2022 Maritime RobotX Challenge Task Ideas

RobotX 2022 *www.robotx.org*

1. Overview

The 2022 Maritime RobotX Challenge will be held at the Sydney International Regatta Centre, Penrith in New South Wales, Australia. The Challenge will take place from November 11-17, 2022.

To prepare teams for this challenge, organising staff have conceptualised some rules and task ideas, and presented them below. Teams are encouraged to provide their feedback to ensure future iteration of the rules and tasks are designed and integrated with the end user in mind (you all). This feedback is requested no later than 05 April 2021.

Information in this document is subject to change and as such all participants are requested to stay tuned to the website and the RobotX Forum for latest developments.

2. The Venue

2.1 Team Village

Each team will be provided with a covered working area on the island which will have access to both power and a wireless internet connection.

2.2 Practice/Qualifying Area

Three Practice/Qualifying courses will be set up along the shore and in-water, each containing all six challenge tasks. The practice/qualifying courses will be arranged so that multiple teams may practice or qualify at the same time on the same course. An example course configuration is shown in Figures 1 and 2.

2.3 Final Competition Area

For the final round, only one of the courses in Figure 1 will be used and may be in a different configuration to the practice/qualifying courses. Each task may be used to inform the completion of the following, sequential task.

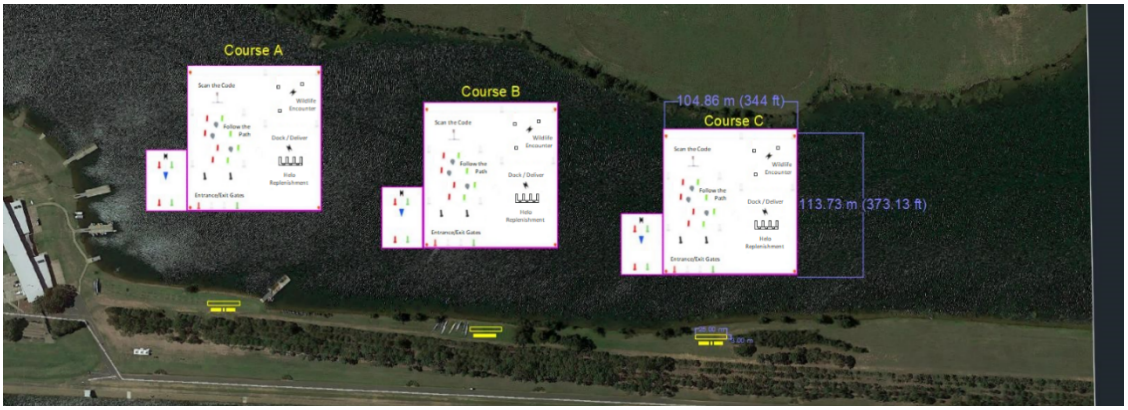

Figure 1: Proposed Course Configuration (subject to change)

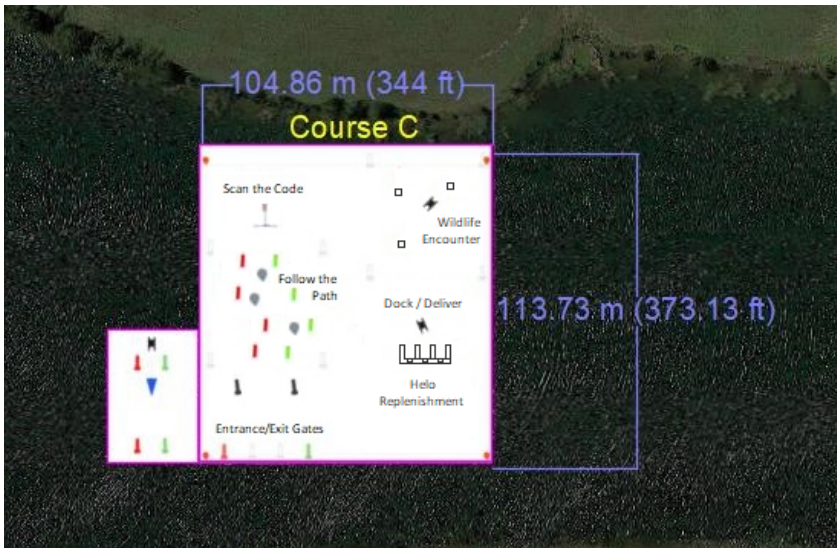

Figure 2: Proposed Challenge Course Configuration (subject to change)

3. Safety Inspections

Prior to entering any of the challenges, teams must demonstrate their ability to safely control their Wave Adaptive Modular Vehicle (WAM-V) and their Unmanned Aerial Vehicle (UAV).

