RobotX Challenge 2022

Team

Singapore Advanced Boat

(SINGABOAT)

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1. Technical Approach and Justification

1.1. Challenge Task 1 - Entrance and Exit Gates

A set of three gates will be located in the course area with a beacon placed underwater within each gate. The AMS must detect the active underwater beacon, transit through the gate in which the active beacon is located, and then circle one of two buoys. The Beacon to be used is the Teledyne Benthos ALP-365 Pinger used in previous years.

Our proposed solution is described in the form of the flowchart as shown in Figure 1.1:

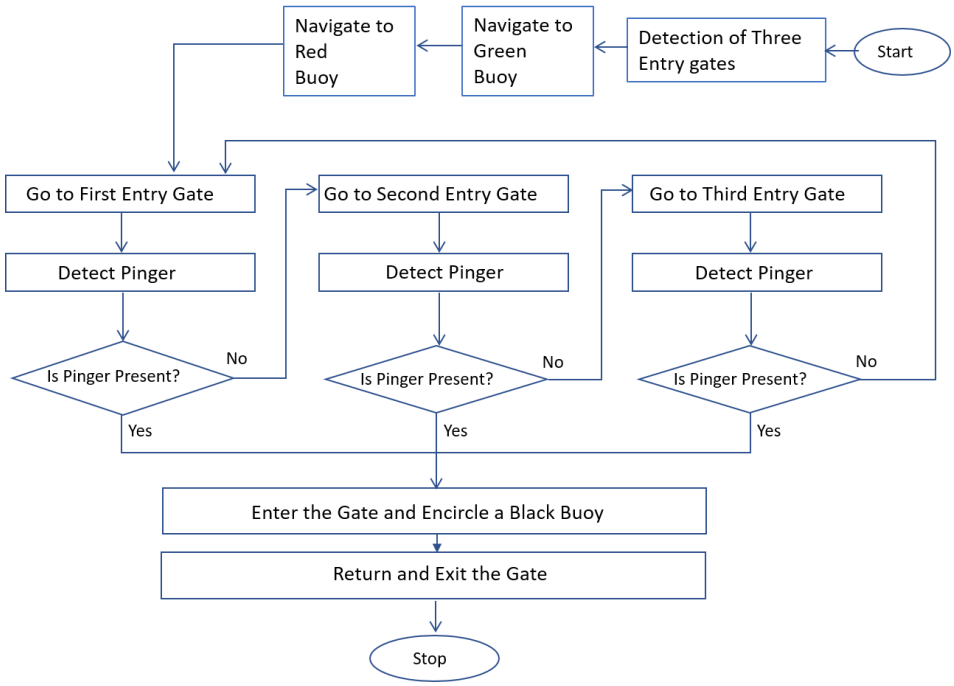

Figure 1.1

1.2. Challenge Task 2 – Follow the Path

This task is modelled after the "Traverse Navigation Channel" task from the 2019 Virtual RobotX competition. The AMS must deploy a UAV to map the challenge task, and then use this to guide the WAM-V through a path defined by sets of buoys, where each set is a pair of red/green coloured buoys. The exact buoy types may vary from what was used in the Virtual RobotX competition. Obstacles may be included within and around the path.

Our solution is described in the form of the flowchart as shown in Figure 1.2:

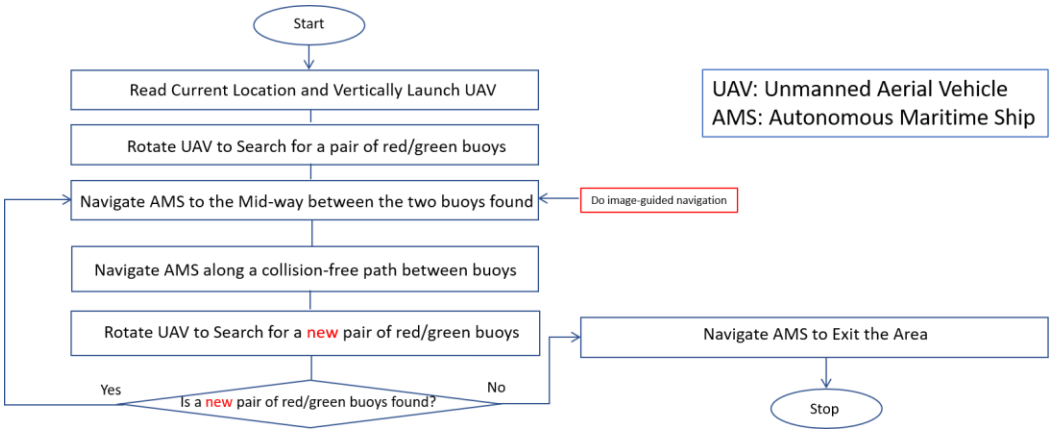

Figure 1.2

1.3. Challenge Task 3 – Wildlife Encounter and Avoid

The Wildlife Encounter and Avoid task requires the UAV to identify objects of interest and inform the WAM-V to circumnavigate the object. These objects of interest will represent Australian Marine Life such as platypi, turtles and crocodiles and will each be painted in distinct coatings with unique spectral signatures to enable identification and classification with a hyperspectral camera. To successfully circle the marine life, the AMS must transit around them until it has crossed its original path, transiting at least 360 degrees. The clockwise/counter-clockwise direction will be based on the classification of the marine life by their spectral signatures (to be developed).

Our solution is described in the form of the flowchart as shown in Figure 1.3:

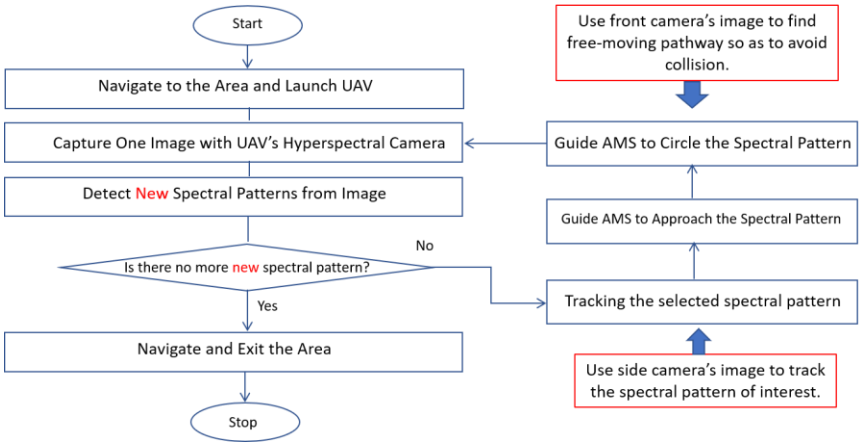

Figure 1.3

1.4. Challenge Task 4 – Scan the Code

The Scan the Code task has been a staple of the RobotX Challenge, since the inaugural event in 2014. The AMS is required to observe a light sequence displayed by an RGB buoy and report the colour pattern. The light assembly on the buoy will successively display colours one at a time to generate a sequential pattern of three colours (e.g. red-green-red).

Our proposed solution is described in the form of the flowchart as shown in Figure 1.4:

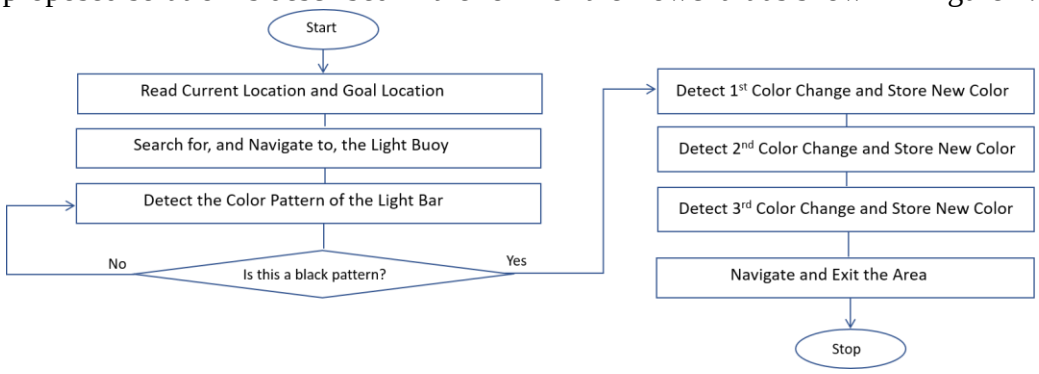

Figure 1.4

1.5. Challenge Task 5 – Dock and Deliver

For the 2022 RobotX Challenge, the docking bays will have a parallel dock configuration (similar to the 2016 RobotX Challenge). This task combines the docking task and the Detect and Delivery task from 2018 RobotX Challenge. The Dock and Delivery task will be anchored in the course. The AMS will need to dock in the bay displaying the correct coloured light. Once docked, the AMS will deliver a payload (racquetball) into one of the holes (located above the coloured light). As in previous years, there will be a smaller and a larger hole for payload delivery.

