

# Virtual Reality Environments

## PROJECT PLAN

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# 1 Introduction

## 1.1 PROJECT STATEMENT

Explain what the project is about. What are you trying to do?

The project is to design a simulation for multiple people in a virtual reality environment (VRE), using the HTC Vive Head Mounted Display (HMD). Currently, the Vive is only designed for a single person in an environment. There are some instances of there being multiple people in the same environment, but not in the capacity that our client wants.

## 1.2 PURPOSE

Explain what is driving this project. Why is this work of benefit to the society?

Our client wants to create a platform to facilitate multiple people in a VRE with the HTC Vive HMD. He wants to use this platform to allow for multiple people (e.g. astronauts, soldiers, firefighters, and law enforcement personnel) to interact with each other in a VRE. Along with this basic interaction, he wants them to be able to engage in group decision making and exchange information, all while in the environment.

## 1.3 GOALS

Explain what you hope to accomplish through this particular senior design project. What would you like to achieve? Enlist as many goals as you can envision.

The main goal is to have multiple people in a single VRE at the same time. Other goals include: representation of people in the VRE to others, communication in a selective manner between two individuals, various types of locomotion within the VRE, two different types of decision matrices: full release and diffusive, recording of decision matrices interactions, recording feedback from the people in the VRE about the scene they just interacted with, and finally the ability to playback the entire simulation with the ability to go to certain spots and speed up and slow down time.

# 2 Deliverables

These tie in with the goals. What deliverables are necessary to meet the goals outlined in the introduction?

We need to come up with a way to allow multiple people to interact with each other in the same VRE. More specifically, we need to make this intuitive for the person creating the simulation. What goes on behind the scenes in the networking that allows multiple people to interact can get very confusing; this needs to be made somewhat simple to interact with.

The presentation of people to others within the VRE will be implemented using an avatar or some other type of virtual presence. The communication between two people will be done by having a menu come up upon pressing a button that will allow one person to select any number of other people that are in the VRE to talk to. Specifically, only the people that are selected will be able to hear and speak to each other. The ability to move in a VRE can be accomplished in many

different fashions. Our client wants the facilitation of multiple ways to be accessible while in the simulation; we intend to create some sort of a radial menu attached to one of the Vive's motion controller's touchpad. This radial menu will house different “forms” of movement. What this is means, is that by clicking in a certain portion of the radial menu, the user will change the way in which they move. For example, say you start the simulation with P2V (position-to-velocity) and you come to a point where you need to move up to a ledge or over an obstacle, using the radial menu, the user could switch to teleportation. For the P2V, we also intend to implement a way in which the speed can be adjusted, possibly also using a radial menu.

The decision matrices and the input recording go hand in hand. The first type of matrix, full release, is simply a matrix that will appear to the user either upon triggering it by interacting with something in the VRE or by calling it with a button. All the interactions that the user has with the matrix will be recorded in an XML file formatted in such a way that it will be able to be “parsed” by an already existing application for later review. Also, to be stored in the XML file will be the decision matrix itself, specifically in a way that will allow it to be recreated with this parser. We need to come up with a way to format the XML file so that the parser can read it; to do this, we will use the built-in functionality of Serializability in C#. The second type of matrix, diffusive, will be similarly called into view as the full release type, however this matrix's cells will need to be “asked for” by the user. Meaning that not all the cells will be visible in the beginning and only cells that are specifically asked for will be shown. This will also need to be logged in the XML file. See the figure below for a distinction between full release and diffusive matrices.

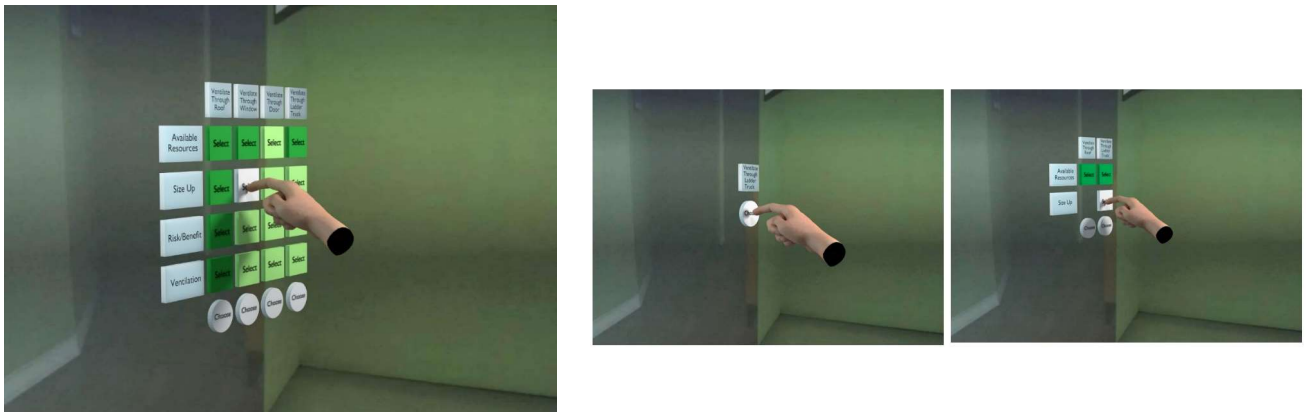


Figure: The two types of matrices: full release on the left, diffusive on the right.

