

Computer Systems Design Lab

SYSC 4805 (Fall 2023)

Instructor: Mahmoud Sayed

Carleton University

Department of Systems and Computer Engineering

Project Description

Autonomous Snowplow

The task of your robot is to clear the snow off an area enclosed by a closed black path. The area will contain some fixed obstacles and some moving obstacles. The robot is required to complete its task without hitting obstacles. In our indoor testing arena, the black path is a black painter's tape, the obstacles are boxes and possibly other moving robots, and the snow is simulated with lightweight wooden cubes.

You should build your robot while considering the following specifications.

- The area of the testing space is roughly 6 m². This can be a square space of almost 2.5 x 2.5 meters, or any rectangular space of a similar area.
- The snow is represented by lightweight wooden cubes with side length of 20 mm.
- The maximum robot size: Width x Length x Height = 226 x 262 x 150 mm. Given that the actual robot is 176 x 232 x 79.5, this means that the plow can extend in width by a maximum of 50 mm (25 mm in each direction), and extend in length by a maximum of 30 mm.
- The use of a plow is optional, but strongly recommended. You have to design a unique plow for your robot to control pushing the snow cubes in the desired direction to eventually push the snow outside the highlighted perimeter.
- The robot can only start from a corner inside the perimeter, aligned with one edge of the perimeter.
- The maximum allowable robot speed is 30 cm/s.
- The maximum allowed operation time to clear the snow is 5 minutes.
- Penalties:
 - o Going beyond the maximum robot size deducts 20 cubes.
 - o A small hit to an obstacle, which does not move the obstacle, deducts 5 cubes.
 - o A strong hit to an obstacle, which pushes an obstacle away, deducts 10 cubes.
 - o Wheels going outside the boundary by more than 5 cm, deducts 5 cubes.
 - o Touching the robot for any reason (adjust or reset) deducts 10 cubes.
 - o Going beyond the allowable speed for any time during the test deducts a one-time 10 cubes.
- To improve modularity, the function handlers of at least three sensors must be submitted to GitHub repository as part of the progress report. These functions can't be modified or updated beyond this point.
- Lab 5 and Lab 6 should be utilized to prepare the project proposal. Lab 12 for demonstration. Hence, the actual development time is 5 labs (Lab 7 to Lab 11). Each team should assign a

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unique activity per member per week. **A team with 3 members should have 15 unique activities. A team with 4 members should have 20 unique activities.**

- No development is allowed on Lab 12 itself (Dec. 1 and Dec.2). This lab time is dedicated for testing and evaluation.
- The order of testing will be randomized, during the lab time.
- Development should use the distributed version control system GitHub.

<https://classroom.github.com/a/ER-CTlzy> (One member of each team creates a group, then the remaining group members join the group).

The team will be graded based on the number of snow cubes pushed out of the arena - penalties.

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Project Proposal (Due by Tuesday, October 17 @ 11:59 pm):

One document per team, maximum of **15 pages**, uploaded to Brightspace.

- (20%) Project Charter.
 - o Give your team a name from the list of colors:
[https://en.wikipedia.org/wiki/List_of_colors_\(compact\)](https://en.wikipedia.org/wiki/List_of_colors_(compact))
 - o (10%) Overall objective (one paragraph approx. 200 words).
 - o (10%) Overall deliverables (Milestone deliverables, and final deliverables).
- (40%) Scope:
 - o (10%) A list of requirements, following the requirement language (precise engineering requirements).
 - o (10%) A list of detailed deliverables that cover all the requirements, organized in a WBS.
 - o (10%) A list of activities that covers all the deliverables in the WBS.
 - o (10%) Testing Plan: a set of testing that covers all the requirements (success criteria).
- (20%) Schedule:
 - o (10%) Schedule Network Diagram (connect the activities with respect to dependency and time).
 - o (10%) A Gantt chart over the remaining labs with activities, milestones and contingencies.
- (10%) Cost:
 - o (10%) Cost Baseline figure (Assume 50\$/hour/developer + Course kit of \$500).
- (10%) Human Resources
 - o (10%) Responsibility Assignment Matrix (for each activity, assign one responsible and one approver).