3.1 Static Safety Inspection - UAV

Teams must demonstrate that their UAV can pass a static safety inspection prior to being given flight clearance for aerial operations. Documentation listing these safety checks will be provided later.

3.2 Dynamic Safety Inspection – UAV Launch and Recovery

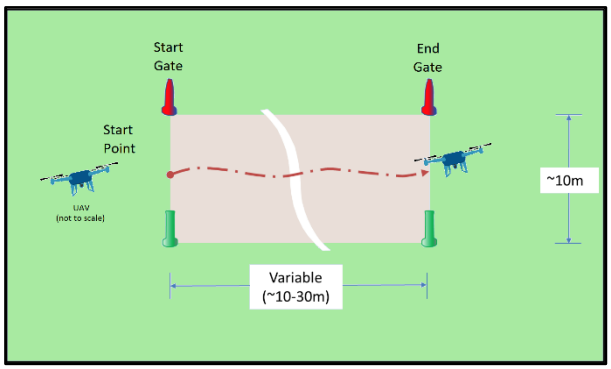

Figure 3: UAV Launch and Recovery

Teams must demonstrate that the UAV can navigate through two pairs of buoys on land, prior to allowing it to attempt any of the challenge tasks on the water. The two sets of buoys will be placed approximately 30m apart and approximately 10m wide on land (see Figure 3). The UAV must also be able to demonstrate a 'return to home' capability that over-rides all other commands. Successful completion of this task will allow the UAV to proceed to the team's assigned area and enable entry to the courses for practice, qualifying, semi-finals and finals.

3.3 Static Safety Inspection – WAM-V

Prior to being allowed on the water, teams must showcase they have met all the safety requirements for water operations. Documentation listing these safety checks will be provided later.

3.4 Dynamic Safety Inspection – WAM-V

Teams must demonstrate that the WAM-V can maintain positive control and effectively detect and navigate through two sets of channel markers. This mandatory task is a minimum requirement for course entry during practice, qualifying, semi-final and final days. Successful completion of this task will allow the AMS to proceed to the team's assigned area and enable entry to the courses for practice, qualifying, semi-finals and finals.

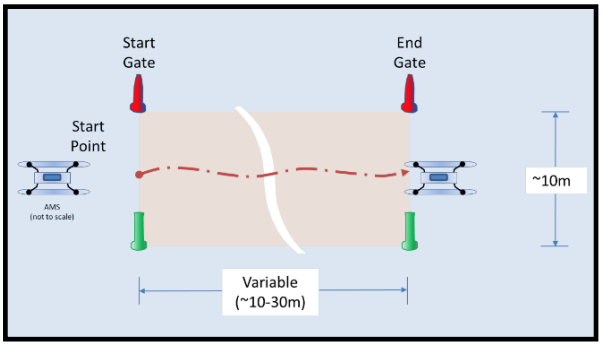

Figure 4: Demonstrate Navigation and Control

3.5 Task Elements

Planned task elements for the two dynamic safety inspections are detailed below.

Table 1: Task Elements for Dynamic Safety Inspections

Task Element	Description	Model No.	Ht. Above Waterline	Base Diam.
Start Gate Port Marker	650mm Dia. Marker Buoy (Red)	N/A	850mm	650mm
Start Gate Starboard Marker	650mm Dia. Marker Buoy (Green)	N/A	850mm	650mm
End Gate Port Marker	650mm Dia. Marker Buoy (Red)	N/A	850mm	650mm
End Gate Starboard Marker	650mm Dia. Marker Buoy (Green)	N/A	850mm	650mm

4. Competition Tasks

This section provides details of the individual RobotX 2022 Competition tasks. For practice/ qualifying days, teams will attempt the tasks individually. For the semi-finals and final Rounds, the tasks may be combined into new, multi-tier tasks. Potential combinations of the tasks for the semi-finals and finals will be released later.

