**CG1112 Engineering Principle and Practice II**
Semester 2 2017/2018
**Project Specification: Vincent 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, unsafe environment to look for any sign of life. Fortunately, recent robotic advancement opens up many new possibilities for the rescue team.

## Vincent to the Rescue!

You are going to build a robotic vehicle, **Vincent**, with search and rescue functionalities. Although we would love to test your Vincent 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.

| **Simulated Environment** |
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| An area of about $8m^2$ in dimension. Cardboard boxes, boards serve as simulated obstructions / walls. The obstruction and walls will be at least as tall as the typical Lidar mounting height of ~20cm. There will be at least one clear path for Vincent to navigate from the starting point to end point. |

| **Evaluation Phase 1 – Teleoperation** |
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| Vincent will be **tele-operated** (i.e. remote controlled). An environment map, built by SLAM algorithm, will be relayed to the operator continuously. The operator can then use the map to navigate the simulated environment manually. **Tentatively,** 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.<br><br>**Minimally**, Vincent must be able to carry out the following commands:<br>a. **Go straight** (you can define how far / how long, speed control etc).<br>b. **Turn left / right** (you can define the turning angle or the compass direction).<br>c. **Mark current location**** (see more below).<br>d. **Start autonomous backtracking** (see phase 2).<br>You can implement additional commands as you see fit. |

During the evaluation, we will ask you to **mark the location** where Vincent is currently at. This should be a command sent to Vincent for it to take recording of the location as necessary. **Up to a total of 3 locations** needs to be marked during this evaluation phase. The **order of the locations** must be recorded for backtracking purpose in second evaluation phase.

Evaluation Phase 1 will stop as soon as Vincent 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.
- Obstacle / Wall hit during navigation.
- Completeness of the environment map.

**Phase 1** contributes **70%** of the overall project score. As long as your Vincent manages to complete this phase, **your team is guaranteed a passing grade** for the project component.

**Evaluation Phase 2 – Autonomous Backtracking**

Vincent will operate by itself (i.e. autonomous). Once the operator sent the "Autonomous Backtracking" command, Vincent will start to navigate back to the starting point **using the same path travelled in phase 1**. More importantly, Vincent must play a 2 seconds cue whenever it reaches one of the **marked locations.** The cue can be audio (e.g. sound clip, music) or visual (e.g. flashing LEDs, exploding Pi etc).

Evaluation Phase 2 will stop as soon as Vincent reaches the starting point **OR** the time limit is up **OR** Vincent veers off course. Exact time limit will be announced nearer to the final evaluation.

Evaluation Criteria:

- Distance of the backtracking (i.e. how far Vincent is able to backtrack).
- Number of marked location reached.
- Time taken.
- Obstacle / Wall hit during navigation.

**Phase 2** contributes **30%** of the overall project score.

Phase 1 simulates the scenario where the robotic rescuer tries to search and locate the survivor, where phase 2 simulates the scenario where robotic rescuer indicates survivors found to the human counterpart.

## Hints, Tips and Information:

1. Most of the components (hardware and software) needed for phase 1 will have been covered in the studio sessions by week 9. Phase 2 is more open ended and require you to explore further than the basic coverage of CG1111/CG1112. Ideas learned from other courses, e.g. CS1010/CS2040, EE2026 etc may be useful here.
2. Phase 1 requires Vincent to move **slowly** as the SLAM algorithm takes substantial time to build the environment map. Focus on movement steadiness and accuracy. You will have a clearer picture (pun not intended) after the Lidar / SLAM studio in week 9.
3. Vincent can go as fast as possible in phase 2. Just ensure that Vincent can backtrack properly and recognized marked locations.
4. The entire evaluation is going to take about **10 minutes** (including both phases). We will not delineate the time limit between the phases, i.e. the more you spent in one phase ➔ the lesser time you have in the other phase.

## Timeline with Milestones:

<table>
<tr><th>Date</th><th>Milestones / Submssions</th></tr>
<tr><td>Week 8<br>16th March, 2359</td><td>a. Design report submission. [Constitute 10% to your CA]<br><br>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>pbear1973</td></tr><tr><td>Monday(2pm), Uncle Soo</td><td>sooyj</td></tr><tr><td>Tuesday(2pm, Ravi</td><td>raviragas</td></tr></table>Use GitHub to do versioning and collaboration with your team. We will also use it to gauge your progress.</td></tr>
<tr><td>Week 9<br>Studio 1</td><td>Feedback on design report.</td></tr>
<tr><td>Week 9<br>Tutorial Timeslot</td><td>CELC Workshop on report writing.</td></tr>
<tr><td>Week 10<br>Both Studios</td><td>CELC Workshops on team presentation. Will use your design report as a basis for mock presentation.</td></tr>
<tr><td>Week 12<br>Studio 1 (Tentative)</td><td>Mock Evaluation.<br>Submission of final report draft [Not graded, for CELC]</td></tr>
<tr><td>Week 13<br>Studio 2</td><td>Final Evaluation (Demo + Presentation)<br>[Demo: 20%; Oral presentation 20%]</td></tr>
<tr><td>Reading Week<br>Monday</td><td>Final Report Due<br>[Constitute 10% of your CA]</td></tr>
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The report template for the final report, demo timeslots will be given by week 12.