Mixed Reality Multi-Domain Operations Milestone 2 Revisited and Alpha Functionality

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Mixed Reality Multi-Domain Operations

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Joshua Shequin, Johnathan Webb, Brenden Smith

Abstract

The goal of the Mixed Reality Multi-Domain Operations project will be to develop an urban military simulation game in virtual reality. The hope of this project is to provide a nice simulation tool for military simulation enthusiasts and to hopefully create the first step for future military simulation tools

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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 provide entertainment for military style game fans and to possibly create a stepping stool for future development into military simulation.[1] We will create entertainment by creating a game in virtual reality in which users can control a simulated military force as it goes through an urban environment. 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 game that will provide a great advantage to users and possibly create a first step for more virtual reality combat simulation. Users will be able to put on their virtual reality headset and immediately immerse themselves into the world created by our system. This will set the player up for an experience in which they will truly believe they are commanding a military force and it will give them the exciting experience of simulated warfare.

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[1] Our vision has changed because our stakeholders never really included military decision makers like we were led to believe. The project is more closely being developed for military style game fans.

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 hardware readily available to each of the developers. It will be constrained to a purely VR (Virtual Reality) format instead of utilizing the full augmented reality and outside data sources as it will also be required to run solely on the Oculus Quest without assistance from another device. The environment being created will rely solely on simulated data instead of data derived from outside sources. Each developer will be constrained to developing based upon the availability of the hardware as the team only has a single Oculus Quest headset between the three members to develop and test upon.

The project's scope will be designing and implementing a virtual battlefield for the user to control specific units within and receive only information available to their units. The user will take the position of a commander on a battlefield and relay information to the units and give them specific commands to follow based upon available data. This system will take time to develop and test as the levels of intelligence and interaction between the units is not a simple one. Each unit must be given their own behaviors and set interactions based on certain conditions within the simulation. Along with the interaction between the commander and the units must also be limited in some way. They must act with some level of independence and drive only taking the commanders orders to attack or move but not how to do so. This project will be constrained by time and availability of resources to the developers.

5   Stakeholders

Military Decision Makers

While this project is not directly made for military decision makers it does open up a first step for developing an application more suited towards serious military simulation. Military decision makers are stakeholders only if they feel like this project will be that good first step for them.

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.

- 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 months 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 2 months to implement as it will require a great deal more logic programming and unique logic for specific units.

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.

8   Alpha Functionality

Joshua Shequin

I am a computer science student at Oregon State University. I have vast experience playing games and I am using my experience in games to help the design of this project. While it does not apply too significantly, I also was in the Military before my time at this school and where available I have used my experience there to improve the realness of the project.

I have mostly served as the manager for this project. This includes setting up meetings within the team, making sure that meeting times are possible with the TA, setting the direction of development within the team and for the project, and creating most frameworks for presentations and leading those presentations. I do need to mention that we as a team do a very good job of managing as a team meaning that we always include the opinions of other team members and we always are on the same page.

One technical contribution to the project that I did was put together the main environment of our scene. This was done with preset objects from the Unity store. Another team member created the Navmesh that our AIs use and this was done via the automated process from Unity. This scene features an urban environment in a cartoony style that will be good enough of graphics for the virtual reality visualization. I will be in charge of expanding in this environment if necessary when we get more feedback from our project partner.

Another technical contribution for this project, and one that I will be in charge of in the future, will be handling the main game loop for our game. This means that I will be in charge of developing the mechanics by which the victory conditions are determined and how each team can arrive there. This is something that is mostly in the concept phase at this point as we are waiting on the feedback from our project partner. I have put in paper the conditions we will use however if our project partner does not give us those conditions.

Overall, the progress of the project has been slower than expected. We have been nearly following our iteration plan, but I would say that we are about 3 weeks or more behind. Part of this issue has been communication

issues with our Project Partner where he has not answered very many of our questions as towards how features should be implemented and we as a group have prioritized other projects over this one.

Johnathan Webb

I am attending Oregon State University in pursuit of a B.S. in computer science with a focus in databases and mathematics. One of my main interests recently in software is in computer vision, mainly in the usage of identifying specific things within photos be it people or certain objects. I plan to get into either database design and management or image processing in some way.

I have been working on the implementation of the VR controls within the environment. The system has taken more time than had been initially expected as the usage of the Oculus Quest is not as developer friendly as I would have liked as it requires the usage of a developer account and the users cell phone to turn on developer mode in order to upload their own software on the Quest itself. As of right now the user can access the simulation using the VR headset and move around freely using the joystick controller in order to move around.

I am now working on building the user controls of units and allowing them to interact within the game with the units and the UI itself. This will allow the user to send commands to the specific units and also allow them to start and stop the game when they so choose. After this portion is done the ability of running purely on the Quest by itself will be implemented as this portion has been the most difficult to implement as the current project has a great deal of conflicts needing to be addressed before it will be allowed to run on the Quest by itself.

Brenden Smith

I am currently attending Oregon State University for my B.S. in computer science with a focus in Artificial intelligence. I have been working to use what I have learned to help the development of this project.

I have worked producing keyboard controls and prefabs for the project enemy/ally AI. Specifically, by creating vision detection and movement capabilities. The pathing for the AI was done by mapping terrain models and baking a navigation mesh. This navigation mesh is used by the AI to determine the best route to a destination given a location.

Currently I am working on producing a finite state machine (FSM) for enemy behavior. This FSM will have much overlap with the ally behavior but will not receive state updates or orders from the user. The ally FSM will take user orders and commands into consideration when choosing states.

Progress is being made with NPC development, but units are currently at a very basic level. Completing the NPC behavior will be a big priority for development. Setbacks have occurred due to communication with our project partner, but this has hopefully been solved.