CG2111A Engineering Principle and Practice II

Semester 2 2023/2024

Project Specification: Alex to the Rescue

Background

72 hours. That is the "golden period" to locate and rescue survivors in the aftermath of natural/manmade disasters like earthquake, landslide, terrorist attack etc. Against the ticking clock, rescuers have to brave incredible difficulties like rubbles / debris, narrow / impassable passages and/or hazardous environment to look for any sign of life. Fortunately, recent robotic advancement opens up many new possibilities for the rescue team.

Alex to the Rescue!

You are going to build a robotic vehicle, **Alex**, with search and rescue functionalities. Although we would love to test your Alex in a real setting, we have to make do with a simulated environment for obvious reasons. Below is a summarized evaluation setup and functionality requirements.

You may draw some additional components from the Lab Technicians, like ultrasonic sensors or infrared sensors, **subject to availability.**

Simulated Environment
A room filled with various obstacles like tables, chairs, boxes, etc, through which you must pilot Alex to find two or more victims. Victims are either “green” – healthy but trapped, or “red” – Injured and trapped. Your task is to locate all victims within a 6-minute window. There may be other similar objects of different colors. These are not victims and should not be identified as such. **There will be at least one clear path for Alex to navigate from the starting room to the last room.**

Main Functionality – Environment Mapping – 80%

Alex will be **tele-operated** (i.e. remote controlled) from your laptop. An environment map will be relayed to the operator throughout the operation. The operator can then use the map to navigate the simulated environment **manually**. In its simplest form, you will communicate with a master control program (**MCP**) on the Pi. The MCP will in turn translate your commands into actual movement control signals for the connected Arduino board.

Minimally, Alex must be able to carry out the following commands:

a. **Go straight** (you can define how far / how long, speed control etc).
b. **Turn left / right** (you can define the turning angle or the compass direction).
c. **Identify object**** (see more in "additional functionality" section below).

You can implement additional commands as you see fit.

During the evaluation, you have to manually take note of the environment mapped out by Alex. This "map" will be submitted at the end of your evaluation.

Evaluation stops as soon as Alex explored and mapped the entire arena **OR** the time limit is up. Exact time limit will be announced nearer to the final evaluation.

Evaluation Criteria:

- Time taken. (Shorter == Better)
- Obstacle / Wall hit during navigation. (Less hit == Better)
- Completeness of the environment map. (More complete == Better)
- Accuracy of the room layout. Total length and breadth of the simulated rescue space (demarcated by four sets of boxes), and position of all the obstacles. (More accurate == Better)

The main functionality contributes **80%** of the overall project score. As long as your Alex manages to complete this phase, **your team is guaranteed a passing grade** for the project component.

Additional Functionality – 20%

There are two additional functionalities worth 20% in total. You may use your $25 budget to purchase parts for more added functionalities.

You are given $25 per team to buy sensors, actuators and other toys to attach to Alex. To ensure a level playing field where personal wealth and resources are not a factor, you are only permitted to put on Alex something bought out of this budget. Personal items are not allowed. You must provide a claim form with receipts for all items on Alex, and the total must not exceed $25. Not even by a single cent. Note the restrictions in the "Hints, tips and information" section that follows. Please keep your receipts!!

Any item placed on Alex during the trial and final evaluations that is not purchased from this $25 must be removed and the team will be penalized by 20 marks.

[**A. "Miss Scarlet" is alive!**] There are 2-3 regular shaped (e.g. cube, cylinder), **of colors other than red or green,** objects scattered throughout the rooms. These objects are at least ~18cm tall. Alex is supposed to figure out the **colour** of these objects during the main evaluation, i.e. the operator should send an "identify object" command when such objects are detected during navigation. The process of determining the colour must be performed remotely i.e. the result must be determined by Alex alone and relayed back to the operator for recording purpose. **Cameras are not allowed.** This functionality is **open ended**, i.e. your group have to come up with your own hardware + software solution as long as the "remote processing" criteria is respected. The lightning condition, if critical to your solution, should be part of your solution (e.g. have additional LEDs to provide sufficient light). **(This functionality is worth 10%)**

[B. "Alex" is awesome!] What other cool things can you make Alex do with some additional components (subject to availability) and imagination? You may make use of the equipment at Makers@SoC to spice Alex up. You must pass the Safety Course before using Makers@SoC **(This functionality is worth 10%)**

Evaluation Criteria:

- Accuracy of the colour of the objects.
- Coolness of your Alex.

Hints, Tips and Information:

1. You will work in teams of 3 or 4.
2. **A peer review will be conducted at the end of the project and students who are scored poorly by their teammates will have marks deducted, while students who are given exceptionally high scores by their teammates will be given bonus marks.**
3. Note the following restrictions:
   - You are NOT ALLOWED to swap out any standard item that was issued to you. For example, you cannot substitute in new motors, new wheels, a different power bank, a different battery pack, a different LIDAR, etc.
   - **You are strictly not allowed to add in a camera.**
4. Most of the components (hardware and software) needed for main evaluation will have been covered in the studio sessions by week 9. For the "additional functionality", they are more open ended and require you to explore further than the basic coverage of CG1111A/CG2111A.
5. Alex may need to move **slowly** for mapping purpose. Focus on movement steadiness and accuracy. You will have a clearer picture (pun not intended) after the Lidar / SLAM studios.
6. The entire evaluation is going to take about **5-6 minutes**. Due to the length of the evaluation, it is unlikely that you can get more than 1 retry.

Timeline with Milestones:

Date	Milestones / Submssions
Week 10 31 March 2024 2359 hours	Design report submission. [Constitute **10%** to your CA)
Week 11 End of week.	Design Report Feedback – comments provided in writing to team leaders, taken to be the first person listed in the team list.
Week 13 Studio 1	Trial Run (Graded – 10% of CA)
Week 13 Studio 2	Final Demo (Graded – 20% of CA)
Reading Week Friday 2359	Final report due (Graded – 10% of CA)

The report template for the final report will be given by week 11, demo timeslots will be given by week 12.