

CG2111A Engineering Principle and Practice II
Semester 2 2021/2022
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 are not given any budget for this project. However you may **OPTIONALLY** collect the following from Uncle Jalil.

1. Up to 2 ultrasonic sensors.
2. Up to 4 red or green LEDs.

You are not allowed to change any of the components given to you. That is, you must use the motors, embedded controllers, power bank, chassis, etc that is provided to you without any modifications.

Simulated Environment
<p>An area of about 3m² 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.</p> <p>Tentatively, the simulated environment will consist 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.</p>
Main Functionality – Environment Mapping – 90%
<p>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.</p> <p>Minimally, Alex must be able to carry out the following commands:</p> <ol style="list-style-type: none"> Go straight (you can define how far / how long, speed control etc). Turn left/right (you can define the turning angle or the compass direction). <p>You can implement additional commands as you see fit.</p> <p>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.</p> <p>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.</p> <p>There will be a hump in the maze that Alex must navigate over.</p> <p>Evaluation Criteria:</p> <ul style="list-style-type: none"> Time taken. 2-mark deduction for every 30 seconds or part thereof over 5 minutes, subject to a maximum of 8 minutes. Your demo will be terminated at 8 minutes. Retry Penalty: 1 mark deduction per retry. Obstacle / Wall hit during navigation. 2-mark deduction per hit. Completeness of the environment map. (More complete == more marks). Accuracy of the room layout. E.g. width of walls, etc. (More accurate == Better) .

Additional Functionality – 10%

There are two additional functionalities worth 10% in total. You may use the additional components from Uncle Jalil for this.

[A. “Alex” is Number 1 (or 2, or 3)] A sliding-scale bonus will be awarded to the top 3 best teams within a studio group in terms of completion time with minimum bumps: **(This is worth 3%)**

Team Position	Bonus
1 st	3%
2 nd	2%
3 rd	1%

[B. “Alex” is awesome!] What other cool things can you do with Alex? **(This worth 7%)**

Note: TAs and Instructors are **NOT ALLOWED** to assist you in implementing bonus portions.

Item	Bonus
Control Alex over TLS secured connection on laptop	1%
FULL bare-metal (serial, PWM, GPIO, interrupts)	3%
PARTIAL bare-metal	0.5 to 2%
Others	0.5 to 3%

Hints, Tips and Information:

1. You will work in your assigned teams of 4 or 5.
2. Most of the components (hardware and software) needed for main evaluation will have been covered in the studio sessions by week 10. For the "additional requirement", they are more open ended and require you to explore further than the basic coverage of CG1111A/CG2111A. **Teaching Assistants and Instructors are NOT ALLOWED to assist you in any way.** You are to do all research and implementation on your own.
3. Alex may need to move **slowly** for mapping purpose. Focus on movement steadiness and accuracy.
4. The entire evaluation is going to take about **4-8 minutes**. Due to the length of the

evaluation, it is unlikely that you can get more than 1 retry.

Timeline with Milestones:

Date	Milestones / Submissions
Week 12	Design report submission. [Constitutes 10% of your CA] Deadline: Friday 8 April 2022, 5 pm.
Week 13	Demo: Monday/Tuesday 11/12 April
Reading Week Tutorial Timeslot	Final report submission [Constitutes 10% of your CA] Deadline: Friday 22 April 2022, 5 pm.