Our solution is described in the form of the flowchart as shown in Figure 1.5:

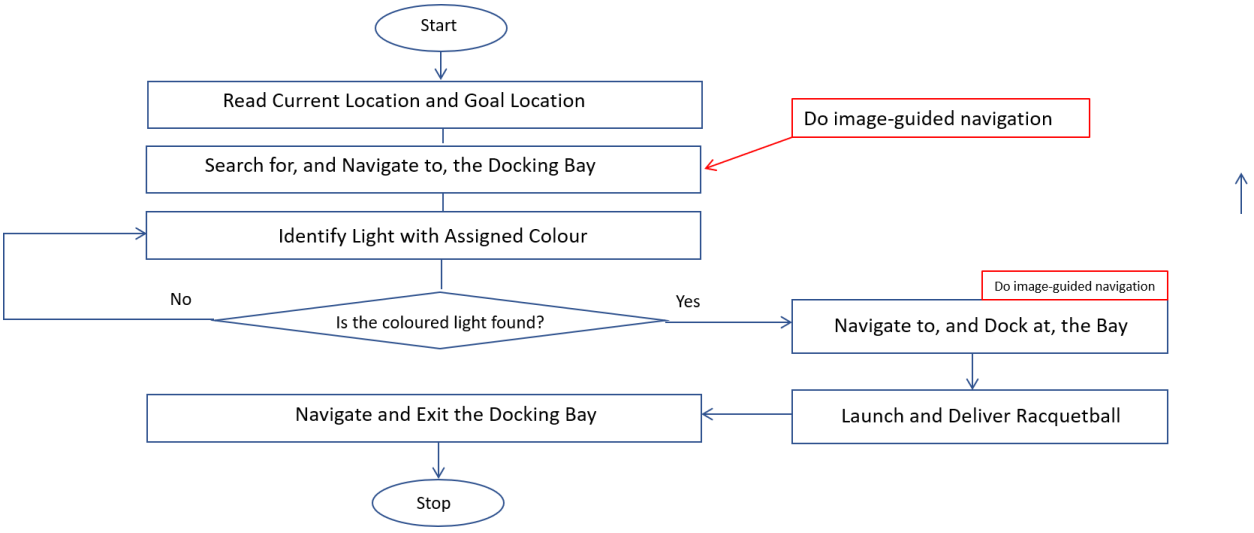

Figure 1.5

1.6. Challenge Task 6 – UAV Replenishment

This is a new task for the 2022 RobotX Challenge which will use the UAV to pick up an item from the dock and deliver it to a helipad ashore.

Our proposed solution is described in the form of the flowchart as shown in Figure 1.6:

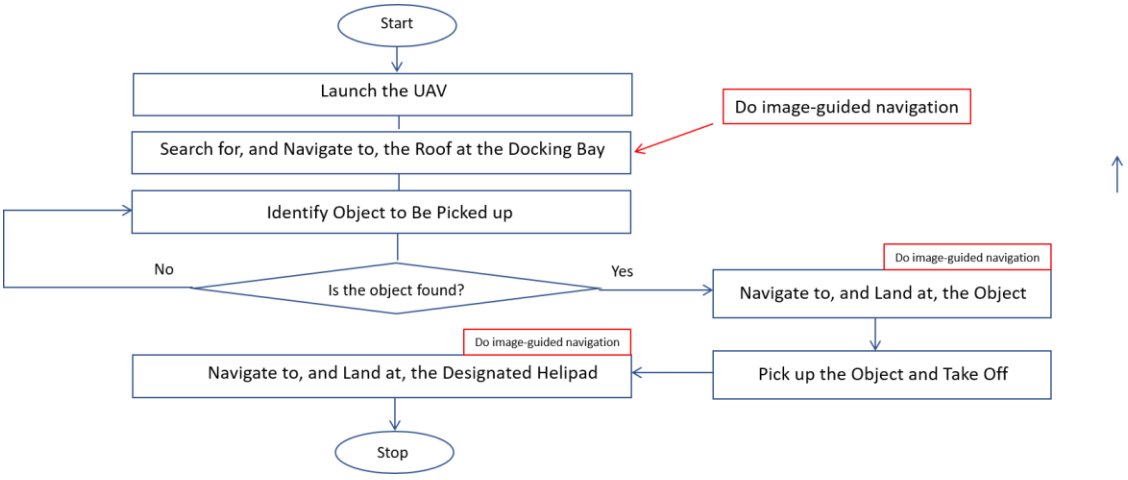

Figure 1.6

2. Team Qualifications

SINGABOAT team will consist of:

- Two faculty members (Associate Professors) who serve as technical advisors.
- Undergraduate students in their final year, who will be divided into six groups, each of which will be in charge of implementation of one task.
- Several laboratory technicians who will provide administrative and logistic supports to the team members.
- (Optional) Postgraduate students who will be assigned to the six groups.

