Virtual RobotX (VRX) Competition 2022: Introduction

Attention: This document provides a preliminary overview of the VRX Competition 2022. The details of the competition are in draft status and subject to change. Tasks listed below may be added, modified or removed in response to community feedback or to better align with the overarching challenge objectives. A final version of the VRX Competition Documentation will be released in September 2021.

1. Overview

The purpose of this document is to communicate the goals, schedule and event description to enable participants to begin planning for the Virtual RobotX (VRX) Competition 2022.

2. Goals and Approach

The objectives of the VRX Competition include the following:

- Use simulation to lower the barrier to entry for new participants for the physical Maritime RobotX Challenge.
- Provide a simulation framework and encourage best practices to support autonomy development.
- Increase the performance level of RobotX participants through modeling and simulation as a complement to in-water testing.

The tasks and scoring reflect this intent by emphasizing the foundational capabilities (e.g, localization, navigation, perception, etc.) that lead to improved autonomy performance. Though simulation is never a replacement for testing system performance in a physical environment, evaluating algorithms in an authentic simulation environment is often more efficient and cost-effective.

The simulation-based competition also rewards robust, repeatable performance by scoring each task over multiple trials where the environmental conditions (e.g., sea state, wind magnitude and direction, lighting, etc.) are varied between trials.

3. Key Dates

Though exact dates are still being finalized, the following approximate dates should suffice for planning purposes:

Table 1: Key Dates for VRX 2022

2021	
July	Release of VRX 2022 simulation software update with tutorials and documentation. Documentation will include detailed draft task descriptions and technical specifications.
September	Final release of simulation software and documentation.
October	VRX Competition 2022 Registration Open
December	Phase 1 (Hello World) Submission Deadline Registration Deadline
2022	
March	Phase 2 (Dress Rehearsal) Submission Deadline
April	Phase 3 (Finals) Submission Deadline

Competition dates will be updated and posted to the VRX Competition 2022 site:
https://robotx.org/vrx-2022

4. Communication and Additional Information

The simulation is an open source project. The source code, documentation and tutorials are always available at https://github.com/osrf/vrx

- For technical communication, please use the GitHub issue tracker:
  https://github.com/osrf/vrx/issues
- For administrative communication, please use the RoboNation sub-forum:
  https://www.robotx.org/vrx-2022/forum

5. VRX Competition Eligibility, Registration and Entry Fee

This section describes eligibility and registration requirements for all participants.

5.1 Eligibility

VRX is open to any student team affiliated with an educational institution. Each team must have at least one student and a faculty advisor that is a full-time employee of the same institution. Alternatively, multiple educational institutions may join together to form a single team, comprised of students and one advisor from each institution. Participants (including advisors) may be members of only one team.

Exceptions to the above requirements will be considered on a case-by-case basis.

5.2 Registration

Registration is required to compete in the VRX Competition 2022. Registration details will be provided on the VRX 2022 site and open in October 2021. Registration will be open from October - December 2021 and closes with the Phase 1 submission deadline.

5.3 Entry Fee

Phase 1. While registration is required, there is no fee to compete in Phase 1 of the VRX Competition.

Phases 2 & 3. Participating in Phase 2 and beyond requires a $300 entry fee. However, teams may apply for a fee waiver (application details to follow). Registered RobotX Challenge 2022 teams who submit a waiver application will automatically qualify to receive a fee waiver.

6. Preliminary Task Descriptions

The VRX Competition 2022 includes both foundational and integrated tasks. The foundational tasks (tasks 1-3) are intended to encourage teams to develop fundamental capabilities in localization, navigation and perception as a foundation for higher-level autonomy. The integrated tasks (tasks 4-6) challenge teams to combine foundational capabilities into multi-step autonomous operation.

The VRX Competition 2022 tasks are modifications and adaptations of the VRX Competition 2019 tasks intended to simultaneously challenge past RobotX participants and lead new teams towards their first successful RobotX entry. The VRX 2022 simulation will include a model of the RobotX Challenge 2022 venue, which will introduce new constraints to the vessel motion, and new physical course elements.

6.1 Task 1: Station-Keeping

The unmanned system should be capable of performing localization by fusing sensor data (e.g., GPS, IMU, etc.) and maintaining USV position and heading in the presence of environmental forcing (e.g., wind and waves).

While very similar to the corresponding VRX Competition 2019 task, in 2022 the competition will introduce different environmental influences to exercise control.

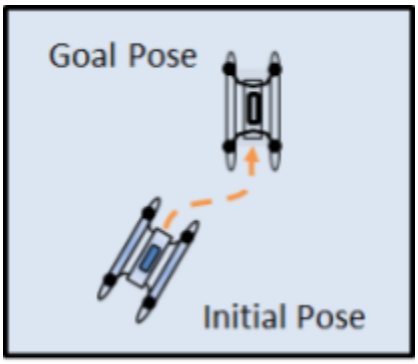

Figure 1: Station Keeping Task

6.2 Task 2: Wayfinding

The unmanned system should be capable of command and control of USV to achieve a series of given goal states, specified as a series of locations/heading values.

