

**CG1112 Engineering Principle and Practice**

Semester 2 2017/2018

**“Vincent to the Rescue”**

**Design Report**

**Team: 02-04-02**

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**Section 1 Introduction**

It would be good to provide some background information on search and rescue robots and their function in disaster recovery operations before discussing Vincent. This will contextualize your project and discussion.

Vincent is a robot designed to simulate a search and rescue robot that would perform disaster search-and-rescue operations in two phases. Phase 1 of the search and rescue operation is tele-operated navigation. Vincent will navigate the given environment and perform simultaneous localization and mapping of the environment using a Lidar mounted on its top, and transmit the map to its operators after the whole maze has been explored. The map is used by the tele-operator to navigate through the maze. Along its navigation, Vincent will also be able to mark up to three locations of the “victims” and store them for phase 2. Various sensors and functional units such as magnetometer, ultrasonic sensors, infrared sensors, carbon monoxide sensors, oxygen level sensor, raindrop sensors, camera and telecommunication units will be in operation to enable Vincent to sense and interact with the surrounding at any time. Phase 1 simulates the operation of exploring unknown human-unfriendly disaster-stricken environment. It involves constructing maps for subsequent rescue efforts and identifying victims as well as environment specifics as reference for rescuers to plan subsequent recovery actions.

In phase 2 of the search and rescue operation, Vincent will backtrack from its current position to its starting position using the same path travelled in phase 1. Each time Vincent reaches the locations saved in phase 1, it will play a cue as an indication that this is the previously marked location. This simulates the operation of interacting with victims after the initial exploration of the whole environment and even saving the victim in full size search and rescue robot. Vincent functions in full autonomy in phase 2, which means it only relies on sensors and data obtained in phase 1 to...

**Section 2 Review of State of the Art**

**Tele-operating search and rescue robotic platform**

**a.** The Emergency Integrated Lifesaving Lanyard (EMILY) from a US company Hydronalix is a self-propelled, remote-controlled robotic rescue boat. It is equipped with ropes and is buoyant enough to keep up to five people alive [1]. EMILY is propelled by a jet pump with inlet grates, which is powered by a battery that lasts 10km on a single charge [2]. It has a built-in Doppler sonar to avoid collisions with unsuspecting swimmers, and also has sensors that detect underwater movements to identify swimmers in distress [1].

**b.** Strength: EMILY can travel 12 times as fast as a human lifeguard (up to 48km/hr) and is able to stay straight no matter how strong the waves are [1]. It is also highly durable and easy to deploy [1].

Weakness: EMILY is unable to save unconscious swimmers [1]. It requires the guidance and control of a human to carry out rescue operation and does not support multi-language instructions (instructions are made from the lifeguards, thus limited by the languages they speak) [3].

Is this state-of-the-art? If so, mention why it is outstanding compared to other models.

**Autonomous search and rescue robotic platform**

**a.** A team of researchers at Worcester Polytechnic Institute (WPI) developed autonomous robots that are shaped like snakes [4]. The robots are made out of soft materials, providing a lot of flexibility that robots with a hard body cannot achieve. For example, soft robots are better at navigating through tight corners compared to hard robots of similar scale. The snake-like robots are made out of silicone rubber and are modularized. Each of its modules has its independent motion. On the software aspects, it is driven by high-level planning algorithms and low-level algorithms that control movements [4]. Autonomous operation of these robots is made possible by these high-level algorithms. It will make its own decision on how to get to the destination from the origin, which are the only two inputs required to be input by users.

**b.** Strength: These robots are capable of being fully autonomous, which makes them very useful in search-and-rescue operations in providing critical information on areas that are hard to be accessed by humans [4]. The soft body of these robots allows them to perform manoeuvre over various obstacles.

Weakness: These robots perform slower than the traditional robots that are mounted with wheels on a flat surface. Since the robots are made out of soft materials, the durability of the robots is to be questioned.

**Section 7 Lesson Learned - Conclusion**

**Lessons learned**

1. It is necessary to combine theory with practice and attach importance to the applications in the real world situations. For example, we should constrruct the robot model and test its functions while designing the architecture, instead of finalizing the design first before testing and simulation. The former approach is more efficient since the designers will be able to modify the structure of the robot if any inadequate settings in the design were discovered throughout the experiment.
2. When doing projects, the ideas should not be limited by the course materials. If the members could explore more information, simpler solutions to certain problems might be found. In addition, since this project results in a product with open-ended features, further exploration in related fields might contribute to the addition of extra functions in the product.

**Mistakes made**

1. Because we overlooked physically mounting the Lidar on the top of the robot and measuring the resulting height, we realized that the Lidar is too high to scan the “walls” in the test environment properly when we saw the demonstration set. We then had to revise the design.
2. We focused too much on the optimization and extra functionalities of the robot that we were eventually left with little time for the basic features such as manually controlled mapping process. Essentially, we had been trying out high-level features before completing low-level ones, which is not the optimal sequence of doing a project work.

**Reference**

[1] “EMILY to the rescue,” *The Economist*, 23-Aug-2010. [Online]. Available:

https://www.economist.com/node/16877335. [Accessed: 17-Mar-2018].

[2] “Key features,” *EMILY - Robotic Rescue Boat*. [Online]. Available: http://www.emilyrobot.com.au/key-features/. [Accessed: 17-Mar-2018].

[3] L. Silverman, “Meet Emily, The Lifeguard Robot That's Saving Refugees Crossing

The Mediterranean Sea,” *KERA News*. [Online]. Available: http://keranews.org/post/meet-emily-lifeguard-robot-thats-saving-refugees-crossing-mediterranean-sea. [Accessed: 17-Mar-2018].

[4] "Researchers developing autonomous snake-like robots to support search-and-rescue teams", *Phys.org*, 2018. [Online]. Available: https://phys.org/news/2017-10-autonomous-snake-like-robots-search-and-rescue-teams.html. [Accessed: 10- Apr- 2018].