ELECOMP CAPSTONE SYMPOSIUM
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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.

Anticipated Best Outcome

The best outcome anticipated to be delivered by April 15th of next year 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.

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.

Basic 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. Uses a combination of variable inputs from evaluator and constants based on specific ship specifications to simulate ship handling physics.

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 ability to customize, create, and plot the course of secondary contacts for the operator to interact with, and ability to set ship movement orders received from operator.

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.

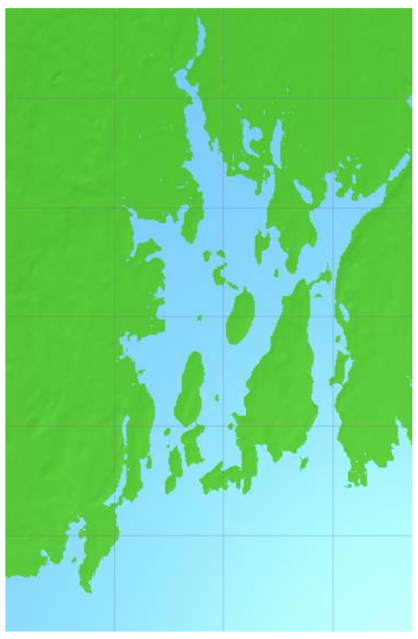

Fig. 3: Rhode Island / Narragansett Bay 3D Model in Unity

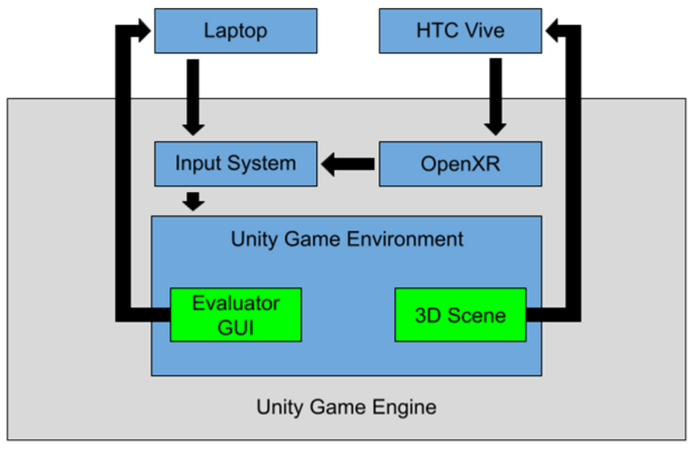

Fig. 1: Functional Block Diagram

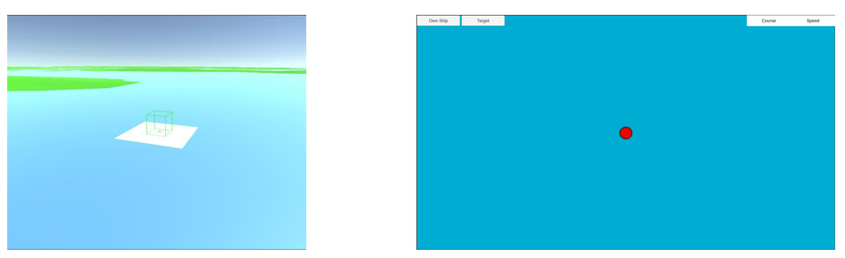

Fig. 2: Unity Project in Editor application (Left: Scene View w/ placeholder boat & water, Right: Evaluator GUI with real time map)

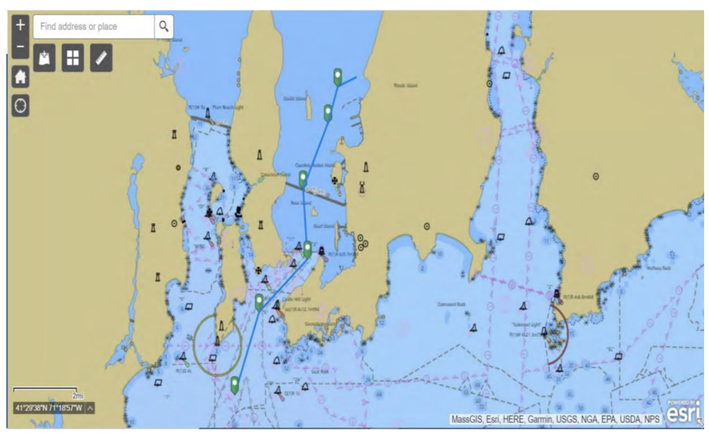

Fig. 4: Example Newport Approach

Remaining Technical Challenges

Audio and Visuals: Audio requirements include interactive sounds from the environment, operator ship, and secondary contacts, such as motor, ship whistle, water, and weather effects. Visual assets, such as 3D models for land and port features, operator vessel, and secondary contacts, must also be implemented into the project. Audio and visual assets, such as the Narragansett Bay geography model **(Fig. 3)** will be created or sourced from open sources and implemented into the Unity project.

Accurate Geographical Simulation: Accurate 3D simulation of the Narragansett Bay area **(Fig. 4)**. Important land and port features modelled and accurately placed in the 3D environment. Navigational aids and buoys plotted based on Digital Nautical Charts. Other nonessential land features implemented as necessary to create an immersive environment for the operator to interact with.

Weather: Ability for the evaluator to set varying weather environments in the simulation, including rain, snow, hail, fog, and wind. Weather elements will be accurately simulated in the 3D environment and interact with the ship handling of the operator vessel and secondary contacts.

Water Simulation: Ability for the evaluator to adjust the sea state in the simulation. Water current and speed impact ship handling physics.

Bridge Interactables: Interactables for the operator to interact with in the VR environment, such as radar, DNC chart viewer, Automatic Identification System, ship whistle, and controls for throttle and steering. OpenXR interactables package will be configured to allow the hand controls from the Vive Cosmos headset to be used to interact with these elements in the 3D environment. Interactables will be modelled and placed with the bridge environment.

Recording: Recording feature will allow the operator and evaluator to review a training scenario after completion and review the session. Session recording should include basic features such as the ability to pause or skip through the recording, as well as include views from both the operator's direct perspective as well as an overview of the vessel.

Implications for Company & Economic Impact

Rite Solutions is continuing to expand their training system capabilities for their DoD/Navy customers. There is a growing demand for standalone trainers for use at sea and onshore to address immediate Navy needs to improve skill sets in numerous areas. The virtual reality trainer addresses a need identified by the Rite Solutions staff who were recently active Navy service members. Rite Solutions views this capstone project as an opportunity to expand their training capabilities into a new and growing market as well as demonstrate the use of new and emerging technologies such as gaming engines and VR to provide training in new ways for a new generation of students.

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