3. Facilities

NTU's team has participated to Maritime RobotX Challenge since its inception. We have one WAM-V of the early version, on which we have deployed: a) multiple-camera vision system, b) acoustic signal sensing system, c) on-vehicle controller, d) GPS system, e) propulsion system, f) battery system, etc. Most importantly, we have implemented an early version of a software system as outlined in Figure 3, in which all the functional modules of control loops are supported.

In addition, we have obtained the permission of using the test site on sea area in Singapore, which is managed by ST Engineering Ltd. Co. (A government-linked company).

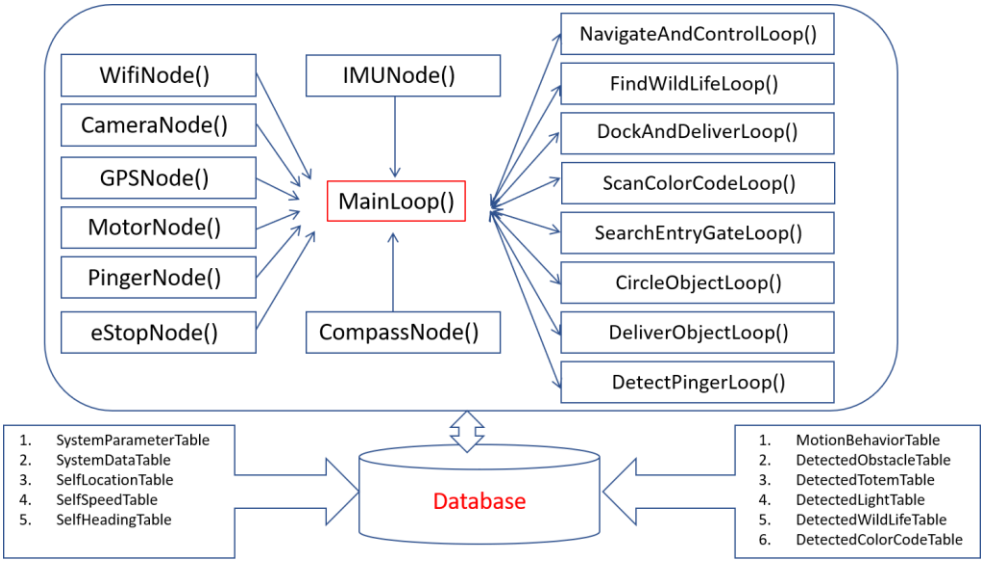

Figure 3

4. Sponsorships and Partnerships

No.	Sponsors/Partners	Contents
1	A government funding agency LIU CHEE KONG Liu_Chee_Kong@defence.gov.sg	Direct costs
2.	ST Engineering Ltd. Co. YUE Kwok Wai, Andrew yue.kwokwai.andrew@stengg.com	In kind, use of test site
3.	SCENST LLP 42 WESTWOOD CRESCENT, SINGAPORE 648762	Provide one UAV to the NTU team.

5. Management Approach

We will recruit the team members from the coming batch of final year students in our university. In particular, we will recruit undergraduate students from two schools which are: a) the School of Mechanical and Aerospace Engineering, and b) the School of Computing Engineering.

The recruited students will be organized into six groups, each of which will be in charge of implementation and testing of one task of RobotX 2022's Challenge. They will work

together for common works such as motion control, wireless communication, power supply and renewal, device installation, transportation, inbound/outbound logistics, etc.

6. Rough Order of Magnitude Cost

No.	Items	Quantity	Unit Price	Sub-Total
1	Digitally controllable propulsion system	2	S$20K	S$40K
2	Embedded Computing Unit	2	S$10K	S$20K
3	Marine Battery Pack	4	S$5K	S$20K
4	Optical Camera	4	S$500	S$2K
5	Hyperspectral Camera	2	S$10K	S$20K
6	Acoustic Signal Sensing System	2	S$1K	S$2K
7	GPS System	2	S$1K	S$2K
8	UAV and Its Accessories	1	S$10K	S$10K
9	Outbound Shipment	1	S$15K	S$15K
10	Outbound Shipment	1	S$15K	S$15K
11	Transportation to Test Site	30	S$100	S$3K
12	Round-trip to Competition Site	15	S$2K	S$30K
13	Accommodation at Competition Site	15x7	S$300	S$31.5K
			Total	S$210.5K

7. Summary

In this proposal, we have highlighted the key aspects of solutions leading to the execution of tasks advocated by the RobotX 2022 Challenge. However, the successful implementation and trial runs will be the major focuses of our team. Most importantly, the competence, dedication and passion of each team member will determine the final success of the team during the competition. We hope that we will be successfully in recruiting highly-motivated undergraduate students who will contribute to the success of our team in RobotX 2022 challenge.