The final aspect that we need to implement is the playback of the simulation. For this, we will need to figure out how to record what is happening in the seen, and not just from the perspectives of the users, but from any conceivable angle. Also needed is a way in which to have a third-party create a “bookmark” to be easily able to go back to any point in the simulation. Lastly, the ability to play, pause, fast-forward, and rewind the playback will need to be addressed with the ability to fast-forward and rewind at various speeds.

## 3 Design

Include any possible methods and/or solutions for approaching the project at hand. You may want to include diagrams such as flowcharts to, block diagrams, or other types to visualize these concepts.

There exist two platforms that are widely available for which previous VR programming has been done. One is Unity3D and the other is Unreal Engine.

### 3.1 PREVIOUS WORK/LITERATURE

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

A program very much like this one, does already exist for the C6. This program was also made for our client, by people employed by ISU. We are working closely with this team.

### 3.2 PROPOSED SYSTEM BLOCK DIAGRAM

For most groups, you can include a flowchart of how the system will work. In case your project is not about putting together some sort of a system, you may describe the process that you will follow to achieve your deliverables.

See Appendix A for flowchart.

### 3.3 ASSESSMENT OF PROPOSED METHODS

Provide a short discussion about the different approaches available and the approach you want to follow in your work.

Valve Corporation (the company that collaborated with HTC to provide software) has an asset for Unity called SteamVR which makes programming for the Vive relatively straight-forward. So, we will use Unity3D for all intents and purposes.

### 3.4 VALIDATION

How will you confirm that your solutions work?

We will test them against the existing simulation in the C6.

## 4 Project Requirements/Specifications

### 4.1 FUNCTIONAL

List and explain the functional requirements of the project. This would include all the technical requirements you fulfil during your senior design project.

Having multiple people in the same VRE, this will include all the networking features previously described.

Movement, this will include the various types of locomotion as well as the ability to select various types.

Decision matrices and input recording, this will include the two different types of matrices as well as the ability record all interactions with these matrices.

The playback of the simulation, this will include the ability to view from any angle, go to bookmarks, as well as pausing fast-forwarding and rewinding at various speeds.

### 4.2 NON-FUNCTIONAL

List and explain the non-functional requirements of the project. This is where you would enlist non-technical requirements. This may still be a fundamental deliverable that your client needs at the end of the semester.

Representation of people in the VRE, the client requires this, but it isn't necessary for the simulation to function properly.

Communication between people in the VRE, again, the client requires this, but it isn't necessary for the simulation to function properly.

Recording feedback about scene, also required by client, but not necessary for the simulation to run.

## 5 Challenges

Include any concerns or details that may slow or hinder your plan as it is now. These may include anything to do with costs, materials, equipment, knowledge of area, accuracy issues, etc.

There are two main challenges that we foresee with this project. The first is to do with the networking involved with the multiple people in the same VRE. The challenge here is that there is little support for this type of interaction. That which does exist is mostly proprietary and build from the ground up. Currently, we are using a Unity plug-in that helps in facilitating the connection between two people, however as it is right now, it is very user unfriendly and only works over a Local Area Network. The second challenge is based around the playback system. Again, there is little to no support for this. Currently, we are not quite sure how we will do this. We are exploring a method of logging all interactions with the environment into an XML file.

## 6 Timeline

You may want to include a Gantt chart/something similar to help visualize your timeline to complete the project.

See Gantt chart in Appendix B.

### 6.1 FIRST SEMESTER

Breakdown your timeline into detail of what needs to be done by the end of the first semester. You may want to include division of work amongst the team.

Our plan for the first semester is to have a working simulation, albeit slightly rough around the edges. This means that all the core functionality, including multiple people in the same VRE at one time, movement around the VRE, the decision matrices, and possibly the recording of inputs.

### 6.2 SECOND SEMESTER

Detail what needs to be done in the second semester. You may want to include division of work amongst the team.

In second semester, we plan to “polish” the simulation. This would include such things as the representation of people in the VRE to others. We also plan to do the communication between two people in this semester as well as finishing (if not already done) the recording of inputs from the users, the feedback recording from the user about the scene they just interacted with, and finally the playback of the simulation.

## 7 Conclusions

Sum up your project plan. Briefly re-iterate your goals for the project and the plan your team has put in place to achieve these goals.

