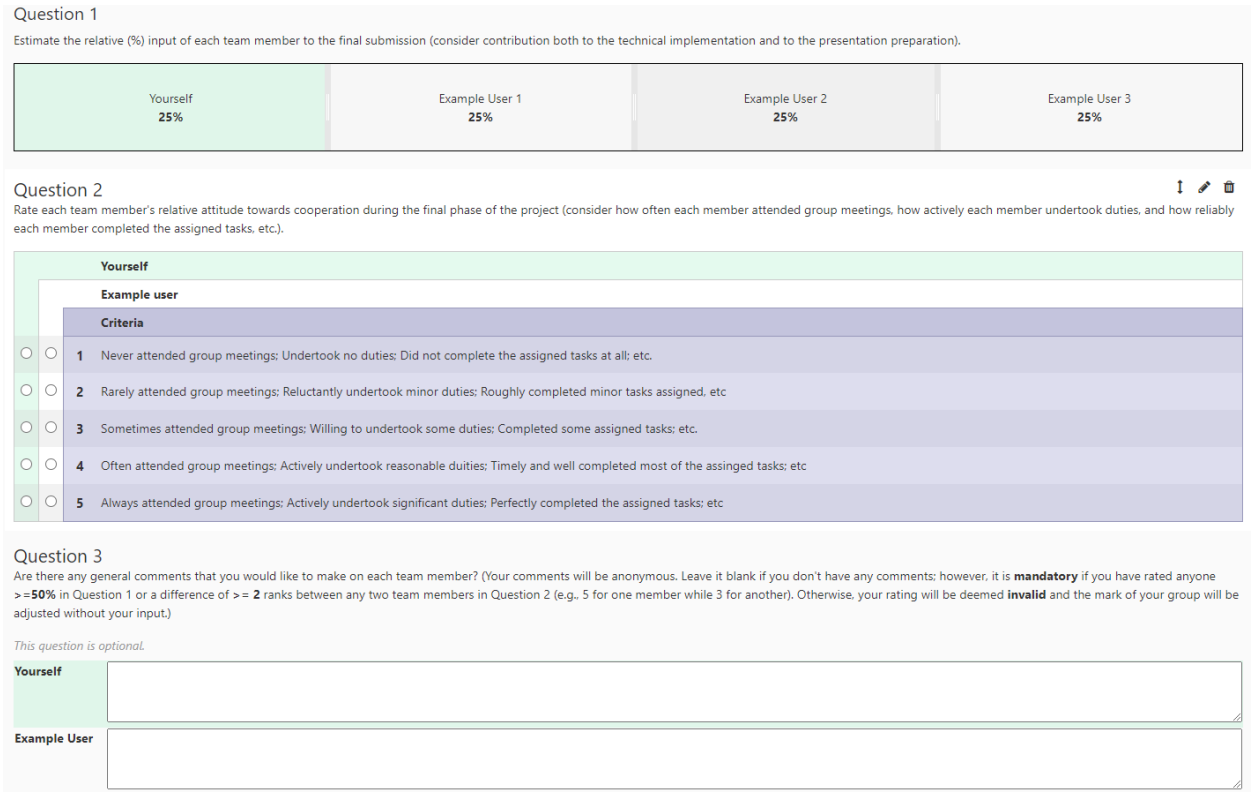
Your group submission will be assessed mainly based on the video presentation by using the following criteria (your submitted source files may also be checked to validate the claimed features/help evaluate the depth of the work):

Task	Description	Marking (0-5)		
1	Collect, compare, and analyse the solutions to the previous assignments, improve the solutions, and integrate them into an integral project (35~~20~~%)	5	Accomplished	Collected the solutions of all the members, performed thorough comparison and analysis in breadth and depth, resulting in substantial improvements; Solutions to the three modules are perfect/substantially improved; Excellent integration into an integral project
		4	Distinguished	Collected the solutions of all the members, performed good comparison and analysis from multiple perspectives and/or at different levels, resulting in good improvements; Solutions to the three modules are in high quality/well improved; smooth integration into a complete project
		3	Solid	Collected the solutions of all the members, performed some comparison and analysis, leading to some improvements; Good combination of the three modules developed in the previous phases with some smooth connection and improvements
		2	Adequate	Collected the solutions of all the members but performed little to no comparison or analysis, leading to few to no improvements; Simple combination of the three modules developed in the previous phases without any smooth connection or improvements
		1	Deficient	Collected the solutions of some members but performed little to no comparison or analysis, leading to few to no improvements; Separate demonstration of some of the three modules

		0	Not addressed	No evidence of collecting, comparing, or analysing the solutions of all the members; No demonstration of any of the modules
2	Develop more capabilities of the robot and the vision program (3540%)	5	Accomplished	Outstanding development of new capabilities showing creativity and mastery of knowledge and skills in robot design
		4	Distinguished	Excellent development of new capabilities showing a good application of knowledge and skills in robot design
		3	Solid	Evident efforts in developing new capabilities with a good demonstration
		2	Adequate	Some efforts in developing new capabilities with an adequate demonstration
		1	Deficient	Few efforts in developing new capabilities with little to no demonstration
		0	Not addressed	No evidence of attempt in developing new capabilities
3	Prepare a video presentation to demonstrate your final group project (3040%)	5	Accomplished	A clear and logical structure; straightforward to understand; excellent language style; engaging and helpful visual aids; obvious evidence of group effort; perfect use of time
		4	Distinguished	A good structure; easy to understand; reasonable choice of language style; helpful visual aids; good evidence of group effort; good use of time
		3	Solid	Reasonably easy to understand; some issues with language usage but does not affect comprehension; adequate use of visual aids; adequate evidence of group effort, fair use of time
		2	Adequate	An adequate structure; adequate choice of language style; some use of visual aids but not very helpful; occasional evidence of group effort; a bit short/long
		1	Deficient	Poorly structured; inappropriate language style (e.g., too informal); little to no use of visual aids; little to no evidence of group effort; too short/long
		0	Not addressed	No presentation submitted; presentation not relevant

5.3. Team Evaluation

There will be a "team evaluation" at the end of this phase, when you will be asked the following questions after your submission. You will rate each team member's attitude towards cooperation and contribution to the final project. 50% of your mark for the final phase will be adjusted based on the team evaluation results of Questions 1 and 2.