Autonomous station keeping and controlled maneuvering are capabilities that enable successful completion of several tasks in the 2022 RobotX Challenge. Light contact with some course elements may be permitted; the Technical Director's team and judges may require teams to end their attempt if they determine that the AMS is in danger of damaging course elements.

4.1 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.

4.1.1 Task Description

There will be four marker buoys designating the three gates: Gate 1 will be bounded by a red buoy and a white buoy; Gate 2 will be bounded by two white buoys; and Gate 3 will be bounded by a white buoy and a green buoy. The AMS must detect and pass through the gate with the active beacon. The space between the ENTRY and EXIT gates will be approximately 10m.

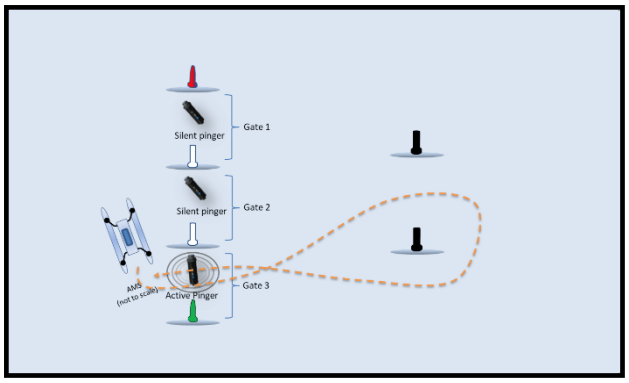

Figure 5: Entrance and Exit Gates

4.1.2 Task Elements

Proposed task elements for the Entrance and Exit Gates task are detailed in Table 2.

Table 2: Task Elements for Entrance and Exit Gates

Task Element	Description	Model No.	Ht. Above Waterline	Base Diam.
Port Marker	650mm Dia. Marker Buoy (Red)	N/A	850mm	650mm
Middle Marker (1 of 2)	650mm Dia. Marker Buoy (White)	N/A	850mm	650mm
Middle Marker (2 of 2)	650mm Dia. Marker Buoy (White)	N/A	850mm	650mm
Starboard Marker	650mm Dia. Marker Buoy (Green)	N/A	850mm	650mm
Buoy to Circle	650mm Dia. Marker Buoy (Black)	N/A	850mm	650mm

4.2 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.

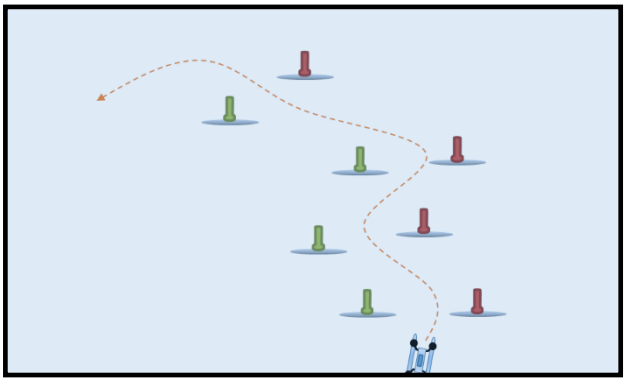

Figure 6: Follow the Path

4.2.1 Task Description

For this challenge, 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. In this challenge, there will be a number of obstacles in the field which will be marked by four white buoys (listed in Table 4). The AMS must transit through the path marked by the pairs of red/green coloured buoys without striking any obstacle.

4.2.2 Task Elements

Proposed task elements for the Follow the Path task are detailed in Table 3.

Table 3: Task Elements for Follow the Path

Task Element	Description	Model No.	Ht. Above Waterline	Base Diam.
Field Boundary Marker	470mm Dia. Round Buoy (Orange)	N/A		
Start Gate Port Marker	650mm Dia. Marker Buoy (Red)	N/A	850mm	650mm
Start Gate Starboard Marker	650mm Dia. Marker Buoy (Green)	N/A	850mm	650mm
Obstacle	470mm Dia. Round Buoy (Black)	N/A		

4.3 Challenge Task 3 - Wildlife Encounter and Avoid

The Wildlife Encounter and Avoid task will be similar to the Find the Totems task in the 2018 RobotX except it will incorporate Hyperspectral Imaging and a UAV.