6.3 Task 3: Perception Object Localization and Characterization

Using perceptive sensors (cameras, LiDAR, acoustic receiver, etc.), the system should be capable of identifying, characterizing and localizing RobotX objects including buoys, totems, pingers, placards and docks. Perception should be robust with respect to vehicle motion (heave, pitch and roll) and environmental conditions (lighting, camera noise, etc.).

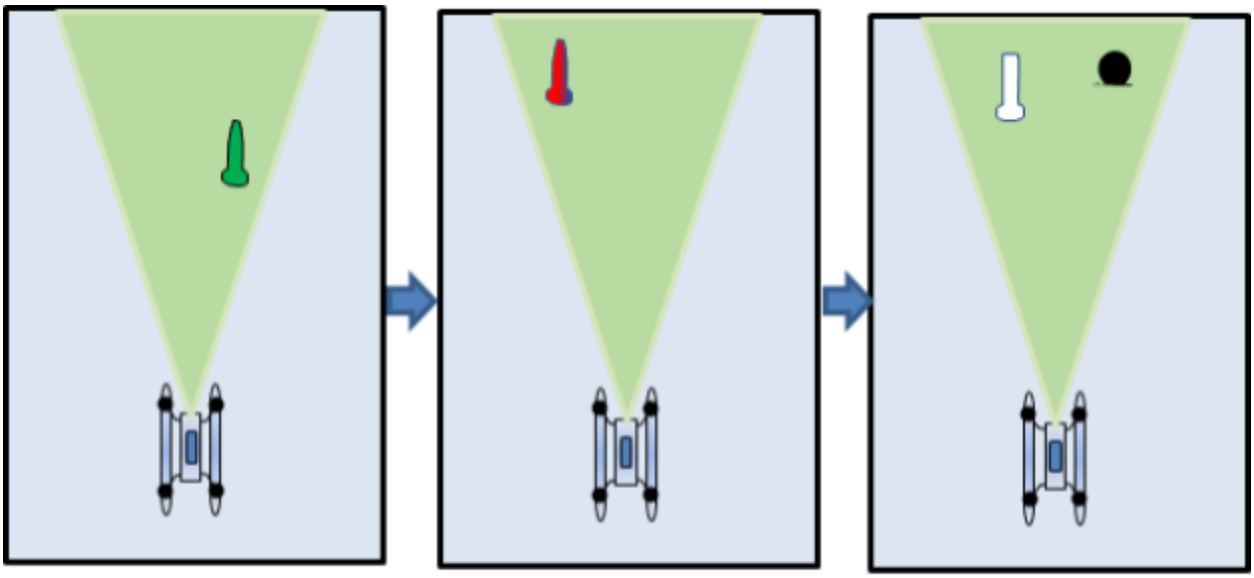

Figure 2: Three individual cases during Task 3 (perception) as objects are sequentially added to the field of view.

6.4 Task 4: Wildlife Encounter and Avoid

The system should be capable of combining perception and navigation capabilities to identify specific objects of interest in the arena and take an appropriate action for each object. To test this ability, a bounded portion of the arena will be populated with markers representing three different types of wildlife: platypus, turtle and crocodile. (The markers will be provided in advance and will be visually distinct.) The system should detect and identify all such markers within the designated area, and plan a path that circles clockwise around platypus markers, counterclockwise around turtle markers, and avoids crocodile markers (i.e. does not approach them within a specified distance).

