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1 Background

History of the project

The need for an accurate and detailed map of an active battlefield has been around since the invention of war. The ability to quickly access pertinent information about troop movement and quickly relay them information can help change the outcome of a battle. In our current age of VR and augmented reality where we can immerse ourselves into a virtual environment to gain a better view of the current situation is greatly needed for the changing times.

Current needs of the project

This project has some necessary hardware requirements for development and use of the project software. Oculus VR sets will be used during production, as the final product will revolve around using these sets for the delivery of a VR (virtual reality) experience.

To deliver this simulation experience, the project will be developed with the Unity engine. Unity has support for VR integration, free-to-use assets, and plugins that can expedite the development process. The engine will also deal with all lighting and physics-based properties that are to be utilized.

The project is focused primarily on the delivery of a simulation experience and not on the reinvention of VR tracking and handling. As such, pre-existing plugins that handle VR set integration will be utilized in the Unity engine.

Project Partner and stakeholders

Our project partner, Raffaele de Amicis, performs research in virtual and augmented reality which will be a great benefit for the project. Beyond the direct project partner for this project the other potential stakeholders would be those that would use the software or those that would adapt the software in the future. This project is closer to a research and prototyping project and so it is very likely that future groups will take up this project and take it farther. Particularly after looking at requirements from potential stakeholders such as military decision makers.

2 Vision Statement

Our vision is to provide a tool that will save lives in the field for future military commanders using our product. We will save lives by providing real time information as a new way of visualization

to inform commanders and users of vital information in a new theatre of display. By creating a system for simulation in a real-time war environment simulated in a virtual reality environment we will create a new training, simulation, and real-time application tool that will provide a great advantage to users and commanders. Users will be able to put on their virtual reality headset and immediately immerse themselves into the world created by our system. This will immediately increase the value of all systems that normally provide information to commanders by allowing them a new way of viewing and understanding the intelligence from the field.

3 Success Measures

There will be many opportunities during this project to test if vision goals will be met. The first step should be a usable prototype that uses the Oculus VR successfully. This measure can be evaluated by proper integration of the Oculus set in the Unity engine, including head and hand tracking. It is expected that full integration of the set is successful.

Once VR integration is set-up, the bulk of the project can then be evaluated in parts. A large part of this project revolves around semi-autonomous computer characters. As such, with each introduction of a new computer character the autonomy should comply with the vision of the project. This can be measured by the successfulness of information intake, movements, and the ability to receive and enact commands. It is expected that all friendly NPCs (Non-player characters) should be able to enact commands received from the player. It is expected that all NPCs will take information from the environment to compute actions.

Player involvement will be the other large area of development in this project. The player should be able to command friendly NPCs to an extent and perceive the field from multiple perspectives. This can be measured by the usable options that the player has access to. It is expected that only friendly NPCs will adhere to orders from the player.

Lastly, visual elements and objects introduced to the project should serve a purpose, even if that purpose is fleshing out the environment. These elements can be measured if they are simply extra details (landscape and extra environment details) or view/path blocking objects such as buildings and trees. The details of models matter little, but they must serve a purpose in the environment.

4 Prioritized Project Constraints

This project is limited greatly in the time allocated to it as it only has 8 months from creation to delivery. This project will also be limited by the amount of computing power given to the developers working on it. As it requires a great deal of calculations and data manipulation and visualization. It will be constrained to a purely VR (Virtual Reality) format instead of utilizing the full augmented reality and outside data sources. It will be purely simulated from the environment where it takes place to the data being presented to the user within said environment. Each developer will have access to server-side computing given by Oregon State University to properly utilize the virtual reality headsets. Each developer will also be given their own virtual reality headset for which to test the software being developed.

The scope of the project will remain within the realm of virtual reality as it will not be accepting data from outside sources such as drones, cameras, soldiers or various other data sources that are not generated within the virtual reality. The project will be developed in order to show that a virtual reality could be created in such a way that the user could relay the data to soldiers on a battlefield in real time while also being able to quickly update toward the data being presented by the simulation. It will not involve the augmented reality that was in the initial project scope as it will prove difficult to test and implement without a centralized location for each of the developers to work. The main constraints will be the 8 months from team creation to deployment, the power of each developer's computer or capabilities to properly render a virtual environment, along with the need for virtual reality headsets in order to properly test the system.

5 Stakeholders

- **Military Decision Makers**

  Ultimately this project is a research project, and it is tuned in terms of creating value for military decision makers and commanders. They will gain value in the simulation provided by the tool or by the ability to gather information in real time in a new domain.

- **Interested Military Simulation Users**

  The simulation aspect of this project will be a great resource to any users who wish to simulate military-like environments in a more modern world. This may be for use in wargame-like scenarios or resource estimation.

- **OSU's Raffaele De Amicis and further research partners**

Since this is more of a research project Dr. De Amicis and other interested research members of OSU have high stakes in this project as it may be of use to them and they may develop it further. Dr. De Amicis will also be helping with development and may lend resources to aid in the project's development.