Our main goal is to make it possible for multiple people to interact with each other in the same VRE. Beyond that however, we need to make this interaction as smooth as possible, and the way in which the connection is made must be simple as well. To represent people in the VRE we will most likely use some sort of avatar. To facilitate communication between two people we will most likely use some sort of third party software that we will control through Unity. We will have two main types of locomotion (P2V and Teleportation) that will be able to be switched between by the user. We will have the two different types of matrices (full release and diffusive) that all interactions the user makes with will be recorded to an XML file for use in the playback of the simulation. Lastly, we will have an interface that the user will be able to interact with and report feedback about the scene they just interacted with.

## 8 References

List all the sources you used in understanding your project statement, defining your goals and your system design. This report will help you collect all the useful sources together so you can go back and use them when you need them.

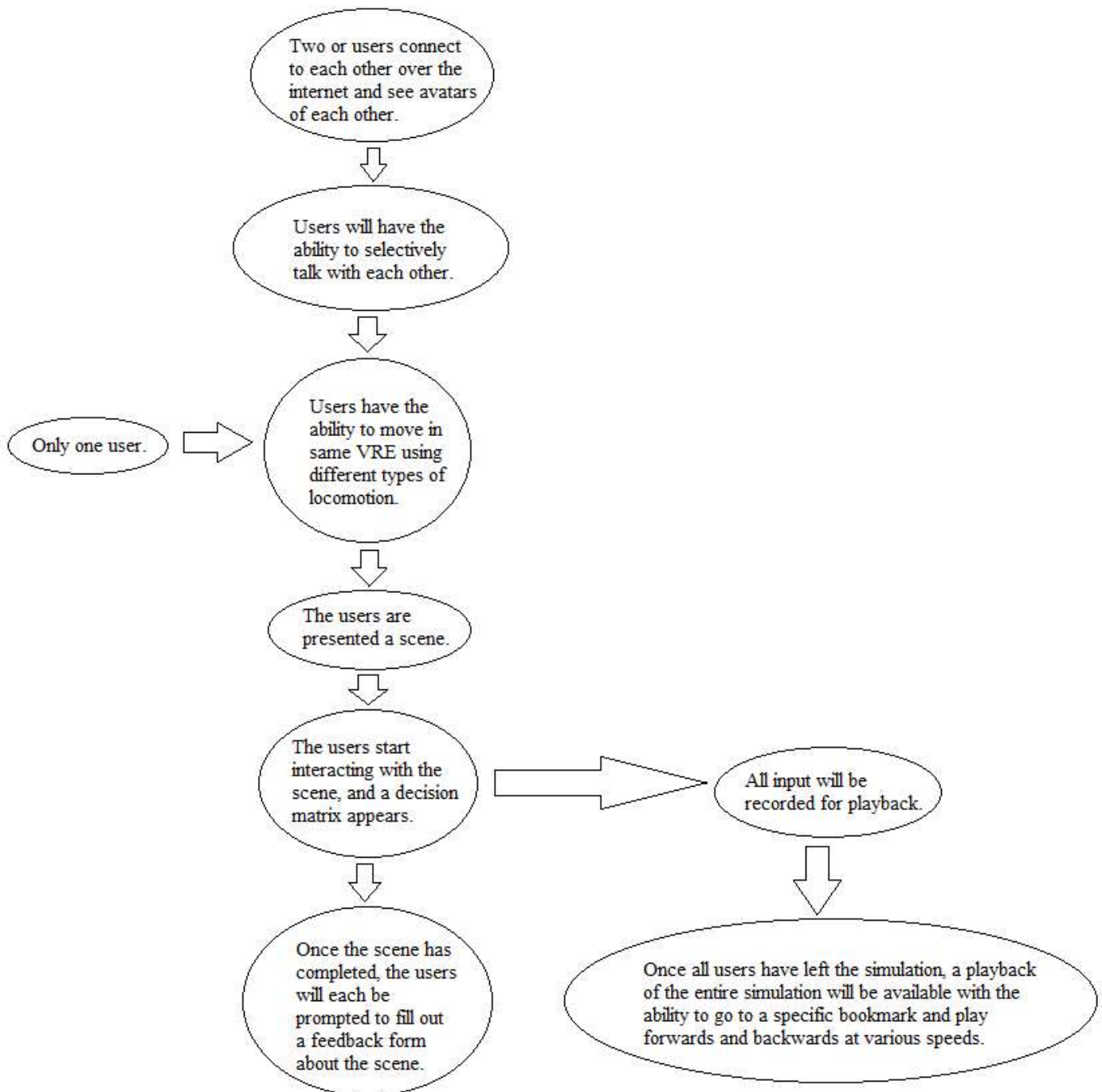
The Scope document given to us by our client.



## 9 Appendices

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. You may also include your Gantt chart over here.

Appendix A



# Virtual Reality Environments

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