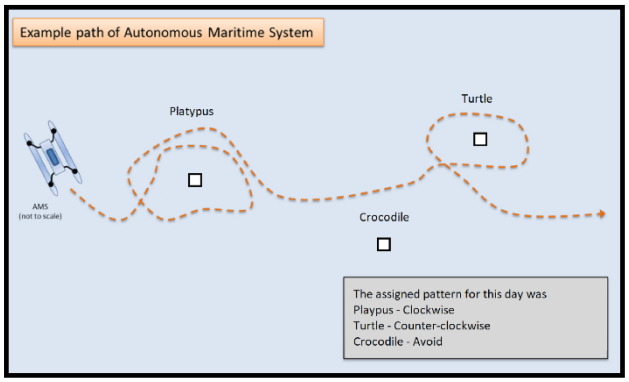

Figure 7: Wildlife Encounter and Avoid

4.3.1 Task Description

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).

4.3.2 Task Elements

Proposed task elements for the Follow the Wildlife Encounter and Avoid task are detailed in Table 4.

Table 4: Task Elements for Wildlife Encounter and Avoid

Task Element	Description	Model No.	Ht. Above Waterline	Base Diam.
Marine Life Markers	Horizontal plywood with different coatings	N/A		
Field Boundary	470mm Dia. Round Buoy (Orange)	N/A		

4.4 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).

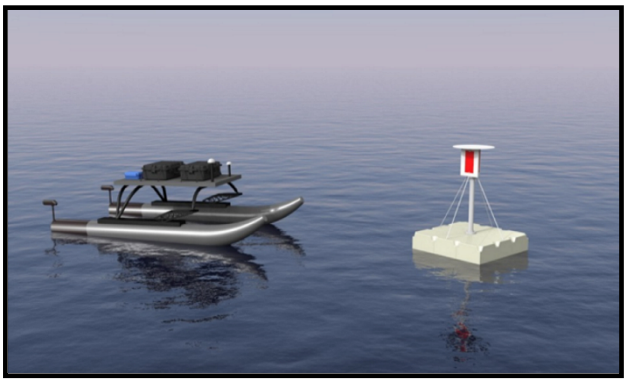

Figure 8: Scan the Code

4.4.1 Task Description

A floating platform with a vertical pole will be located within the search area of approximately 40 x 40 meters. The light bar atop the buoy will be no more than 3 meters above the water's surface and will display any of the following three colours: red, green, or blue. The light bar will appear black when it is off. The light assembly on the buoy will successively display colours one at a time to generate a sequential pattern of colour combinations (e.g. red-green-blue). Each individual colour will appear for 1 second, after which the lights will remain off (black) for 2 seconds before repeating the same pattern. A colour may be repeated in the pattern, but the same colour will not appear twice in a row.

4.5 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.

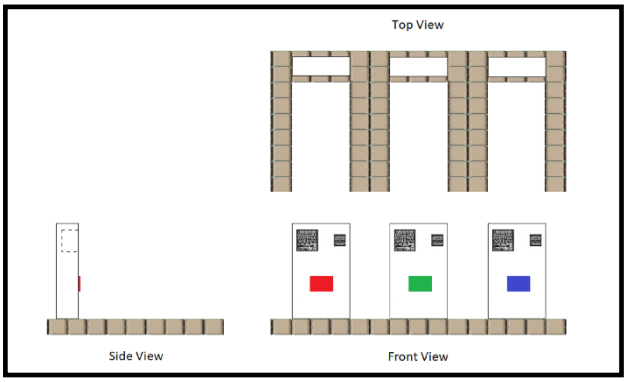

Figure 9: Docking and Delivery Bays

4.5.1 Task Description

The AMS must demonstrate the ability to successfully dock in bays identified by a coloured light.