- **OSU Final Project Members**

Beyond developing the prototype and developing the research needed to get this project off the ground, further groups may be required to extend onto the work of this project past this term.

6 Risk

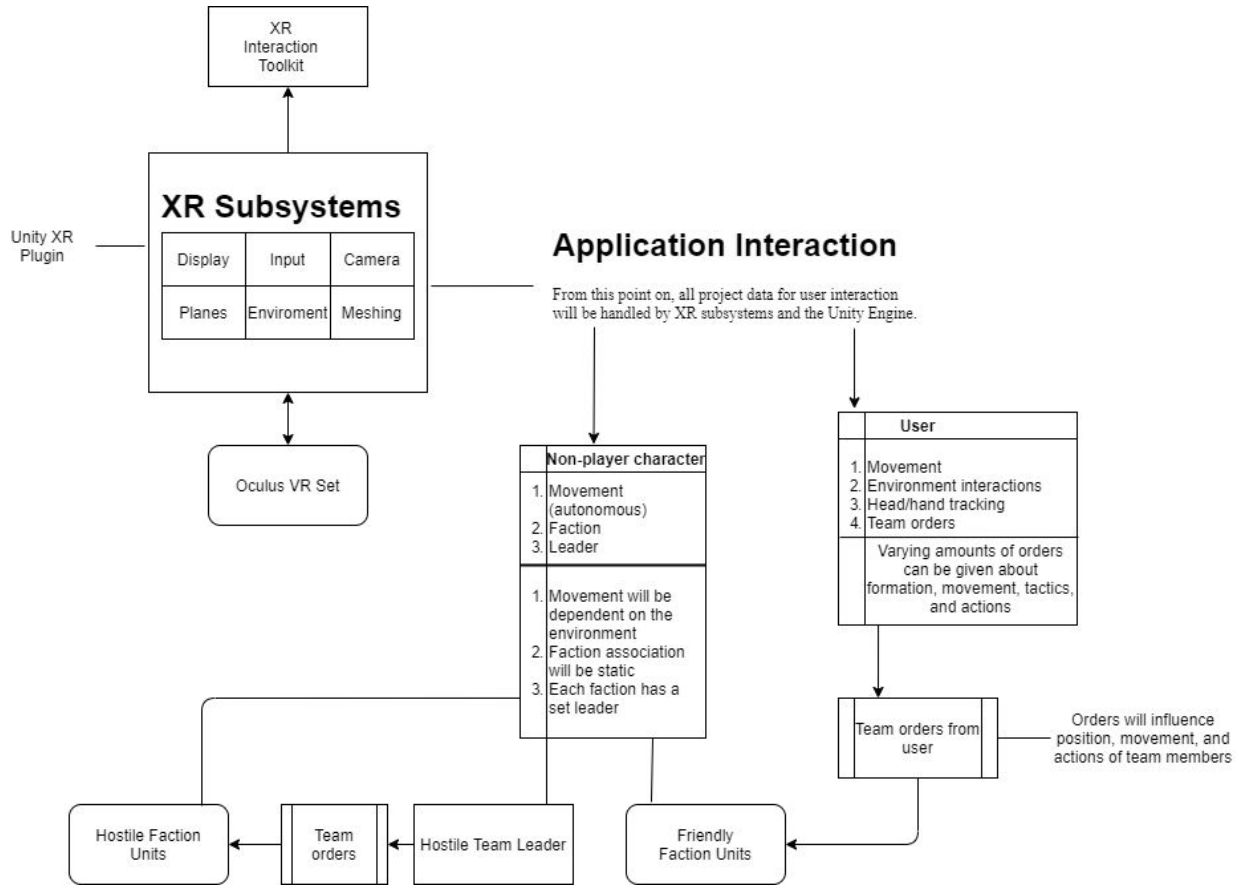
Risk	Likelihood	Impact	Mitigation Strategy	Early Detection	Consequence
Derailment/Loss of direction in project flow	Low	High	To mitigate this, we will meet with our project partner each week to go over core progress. This will keep us on track toward their key goals.	Multiple standup meetings a week to maintain workflow on a positive direction toward the core goal of the project.	Loss of core features or at worst a failure to deploy the project as expected.

Overzealous Desire/Too large of a scope.	Low	High	To mitigate this, we will meet with the project partner while also meeting with our TA to keep our project scope within the realm of possibilities.	Progress toward project goals will be present on Asana, which will be used to detect if the project is not reaching expected milestones.	Having too large of a project or too ambitious of goals could result in the loss of core features or in a project failing to deploy.
Loss of developer/Unexpected leave of absence	Low	High	To mitigate this, we will keep work equally separated to allow for slack if such an event arises.	Constant communication between group mates along with weekly standup meetings will help detect oncoming absences.	Result in delays or failure to launch the project.

