CG1112 Engineering Principle and Practice II

Semester 2 2020/2021

Project Specification: Alex to the Rescue

[REGULAR SPECIFICATION]

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 will be given a $100 budget to enhance Alex, subject to the rules at the end of this document.

Simulated Environment
An area of about 3m^2 in dimension. The configurable "Maze Table" from EPP I will be used as the "outer walls" of the simulated environment. In addition, cardboards, boxes and other materials will be used as simulated obstructions / walls. The obstructions and walls will be at least as tall as the typical Lidar mounting height of ~18cm. Tentatively, the simulated environment will consists of 2–4 "rooms". Each room is guaranteed to have **at least one entrance / exit**. **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. Outer wall dimension (i.e. how wide is the wall) for each room should be estimated / measured by Alex and noted down. (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 $100 budget to purchase parts for more added functionalities.

[**A. "Miss Scarlet" is alive!**] There are 2□3 regular shaped (e.g. cube, cylinder), **either red or green,** objects scattered throughout the rooms. These objects are at least as tall as the outer wall (i.e. ~18cm). 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 (Red or Green) must be determined by Alex alone and relayed back to the operator for recording purpose. 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). **(Tentatively: this functionality is worth 10%)**

[**B. "Alex" is green!**] The (average) power consumption of the Alex will be evaluated. You have to find ways to reduce the power consumption of Arduino + Pi + Lidar during the entire evaluation. We will supply a power measurement dongle to measure
consumption from the power bank. **(Tentatively: this functionality is worth 5%)**

[C. “Alex” is awesome!] What other cool things can you make Alex do with $100? **(Tentatively: this is worth 5%)**

Evaluation Criteria:

- Accuracy of the colour of the objects.
- Power consumption of Alex

Hints, Tips and Information:

1. You will work in teams of 4.
2. You can use up to $100 per team to enhance Alex. The usage is subject to the following conditions:
   a. It is strictly on a reimbursement basis. You will pay for the parts first and submit a claim at the end of the semester. Please ensure that you keep all receipts. **You will not be able to claim without receipts.**
   b. You can only purchase from suppliers in Singapore, like SGBotics or Element14. Do not purchase from suppliers outside of Singapore. Doing so will void your claims.
   c. You can only add additional items to Alex that are not originally provided. You CANNOT change the core components that you have been provided with. I.e. you cannot change the chassis, motors, Arduino, Raspberry Pi, power bank, wheel encoder, LIDAR, motor driver, Eneloop batteries, etc.
   d. You CANNOT add a camera of any form.
   e. You may use your own components purchased at your own expense, but subject to the rules above.
3. 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 requirement", they are more open ended and require you to explore further than the basic coverage of CG1111/CG1112.
4. 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 in week 6 and 9.
5. 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:

<table>
<tr><th>Date</th><th>Milestones / Submssions</th></tr>
<tr><td>Week 7
6th March, 2359</td><td>a. Design report submission. [Constitute 10% to your CA]
b. Setup GitHub <u>Private</u> Repository with your team name XX□YY□ZZ and add your section’s instructor as one of the members. Your section’s instructor GitHub id:
<table>
<tr><td>Monday(9am), Colin</td><td>colintan-soc</td></tr>
<tr><td>Monday(2pm), Prof. Soh</td><td>weesoh</td></tr>
<tr><td>Tuesday(9am), Ravi</td><td>raviragas</td></tr>
<tr><td>Tuesday(2pm), Boyd</td><td>boydanderson</td></tr>
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Use GitHub to do versioning and collaboration with your team. We will also use it to gauge your progress.</td></tr>
<tr><td>Week 8
Studio 1</td><td>Feedback on design report.
[CELC evaluation contributes 5% for participation]</td></tr>
<tr><td>Week 8
Tutorial Timeslot</td><td>CELC Workshop on report writing.</td></tr>
<tr><td>Week 11</td><td>Submission of Final Report Draft, 2 April 2359
[Not graded, for CELC]</td></tr>
<tr><td>Week 12
Studio 1 (Tentative)</td><td>Mock Evaluation.</td></tr>
<tr><td>Week 12
Tutorial Timeslot</td><td>CELC Workshop</td></tr>
<tr><td>Week 13
Studio 2</td><td>Final Evaluation (Demo + Presentation)
[Demo: 20%; Oral presentation 20%]</td></tr>
<tr><td>Reading Week
Saturday 17 April 2359</td><td>Final Report Due
[Constitute 10% of your CA]</td></tr>
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The report template for the final report will be given by week 9, demo timeslots will be given by week 12.