BUILDING A SIMULATION ENVIRONMENT FOR AUTONOMY VERIFICATION AND VALIDATION

Project aims

To set up the Virtual RobotX (VRX) simulation environment for autonomous systems verification and validation (V&V)

The use of simulation environments in autonomy V&V

- Using simulators in autonomy V&V allows for accelerated testing as simulations can be carried out faster than in real time
- Simulations allow for problems to be detected and rectified earlier on in the project phase
- Simulations are more cost efficient as a physical ship does not have to be built for testing

Evaluation of the environments set up by each method

	Base Gazebo *Can be done in a VM	Using ROS 2 Humble and Gazebo Garden in a VM	Using ROS 2 Humble and Gazebo Garden in a docker container
Operating system (OS)	• Can run on either the VM or host machine's OS	• Runs on the VM's own OS	• Runs on the host machine's OS
Environment	• Empty environment with no models • Models have to be manually installed, sourced and added into the environment	• Launched with all the VRX environment models in place	• Launched with all the VRX environment models in place
Models	• Models do not have the element of collision • Models fall through the ground plane upon starting the simulation	• Models have the element of collision	• Models have the element of collision
Simulator plugins	• Plugins are fully functional	• Plugins are fully functional	• Plugins are fully functional
Real time factor (RTF) *RTF ≈ time elapsed in the simulation ÷ time elapsed in reality	• Ranges from 38.0-42.0% • Highest RTF achieved of the three methods	• Ranges from 7.0-9.0% • After removing all other models except the USV and the ocean, the RTF maintains a range of 8.0-11.0%	• Ranges from 7.0-9.0%

Evaluation of USV teleoperation within the environment

- The USV can be controlled with a gamepad however moving the USV from point to point takes a significant amount of time due to the low RTF of the simulation
- Using a gamepad to control the direction of the USV's movement, the USV took 88s to move from it's starting point to the buoy.

The USV at the starting point

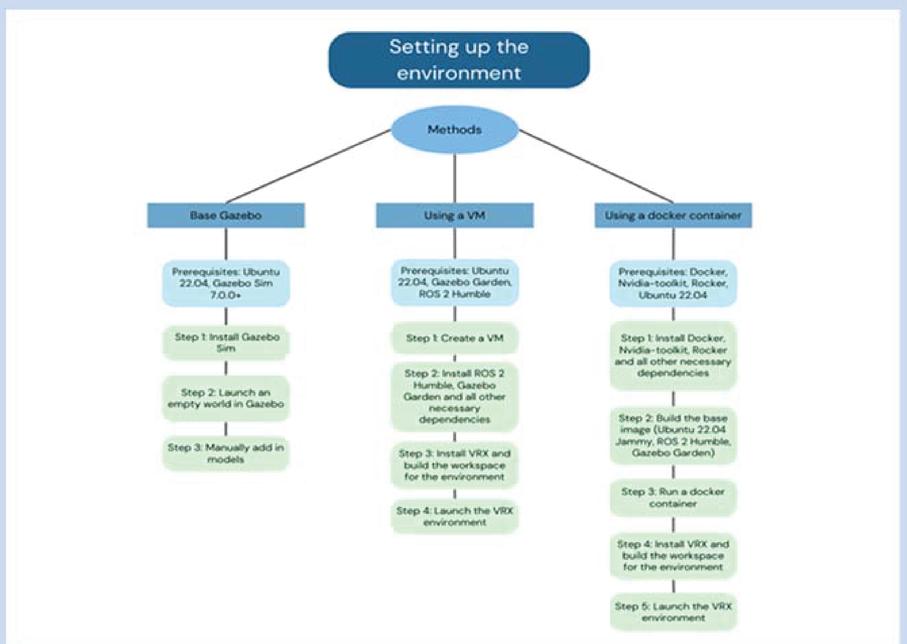
The USV after reaching the buoy

The VRX environment

- Jointly created by the USA's Naval Postgraduate School and Open Robotics
- It is an open source environment and has physics models

Methods attempted to set up the environment

- Creating a world in Gazebo and manually adding the VRX world models (Base Gazebo)
  - This method can be carried out in a VM
- Using ROS 2 and Gazebo to create the VRX environment in a Virtual Machine (VM)
- Using ROS 2 and Gazebo to create the VRX environment in a docker container



Future improvement & future work

- Be more mindful of the different interlinked dependencies that are involved with using open source software
- Increase the RTF of the simulation such that it is faster than in real time so as to allow for accelerated V&V testing
- Find a solution to increase the RTF while still retaining all the models in the environment

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YDSP Young Defence Scientists Programme
DSTA Defence Science & Technology Agency
DSO NATIONAL LABORATORIES