ELECOMP CAPSTONE
VIRTUAL SUMMIT
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THE UNIVERSITY OF RHODE ISLAND

THINK BIG WE DO℠

# Virtual Reality Bridge Trainer

Standalone Ship Bridge Trainer using Virtual Reality

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## Project Motivation

For many of Rite Solutions' customers (commercial and DoD/Navy), a well-trained workforce is essential. Accidents at sea are unfortunately all too common, and the lack of adequate training has been identified as a key contributor on many occasions. Finding a way to improve the overall efficacy of training for the various scenarios that can play out while at sea or onshore is difficult, as there is a great lack of availability of training facilities and resources for individuals that require such experience. This project addresses the challenge by developing a standalone training system which utilizes new technologies such as virtual reality and gaming engines. The goal is to develop a ship bridge trainer to improve the navigation skills of junior officers and navigation technicians by providing a realistic virtual training environment. Being able to operate this training system with just a laptop and VR headset results in a low cost, portable, and individualized training solution.

## Key Accomplishments

- **Set Up Development Tools:** Researched, selected, ordered, and received an appropriate laptop that met established hardware requirements from project proposal. Learned and set up key development tools--Unity and Blender--and set them up on the physical environment **(Fig. 1)**.
- **Virtual Reality Functionality:** Performed research on Virtual Reality implementation in Unity. Selected VR framework (OpenXR), installed, and implemented it in Unity project. OpenXR provides fundamental VR controls for several VR headset brands including HTC Vive, Oculus, and Valve Index. Additional XR Interaction Toolkit package provides a framework for 3D environment interactables and UI interactivity through Unity's input events system.
- **Ship Handling Physics:** Ship handling physics simulated using a C# based script and the Unity physics engine. Interfaces with evaluator GUI to receive user inputs for desired thrust, course, and rudder angle. Operator VR environment moves seamlessly with ship movement. Movement is input by the evaluator in the evaluator GUI and is modeled off of simulated acceleration tests and tactical diameter measurements.
- **Secondary Evaluator View:** Separated laptop monitor and VR headset views in software build for operator and evaluator. Evaluator view includes menus for scenario selection on startup and minimap and supporting GUI for scenario customization and execution. Evaluator GUI and 3D game environment run through the same application **(Fig 2)**.
- **Evaluator GUI:** GUI for secondary evaluator includes a real time map to show the location of own ship in relation to geography and secondary contacts, along with the ability to customize, create, and set the movement of secondary contacts for the operator to interact with, and ability to set ship movement orders received from operator.
- **Evaluator GUI Sprites:** Used Affinity Photo to create 2D image sprites for secondary contacts, merchants, own ship, buoys, submarines, warships, and planes. Sprites will appear on the evaluator GUI map to represent the location of its corresponding vehicle/buoy in relation to the own ship. Took overhead images of Rhode Island geography in Blender to create a geography sprite to represent land on the evaluator GUI map.
- **Secondary Contacts:** Secondary contacts can be created through evaluator GUI during scenario setup or after scenario start. Contacts can be created in larger groups such as merchant transit lanes or fishing groups or as singular vessels. Evaluator can select spawn location based on coordinates or using the cursor as well as set and edit a course and speed for the contact to follow through the contact GUI.
- **Rhode Island Geography Models:** Used TouchTerrain to create a geography model of RI with elevation data, and purchased a separate model from cgtrader.com containing building assets. Combined both models, resulting in one model with accurate elevation data and buildings/port features to provide an accurate representation of the Rhode Island coast **(Fig 3)**.
- **Ship & Buoy Models:** Downloaded free ship models for secondary contacts and own ship. Secondary contact ships include a merchant (cargo ship), sailboat, trawler, and small craft. The ownship's model is a Virginia class submarine. Created buoy models in Blender, as there were no free buoys models available online.
- **Weather:** Rain and snow effects were implemented using the Unity Engine's particle system component. Fog effects are created using the scene lighting settings. Particle effects are created in a large radius around the operator to maintain performance while reducing the operator's visibility. Evaluator can enable or disable weather effects during active simulation via the Evaluator GUI.

