Preliminary Tasks

2020 Maritime RobotX Challenge *www.RobotX.org*

This is a Working Draft to permit early publication of the intended tasks for RobotX 2020. Information contained herein is subject to change. Graphics are for illustration purposes only.

1. Introduction

This document presents an overview of the **proposed** tasks for the 2020 Maritime RobotX Challenge. Our objective for RobotX is to engage, challenge, and educate students in the development of maritime autonomy through the principles of systems engineering. The competition will be conducted 12-19 December 2020 at Sand Island on Oahu, Hawaii. The term Autonomous Maritime System (AMS) will be used throughout this document to refer to the entire maritime system, including the WAM-V and any offboard systems deployed from the surface platform.

A more detailed RobotX Challenge Task Description and specifications document will be published at a later date. In the interim, teams should use this document and the 2018 RobotX Rules and Tasks document to prepare for the 2020 RobotX Challenge, currently listed under the Resources section of the RobotX website.

2. Performance Tasks

2.1. Demonstrate Navigation and Control

The Demonstrate Navigation and Control task is **mandatory**. The Autonomous Maritime System (AMS) must autonomously navigate through two sets of buoys, placed approximately 30m apart and approximately 10m wide. Successful completion of this task is required for teams to gain entry to the courses for practice, qualifying, semifinals and finals.

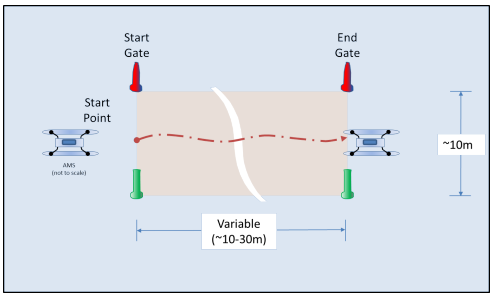

Figure 1. Demonstrate Navigation and Control (Illustration only)

2.2. 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 and transit through the gate in which the active beacon is located.

After transiting through the active gate, the AMS must detect and circle one of two buoys in the field beyond the gates. One of the buoys to be circled will be an instance of the light buoy (used in the Scan the Code task), while the other will be a marker buoy (similar to the one used in the 2018 RobotX Challenge). The AMS must circle the light buoy if it is actively displaying a light pattern. If the light buoy is off, then the AMS must circle the marker buoy.

After the AMS has circled the correct buoy, it must exit through the gate with the active underwater beacon. The gate with the active beacon may change between entry and exit.

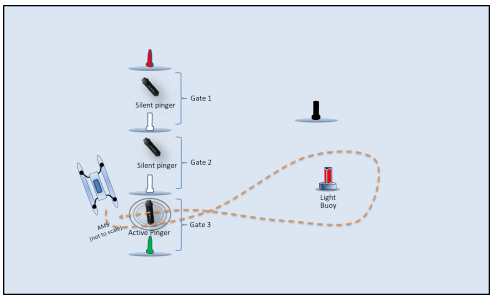

Figure 2. Entrance and Exit Gates (Illustration only)

2.3. Follow the Path

This task is modeled after the "Traverse Navigation Channel" task from the 2019 Virtual RobotX Competition.

The path is defined as a set of buoys, where each set is a pair of colored 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.

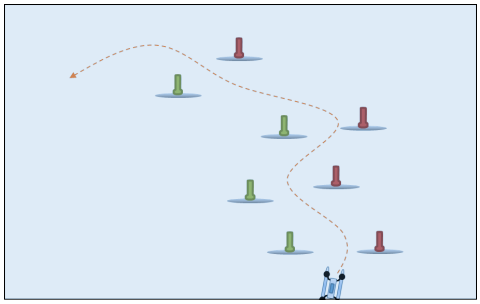

Figure 3. Follow the Path (Illustration only)

2.4. Find Totems

The Find Totems task will be very similar to the 2018 RobotX Challenge task. For practice and qualifying days, the totems may be placed within a field of obstacles. On these days, the Technical Director (TD) will announce the assigned totem sequence and direction.