Progress Report (Due by Tuesday, November 14 @ 11:59 pm):

One document per team, maximum of **20 pages**, uploaded to Brightspace and your GitHub repository. The progress report should include all the information in the project proposal, plus:

- o (40%) Update the Project Proposal document, addressing all the raised concerns.
- o (10%) The overall Architecture of your system.
- o (10%) Statechart of the overall system.
- o (10%) A sequence diagram (or diagrams).
- o (10%) Demonstrate the use of a watchdog timer.
- o (10%) An updated Planned Value Analysis figure.
- o (10%) A working code on the GitHub repository with 3 committed activities per student.

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Final Report (Due by Friday, December 8 @ 11:59 pm)

One document per team, no maximum length. The final report should include all the information in the progress report, plus:

- (25%) Update the Project Proposal document to incorporate comments and include any changes. Clearly identify the contribution of each member.
- (25%) Control Chart(s) with at least 5 runs per requirement.
- (25%) Results of system testing, happening in Lab 11, in addition to the customer testing on Lab 12.
- (25%) A complete, well-commented working code on your GitHub repository.
- Upload the report to your GitHub repository to have a complete project repository.
- Export the Git Repository to a .zip file.
- Upload both the report and the .zip file to Brightspace, for department purposes and bookkeeping.

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In-Lecture Presentation (During the last four lectures)

Each team gets 15 mins (13 mins presentation + 2 mins for questions).

Slides are to be uploaded on Brightspace at the time.

- Lecture 10, Nov. 16: L2 Groups 1 to 5. (5 groups)
- Lecture 11, Nov. 23: L2 Groups 6 to 10 (5 groups)
- Lecture 12, Nov. 30: L3 Groups 2 to 6 (5 groups)
- Lecture 13, Dec. 7: L3 Groups 7 to 12 (6 groups)

The grading rubric of the in-lecture presentation is as follows:

PRESENTATION COMPONENTS		SCORES		
Introduction	Got attention? Provided a preview of presentation?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Preparation	Preparation apparent? Practice apparent? Members equally well prepared?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Organization	Good organization? Easy to follow?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Creativity	Did the group show creative thinking/innovation in the method of development and in the presentation?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Technical aspects	Innovative solutions? Justification of choices?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Project objectives	Clear and complete explanations?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Presentation style and delivery	Language appropriate and clear? Members know their material or read notes? Use appropriate volume, body language (posture, gestures, etc.)?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Visual Aids	Usefulness? Appearance (Professional look, fonts large enough)?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Conclusion	Ended with summary?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Overall team cohesiveness	Connected to each other? Attentive when group member spoke? Met time requirements?	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No

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In-Lab Demonstration

Two testing arenas will be set up in the lab. The entire lab (Lab 12) will be dedicated to testing. No further development is allowed in Lab 12.

Each team gets 15 mins (10 demo + 5 code review).

The grade will be mainly based **on the number of snow cubes cleared off the perimeter – penalty points**, in addition to the following grading rubric:

DEMONSTRATION		SCORES		
Functionality	The implementation works.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
	The implementation is robust and reliable.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
	The implementation is accurate with respect to the project plan. If changes were brought to the plan, students are able to justify the rationale.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Quality	The code is well organized and commented.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
	The implementation considers multiple factors (i.e. performance, health/safety, usability, aesthetics, reusability, expandability, and efficiency).	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
	Team members indicate clearly the source of the software they make use of and acknowledge that the code use from others cannot count for more than 25% of the code in their project.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
	The students show proof of appropriate testing performed.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Utility	Implementation fulfills purpose or design intent.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Explanations	Team members are able to answer general questions about their solution.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
	Team members are capable to reply point/very specific questions about their solution.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No
Extras	The implementation goes beyond minimum requirements. Innovative solutions are used to solve the problem and/or the project makes use of additional components and their impact is justified and demonstrated.	<input type="checkbox"/> Yes	<input type="checkbox"/> Partially	<input type="checkbox"/> No