MTRN4110 20T2 Project Phase D Task Descriptions (week 10-11)

(Updated 02/08/2020)

Changelog

- 02/08: Changes made to the examples of new capabilities in Section 3.3; Changes made to the weight of Task 1 and 3 in Section 5.2; Added more details about team evaluation in Section 5.3; Added more details about progress check in Section 5.4
- 31/05: First release

1. Overview of the Course Project:

The main project of MTRN4110 20T2 is a simulation-based project adapted from the Micromouse competition. Webots will be used as the simulation platform throughout the course. 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 55% to your final mark of this course.

The project consists of four sequential phases:

- Phase A: Driving and Perception (week 1-3, 15%, individual)
- Phase B: Path Planning (week 4-6, 15%, individual)
- Phase C: Vision (week 7-9, 15%, individual)
- Phase D: Integration and Improvement (week 10-11, 10%, group)

This document will describe the tasks of Phase D.

2. Overview of Phase D – Integration and Improvement:

The purpose of Phase D is to integrate the three modules developed in the previous phases (Driving and Perception, Path Planning, and Vision) to 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 the end of week 11.

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;
- attempt more tasks to endow the program of your group with more capabilities;
- prepare a video presentation of 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 Descriptions:

The completion of the tasks of this phase will be a group effort. You will be randomly assigned to a group of three (or 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:

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

There could be different approaches to addressing the same tasks. By comparing the solutions of your group members, you should recognise different possibilities, analyse the pros and cons of each approach, 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, e.g., in terms of 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.

You should outline this process in your final video presentation.

3.2. Improve the solutions and combine them into an integral project:

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 an image of a maze with a robot in it and extract a map out of the image
- 3.2.2. generate an optimal path plan from the map using a planning algorithm in Webots
- 3.2.3. execute the path plan in Webots and demonstrate the robot moving from the initial state to the centre of the maze

Task 3.2.1 can be completed with Python/MATLAB and Task 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 the three tasks is expected. Refer to Section 6 for resources that may help with this.

You should demonstrate the process in your final video presentation (you could show the execution of the program at a higher speed than real-time).

3.3. Develop more capabilities for the robot and the vision program:

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

This is an open task 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 (potential difficulty level: 1-low, 2-medium, 3-high):

- Replace the E-puck robot with a new one (either provided by Webots or developed by your own) which exhibits different features 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 the onboard sensors, as an alternative to Task 3.2.1 (2-3);
- Include trajectory planning, e.g., Bang-Bang trajectory in Task 3.2.3 (1-2);
- Include obstacle avoidance in Task 3.2.3 (e.g., automatically bypass unknown obstacle blocks in some cells along the path) (1-2);
- 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 the 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);
- …

You should show the new capabilities separately from the demonstration of the primary tasks in 3.2 in the final video. You can try one or more tasks (example tasks or tasks proposed by you); your mark for this part will be assessed based on the number and difficulty level of the tasks attempted and how well the tasks are addressed.

3.4. 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 no longer than 6 mins.

The presentation should cover:

- your comparison and analysis of the solutions to the first three phases from ALL the team members and the improvements finally made;
- 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).

3.5. Task summary:

Task	Description
1	Collect, compare, and analyse the solutions to the previous assignments
2	Improve the solutions and combine them into an integral project
3	Develop more capabilities of the robot and the vision program
4	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. avoid unnecessary animations
    e. speed up playback of video where appropriate to save time for other parts
    f. show confidence
    g. show teamwork
3. Team collaboration means not only your contribution finally incorporated in the product, but also, and sometimes more importantly, your attitude towards cooperation.
4. Contribution can be to the technical implementation but also to the presentation preparation.

5. Assessment:

5.1. Submission of your work

You should zip your project and rename 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.

5.2. Marking criteria:

This assignment will contribute 10% to your final mark.

Your group submission will be assessed mainly based on the video presentation by using the following criteria:

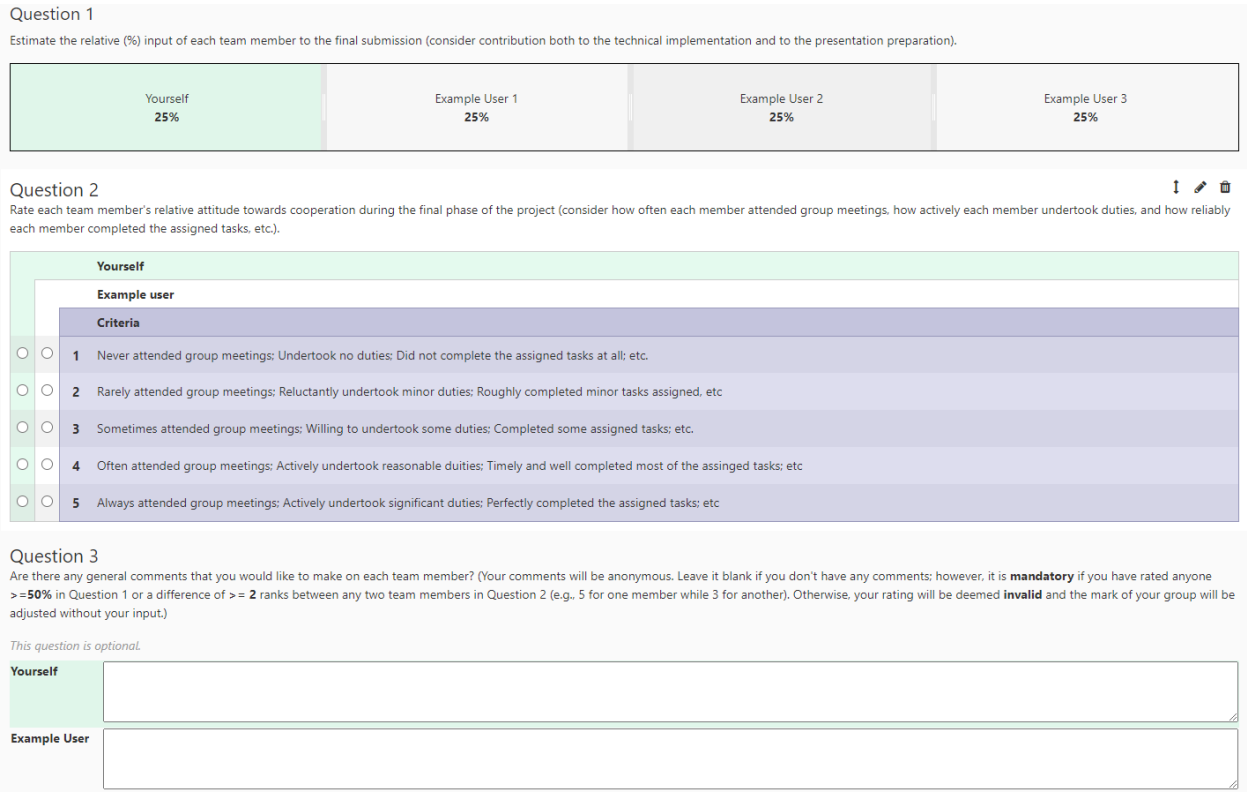
Task	Description	Marking (0-5)		
1	Collect, compare, and analyse the solutions to the previous assignments (15%)	5	Accomplished	Collected the solutions of all the members, performed thorough comparison and analysis in breadth and depth, resulting in substantial improvements
		4	Distinguished	Collected the solutions of all the members, performed good comparison and analysis

				from multiple perspectives and/or at different levels, resulting in good improvements
		3	Solid	Collected the solutions of all the members, performed some comparison and analysis, leading to some improvements
		2	Adequate	Collected the solutions of all the members but performed little/no comparison or analysis, leading to little/no improvements
		1	Deficient	Collected the solutions of some members but performed little/no comparison or analysis, leading to little/no improvements
		0	Not addressed	No evidence of collecting, comparing, or analysing the solutions of all the members
2	Improve the solutions and integrate them into an integral project (20%)	5	Accomplished	Solutions to the three modules are perfect/substantially improved; Excellent integration into an integral project
		4	Distinguished	Solutions to the three modules are in high quality/well improved; smooth integration into a complete project
		3	Solid	Good combination of the three modules developed in the previous phases with some smooth connection and improvements
		2	Adequate	Simple combination of the three modules developed in the previous phases without any smooth connection or improvements
		1	Deficient	Separate demonstration of some of the three modules
		0	Not addressed	No demonstration of any of the modules
3	Develop more capabilities of the robot and the vision program (35%)	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 good application of knowledge and skills in robot design
		3	Solid	Clear efforts in developing new capabilities with good demonstration
		2	Adequate	Some efforts in developing new capabilities with adequate demonstration
		1	Deficient	Few efforts in developing new capabilities with little demonstration
		0	Not addressed	No evidence of attempt in developing new capabilities
4	Prepare a video presentation to demonstrate your final group project	5	Accomplished	A clear and logical structure; very easy to understand; excellent language style; engaging and helpful visual aids; very clear evidence of group effort; perfect use of time

	(30%)	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, adequate use of time
		2	Adequate	An adequate structure; adequate choice of language style; some use of visual aids but not very helpful; little evidence of group effort; a bit short/long
		1	Deficient	Poorly structured; inappropriate language style (e.g., too informal); little/no use of visual aids; little/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. You will be asked the following questions after your submission. You will be able to rate each team member's attitude towards corporation and contribution to the final project. 50% of your mark for the final phase will be adjusted based on the team evaluation results of Question 1 and 2.



Note 1: You should complete the team evaluation even if you are going to vote everyone the same; otherwise your results will be adjusted without your own input.

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 17:00 AEST 16 August 2020 (Sunday Week 11).

If your assignment is submitted after this date, each 1 hour it is late reduces the maximum mark it can achieve by 1%. For example if an assignment worth 74% were submitted 10 hours late, the late submission would have no effect. If the same assignment were submitted 30 hours late, it would be awarded 70%, the maximum mark it can achieve at that time.

5.5. Progress check

Your group will have your progress checked with your demonstrator in a 5 min meeting on the afternoon of Thursday Week 10 (or another time on weekdays Week 10 by appointment).

To pass the progress check, you must demonstrate that your group has 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.

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.

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/