For the semifinals and finals courses the totems will be placed at random locations around the competition course. The AMS will be required to find and circle totems based on information gathered from other tasks.

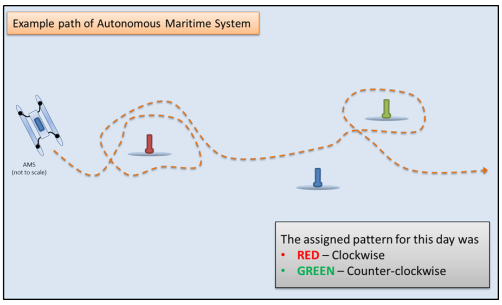

Figure 4. Find Totems (Illustration only)

2.5. Dock and Deliver

For the 2020 RobotX Challenge, the docking bays will revert back to a more traditional parallel dock configuration. This task combines the docking task and the Detect and Deliver task from 2018 RobotX Challenge. The light panel from the Scan the Code task may be integrated into this task, as well. This provides an evolutionary increase in complexity for expected behaviors.

The Dock and Deliver task will be anchored in the course. The AMS will need to dock in the bay displaying the correct color. Once docked, the AMS will deliver a payload (racquetball) into one of the holes (located above the light panel). As in previous years, there will be a smaller and a larger hole for payload delivery.

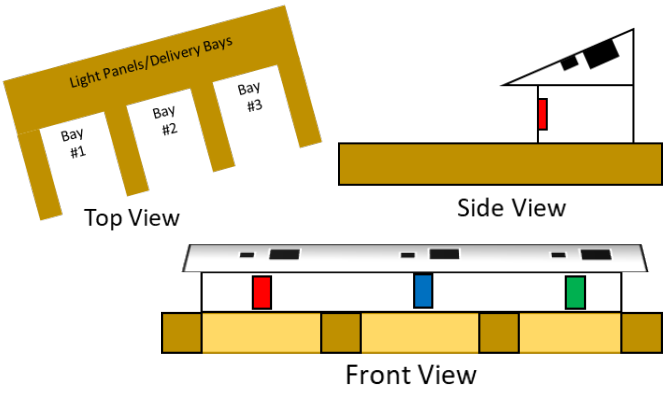

Figure 5. Dock and Deliver (Illustration only)

During practice and qualifying days, the TD will designate the correct color for docking sequence.
During semifinals and finals, obstacle buoys will be scattered throughout the course in varying densities.

2.6. Scan the Code

The Scan the Code task has been a staple of the RobotX Challenge, since the inaugural event in 2014.

During semifinals and finals, the AMS will demonstrate that it has successfully observed the light panels by using active color pattern to complete other tasks. The AMS may also report the observed light sequence using the Scan the Code reporting method.

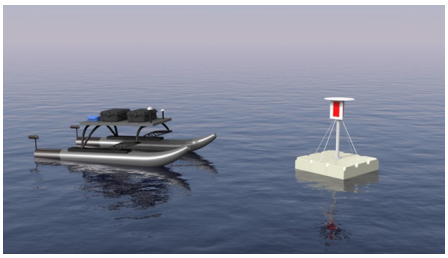

Figure 6. 2018 Scan the Code (Illustration only)

2.7. Underwater Ring Recovery

For this task rings will be attached at varying depths to a PVC structure suspended underneath a marker buoy on the water's surface. The rings will be secured at three levels, with the top tier starting 30-42 inches below the water surface. The middle tier will be placed 24 inches below the top tier, and the bottom tier will be placed 24 inches below the middle tier similar to the image in Figure 7. Each tier will be offset by 45 degrees from the tier above as shown in. The tiers will be colored red, green, and blue from top to bottom.