The task will consist of three identical docking bays arranged as depicted in Figure 10. The dock will be anchored in a fixed location. A coloured light and a pair of square target holes, one small and one large, will be visible on one face of the platform. The coloured lights may be red, green, or blue in colour. The AMS must propel or insert objects (described in Table 5) through the target holes on the correct platform face. During practice and qualifying days, the TD will designate the coloured light of the day.

For each run, teams will be provided with four (4) balls described in Table 5. The AMS must detect the correct coloured light on the target face. The light will be at least 20cm across. Once detected, the system must launch the balls into one of the two target holes on the upper part of the floating platform. There will be two holes, one larger than the other, each outlined in black on a white background. The larger hole will be a square 0.5m on a side, and the smaller hole will be a square 0.25m on a side. For the Semi-finals and Finals, the correct coloured light may be determined by the AMS successfully completing other tasks.

Table 5: Task Elements for Dock and Deliver

Task Element	Description
Blue Projectile	Penn Ultra-Blue Racquetball

4.6 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.

4.6.1 Task Description

For this task, the UAV must launch from the WAM-V, recover the item in Table 5 from the top of the dock in the 'Dock and Deliver' task, and transfer this to a helipad ashore. On top of the dock, there will be three disks (one red, one green and one blue) – one in line with each docking bay. Ashore, there will be a helipad identified by a HELIOS UAV light beacon.

Table 6: Task Elements for Dock and Deliver

Task Element	Description
Coloured Disks	200mm Diameter, 3mm Thick Discs

5. Other Considerations

5.1 Obstacle Avoidance

The ability to avoid obstacles is a core capability for unmanned systems. Each buoy on the course represents an object to be avoided or approached in some way. In addition, obstacle buoys may be placed throughout the operating areas in an effort to provide a more representative real-world challenge. Obstacle buoys will be of the same shape, size, and colour as were used in RobotX in 2014, 2016, and 2018.

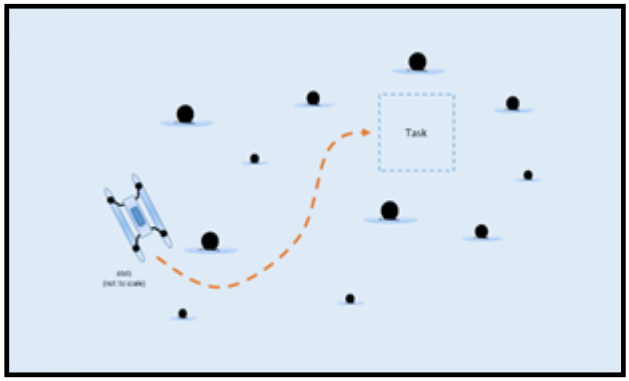

Figure 10 - Obstacle Avoidance

5.2 Autonomous Maritime System Heartbeat

In previous RobotX Challenges (2016, and 2018) teams were required to implement a visual feedback system and a heartbeat broadcast system. This will continue to be part of the 2022 RobotX Challenge requirements.

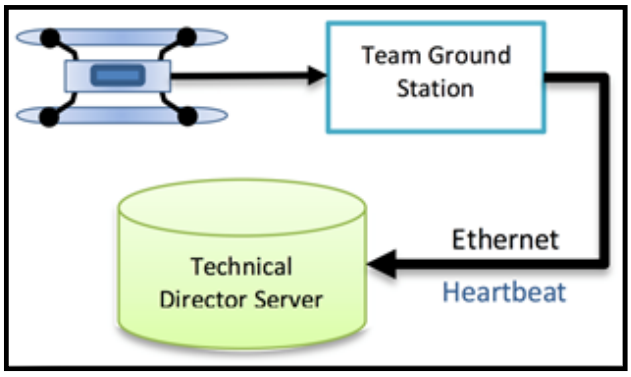

Figure 11 - System Heartbeat

Teams at each of the course operations tents will be provided with a wired RJ45 connection. Information from the team's Ground Control Station (GCS) will be transmitted to the TD network, using this wired connection. Teams are expected to provide their own wireless link for information exchange between the AMS and their GCS. Details regarding communications protocol will be published at a later date.