Question 1

Estimate the relative (%) input of each team member to the final submission (consider contribution both to the technical implementation and to the presentation preparation).

Yourself	Example User 1	Example User 2	Example User 3
25%	25%	25%	25%

Question 2

Rate each team member's relative attitude towards cooperation during the final phase of the project (consider how often each member attended group meetings, how actively each member undertook duties, and how reliably each member completed the assigned tasks, etc.).

		Yourself	
		Example user	
		Criteria	
○	○	1	Never attended group meetings; Undertook no duties; Did not complete the assigned tasks at all; etc.
○	○	2	Rarely attended group meetings; Reluctantly undertook minor duties; Roughly completed minor tasks assigned, etc
○	○	3	Sometimes attended group meetings; Willing to undertook some duties; Completed some assigned tasks; etc.
○	○	4	Often attended group meetings; Actively undertook reasonable duities; Timely and well completed most of the assinged tasks; etc
○	○	5	Always attended group meetings; Actively undertook significant duties; Perfectly completed the assigned tasks; etc

Question 3

Are there any general comments that you would like to make on each team member? (Your comments will be anonymous. Leave it blank if you don't have any comments; however, it is **mandatory** if you have rated anyone **>=50%** in Question 1 or a difference of **>= 2** ranks between any two team members in Question 2 (e.g., 5 for one member while 3 for another). Otherwise, your rating will be deemed **invalid** and the mark of your group will be adjusted without your input.)

This question is optional.

Yourself	
Example User	

Note 1: You must complete the team evaluation even if you would vote everyone the same; otherwise, your results will be adjusted without your input. **10% penalty will be applied if you don't complete the team evaluation.**

Note 2: Question 3 is optional; however, if you have rated anyone >= 50% in Question 1 or a difference of >= 2 ranks between any two team members in Question 2 (e.g., 5 for one member while 3 for another), you must complete Question 3. Otherwise, your rating will be deemed invalid, and your marks will be adjusted without your input.

5.4. Deadline

The submission deadline is 23:59 AEST 19 August 2022 (Friday Week 12).

An extension is available based on the completion rate of the **myExperience** survey, which will close on 23:59 AEST 11th August 2022 (Thursday Week 11). Every 2% of completion will extend the deadline by 1 hour. For example, if the final completion rate is 48%, the deadline will be extended to 23:59 AEST 20 August 2022 (24 hours); if the final completion rate is 100%, the deadline will be extended to 01:59 AEST 22 August 2022 (50 hours).

We will apply a university-wide late policy that has been specified by UNSW and MME (refer to the course outline):

Late policy

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For example:

- Your course has an assessment task worth a total of 100 marks.
- You submit the assessment 2 days (or part thereof) late (i.e. from 24-48 hours after the deadline).
- The submission is graded and awarded a mark of 65/100.
- A late penalty of 10 marks is deducted from your awarded mark (2 days @ 5% of 100 marks).
- Your adjusted final score is 55/100.

Note the 5% penalty will be multiplied by the maximum possible mark and applied directly to the **awarded mark** (refer to the example).

Students are expected to manage their time to meet deadlines or request extensions (apply for special consideration) as early as possible before the deadline.

Submissions late for more than one day will not be eligible for an award (if any).

5.5. Progress check

Your group will have your progress checked with your demonstrator in a 5 min meeting in your Week 10 workshop session.

Your group is expected to have started discussions before coming to the workshop session.

To pass the progress check, your group must demonstrate that you have had at least one group meeting, a clear plan for the project, a reasonable allocation of the tasks to each team member, and a name for your team (your tutor will note down this information).

It is expected that all the team members are present in the demonstration. If it is not possible, at least one member should be present, and all the other members should email the demonstrator to confirm the information above.

You should also report any issues you have perceived regarding your group to your demonstrator, either during the meeting or privately after the meeting, so that the teaching team can intervene timely.

The progress check makes up 1% of the overall course mark (included in the 18%).

All progress checks should be completed before the end of the scheduled workshop session. The late submission policy does not apply to progress checks.

5.6. Plagiarism

You would get zero marks for the assignment if you were found:

- Knowingly providing your work to anyone and it was subsequently submitted (by anyone), or
- Copying or submitting any other persons' work, including code from previous students of this course (except general public open-source libraries/code, for which you should explicitly cite the source wherever applicable).

Your teammates' individual marks will not be directly reduced if they did not participate in the misconduct.

You will be notified and allowed to justify your case before such a penalty is applied. Your team will also be informed about the outcome.

6. Additional Resources:

- Turn your presentation into a video:
  - https://support.office.com/en-us/article/turn-your-presentation-into-a-video-c140551f-cb37-4818-b5d4-3e30815c3e83
- How to Make a Video in PowerPoint - ppt to video:
  - https://www.youtube.com/watch?v=D8JV3w4TOVw
- Webot's Command Line Arguments:
  - https://cyberbotics.com/doc/guide/starting-webots#command-line-arguments
- Executing command prompt arguments in Python:
  - https://stackabuse.com/executing-shell-commands-with-python/