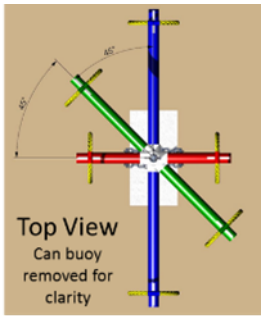

Figure 7. Top view of Underwater Ring Recovery (Illustration only)

The rings will be similar in size to each other, made from yellow polypropylene rope, and marked with colors to indicate the tier from which they were recovered. Rings will be positively buoyant.

The AMS will demonstrate completion of this task by recovering a ring to the surface platform. Recovery of multiple rings will be granted greater points bonuses. The rings must be secured by the AMS to be considered successfully recovered.

The structure of this task is similar to that used in the 2018 RobotX Challenge. Use of a tethered Autonomous Underwater Vehicle (AUV) will be required for completion of this task.

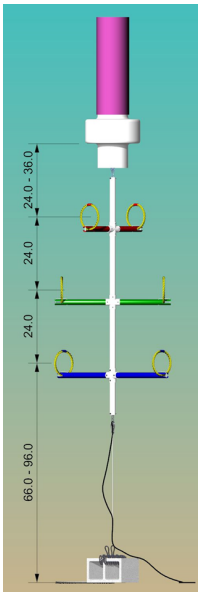

Figure 8. Side view of Underwater Ring Recovery (Illustration only)

3. Interoperability

Situational Awareness is a critical component of any unmanned system. It is a mechanism for earning the trust of humans. With this in mind, the RobotX judges and TD staff would like teams to develop a tool that can be used to record and display (in real time) all the activity in a given course.

This task requires successful implementation of the RobotX Communications Protocol, as well as implementation of the Judge's Interface as specified in the task descriptions. Teams must be able to use the communications protocol messages as inputs to display at a minimum the following:

- AMS Location on map
- System status (autonomous, manual, killed)
- Reporting of perception tasks
- System state (task or tasks being attempted)

Teams are strongly encouraged to showcase their systems during the competition and to submit a documented software package for evaluation by judges and TD staff.

4. Other Considerations

4.1. 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 color as were used in RobotX 2016 and 2018.

During practice and qualifying days an obstacle field will be available for team practice. Totems from the Find the Totems challenge may be placed in the obstacle field.

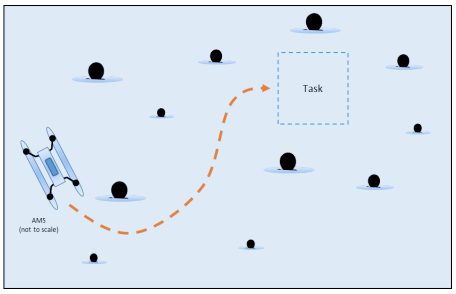

Figure 9. Avoid Obstacles (Illustration only)

4.2. 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 2020 RobotX Challenge requirements.

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.

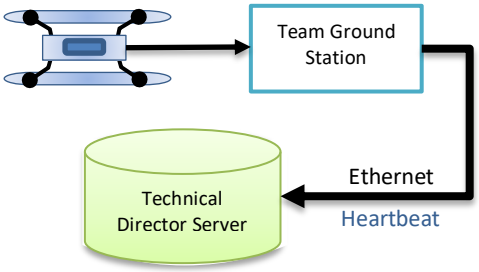

Figure 10. 2018 RobotX Communications (Illustration only)

4.3. Offboard System Launch and Recovery

Requirements for the AUV and its associated launch and recovery system will be included in the 2020 RobotX Challenge Rules document. AUVs will be required to remain tethered to the WAM-V for the 2020 RobotX Challenge due to safety and legal considerations.

4.4. Competition Pre-requisites (New for 2020)

Teams will be required to submit video and technical documentation showcasing implementation and functionality of mandatory buoyancy pods, remote and on-board kill switches. Requirements for these submissions will be published at a later date.