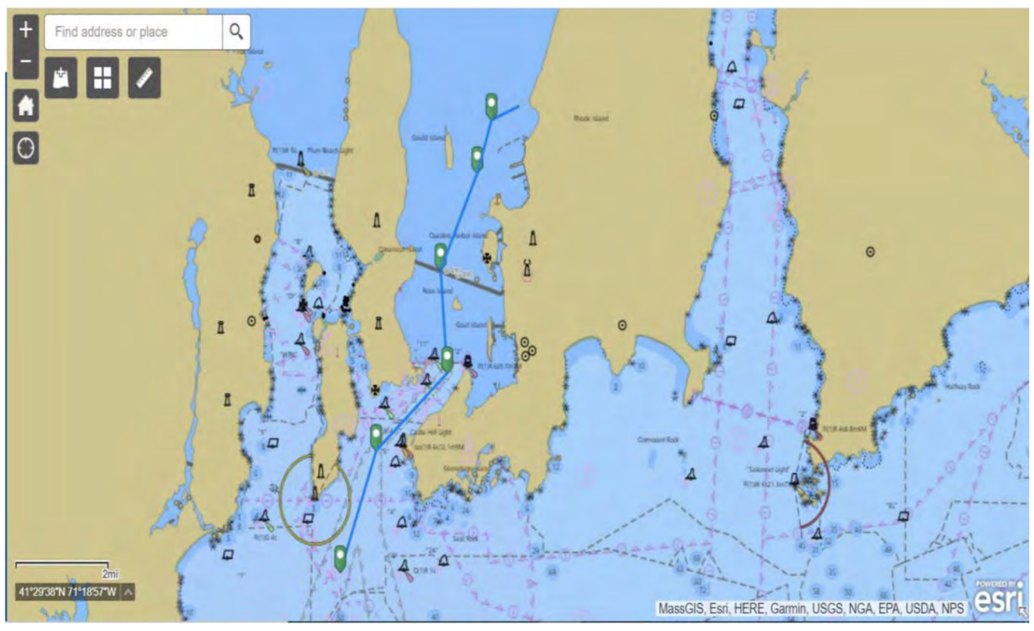


**Fig. 4:** Example Newport Approach

## Anticipated Best Outcome

The best outcome anticipated to be delivered by is a realistic and immersive Virtual Reality training program with the ability to effectively train maritime operators how to handle and navigate their ship through Rhode Island's Narragansett Bay. The primary objectives to be met include realistic ship-handling physics and implementation of secondary contacts for the operator to interact with, in addition to the accurate geography and navigation aids. This application will be able to run on a laptop, and it will be modular to enable accommodation of other hardware and software, which would allow for easy upgrades, such as support for multiple training scenarios.

## Project Outcome

The Anticipated Best Outcome was achieved. At the beginning of the year, we promised a realistic and immersive Virtual Reality training program with the ability to effectively train maritime operators how to handle and navigate their ship under various conditions to include abnormal weather, high contact density, and visual-only navigation through Rhode Island's Narragansett Bay. After 6 months of hard work, we are pleased to declare this outcome a reality.

## Figures

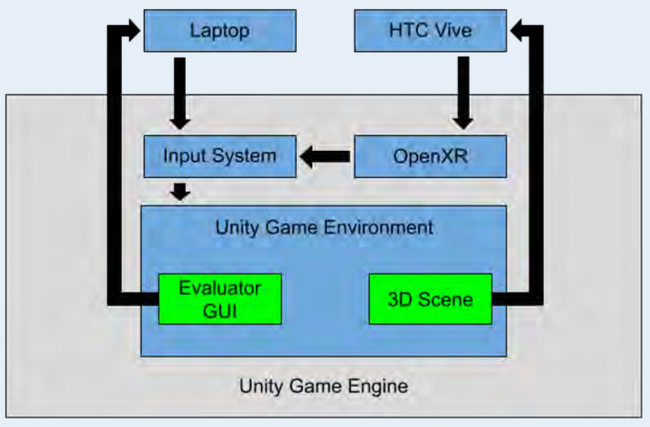


**Fig. 1:** The functional block diagram

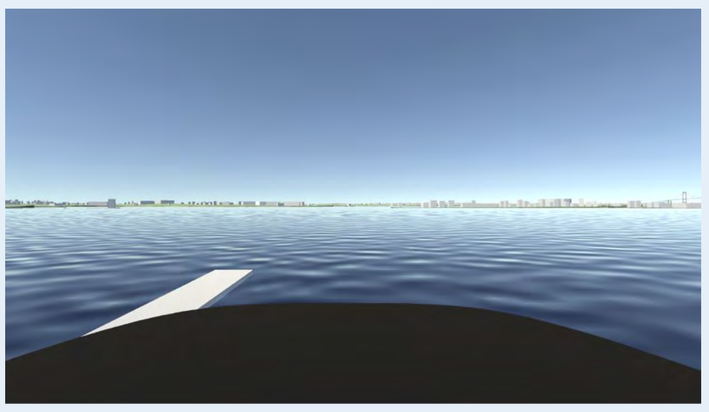


**Fig. 2:** Unity Project in Editor application (Top: Scene View w/ placeholder boat & water, Bottom: Evaluator GUI with real time map)

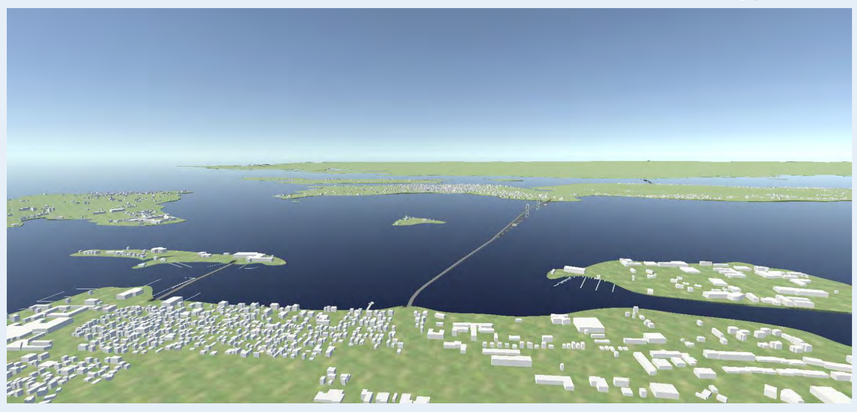

**Fig. 3:** Rhode Island 3D Model (Newport pictured)

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