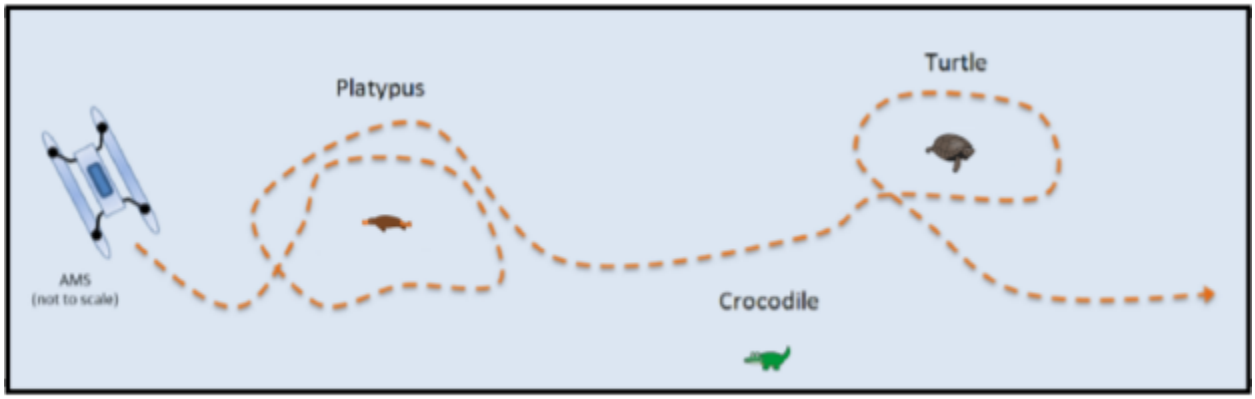

Figure 3: Wildlife Encounter and Avoid

6.5 Task 5: Acoustic Beacon Localization, Channel Navigation and Obstacle Avoidance

The arena is divided into two areas: the channel and the obstacle field. In the channel, teams should create and execute a motion plan to traverse a navigation course specified by red and green markers. After crossing the channel, the USV enters into the obstacle area. Here, the goal is to search and locate an underwater black box containing an acoustic pinger without hitting any obstacles. The obstacles are black buoys of different sizes. Once the black box is localized, USV will have to maintain its position as close to the black box as possible (on the surface of the water) until the end of the task. The solution should be robust with respect to environmental forcing and obstacles within the channel.

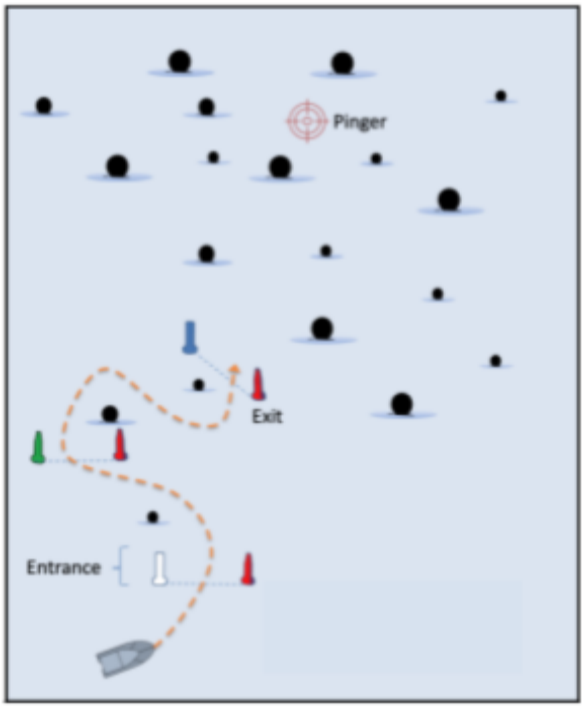

Figure 4: Acoustic Beacon Localization, Channel Navigation and Obstacle Avoidance

6.6 Task 6: Scan and Dock and Deliver

This task combines two RobotX tasks: “Scan the Code” and “Dock and Deliver.” Given multiple docking bays (similar to the arrangement in the RobotX Challenge) the USV should be capable of deciding on the appropriate bay for docking. To accomplish this, the USV is required first to observe a light sequence displayed by an RGB buoy. Teams will be provided a mapping between light sequences and dock symbols, and the USV must successfully dock in the bay identified by the symbol corresponding to the observed sequence. After determining the correct dock, the system must execute a safe and controlled docking maneuver and then exit the dock. Additional points will be awarded for vehicles that can successfully propel a projectile through a hole in the back of the dock.

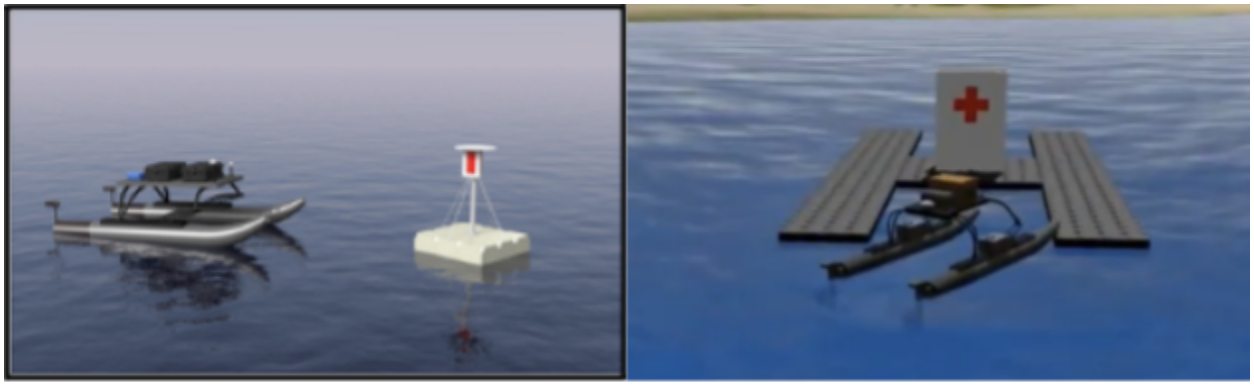

Figure 5: Simulated light buoy and dock (hole not shown)