7 Scope

Process Flows

A VR plugin will be used to handle most interactive and tracking elements of the project. For example, the Unity XR framework will handle most elements associated with the Oculus Quest. This UML diagram visualizes how the hardware components will work with the XR plugins to manipulate the user character and communicate with the non-player characters. The diagram should give a high-level overview of the interactions taking place between the Oculus input and the interactable characters in the project.



User Stories (Epics and Features)

Epic: As a user I should be able to view an urban battlefield environment.

Feature: I want this environment to have several visual elements including buildings, vehicles, trees, etc.

Feature: I want this environment to also obscure the view of the different entities in the environment such that gathering information is a valuable ability from the entities.

Epic: As a user I should be able to control and move around in the battlefield environment using simple VR controls.

Feature: I want the user experience to be viewed through a VR experience, capable with Oculus devices.

Feature: I should be able to use my VR hand devices to interact with entities in the environment.

Feature: I should be able to interact with my party and the non-player characters in my party using quick commands or movements.

Epic: As a user I should be able to view the battlefield in multiple perspectives.

Feature: I want a first-person perspective where I will be able to directly view the perspective of my character as I move through the environment.

Feature: I want a third person perspective where I am slightly removed from my character and could view more of the environment around me.

Feature: I want a third person perspective where I am removed from the scene and I am viewing the whole environment from an over the top perspective.

Epic: As a user I should see a clear and minimal UI that is easy to understand and navigate.

Feature: I want the user interface to be clean and allow for me to see the environment around me.

Feature: I want to be able to receive information from my team of non-player characters and for that information to be clearly visible to me.

Epic: As a user I will be able to interact with friendly non-player characters that will be a part of my team.

Feature: I want interactions to be very simple and distinct when I am trying to interact with my party of friendly non-player characters.

Feature: I want a diverse set of interactions available to me that I can interact with my non-player characters on my team.

Epic: I want these non-player characters to have a simulated mind and to be able to relay information back to me as a user.

Feature: As a non-player character I should be able to move around in the environment automatically and be able to navigate around objects.

Feature: As a non-player character I should be driven to find information about my surroundings and of the other team’s non-player characters or main player.

Feature: As a non-player character I should listen to commands from the main player and react to those commands depending on my situation.

Feature: As a non-player character I should be able to perform with other non-player characters to find more information.

Epic: As a user I will confront and receive information on the surroundings and of enemy non-player characters.

Feature: As a user my main goal during the simulation scene will be to ascertain and react to information found on the enemy non-player character team.

Feature: As a user I will be able to use the information given to me from my own view or from the relays of information from my team of non-player characters in order to advance my goals.

Epic: I want these non-player characters to react to their surroundings and the information they can realistically gather about my team and myself.

Feature: I want limitations to be in-place, such as line-of-sight, that will hinder the realistic ability to gather information by me as a user or by the non-player characters.

Feature: As a non-player character I should be able to navigate around objects and through obstacles automatically to achieve my goals at the time.

Epic: I want not only grounded non-player characters but also flying non-player characters such as U.A.Vs.

Feature: As a flying non-player character I will be flying above the scene providing information to both non-player characters and player characters.

Feature: As a flying non-player character I will react to information I find, information provided to me, and commands given to me.

Epic: I want options such as degraded visual environments to hinder the actions and decisions of me, the user, and the non-player characters.

Feature: As a user my information provided to me from non-player characters may be impaired through the simulation of communication interruptions including both hostile interruptions and environmental interruptions.

Feature: As a user I may find myself in visually impairing environments that will alter what I can view from the environment such as dust storms or weather impairments.

Iteration Plan and Estimate

This project will be structured in a certain way with the first portion being the design of the environment, the second being the implementation of a user interface, the third being a creation of individual units to move around the environment autonomously, the fourth being the implementation of data sources within the environment to be transmitted to the user.

- First Phase: Environment creation, this phase will take a short time as it is just the creation of wireframe objects and a simple landscape to later be populated. This phase should take from 2-4 weeks to implement.
- Second Phase: Creation of user interface within the landscape. This phase should take 2 weeks to complete as the environment will have been implemented by this time.
- Third Phase: Creation of autonomous units within the environment. This phase should take 1-2 months to implement as it will require a great deal more logic programming and unique logic for specific units.
- Fourth Phase: Creation of data sources within the environment. This phase should take less than 2 months to implement as it will be building upon some autonomous units and some new units such as cameras and GPS data sources.

Solution Architecture

The Chosen architecture was an Oculus for the VR set and the Unity engine will be used to compile, render, and deploy the project. These were specifically used due to a request from the project partner Dr. Raffaele De Amicis, and that the team has collective experience with Unity.

Different VR handling plugins were considered but the Unity XR framework seems to offer the features that will be needed for this project. This XR framework is slightly heavy for the project due to its inclusion of augmented and mixed reality integration, however the Oculus XR plugin specifically can be used to trim this size.