EE 496: Midway Report

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We designed our project to be an interactive, educational experience using the Microsoft Hololens. Users are intended to wear a Microsoft Hololens and participate in our application that we design using Unity.

Starting this project off, we decided to go with bottom-up approach. We both did not have experience working with a Microsoft Hololens and wanted to learn the skills and tools necessary to make our project possible. The starting point was to look up tutorials for the Microsoft Hololens and integrating Unity to learn some of the functions we could possibly do with the Microsoft Hololens. This includes interaction techniques such as gaze, voice control, and hand gestures in order to interact with our environment. These interactions were practiced and demonstrated in the Microsoft Academy Tutorial titled "Origami".

After starting with the bottom-up approach, we ran into some difficulties. We realized that although we had a lot of good ideas, we didn't really have an end goal of what we were going to do with our project. There was also the issue of the resources that were available to us as we wanted programs such as a full version of a program called Vuforia but the price was outside of our budget.

From here, we changed to a top-down approach. That way we could have a end goal in mind and then figure out what resources we needed in order to accomplish our goal. We decided that our goal was to pursue the idea of immersive education, where we could create an augmented reality simulation to enhance the learning process of an individual. We decided to start with a windmill simulation and experimenting with height, number of blades, and blade shape. We saw an advertisement for augmented reality devices involving a windmill and wanted to try and replicate it. By creating a simple proof of concept, we could then expand our ideas further to create something bigger in the future but the windmill would act as our minimal viable product.

We would break up the design of our windmill simulation into multiple phases. Phase one would be to create a server that runs a web based application programming interface (API). Our Microsoft Hololens application would interact with our server on which the data required to render the windmill would be stored. The user would then have the ability to interact with the server using a web interface. This would allow us to create a dashboard or control panel by which the user or users could interact with the application. An alternate design choice that we could have made is to have everything self-contained within our application itself, we will explain our design choice later.

Phase two would be creating an object and having it to be seen through the Microsoft Hololens using Unity as well as changing the object on command. The entire point of the Microsoft Hololens is to see some type of hologram so by just seeing an object through the Microsoft Hololens would definitely be a big success. We could see where the object would be placed upon opening the application and then adjust the position of the camera in order to get a clearer view of the object. From there, we would attempt to change the object's shape based on the command from web interface. This phase was important because by accomplishing these two tasks would confirm our proof of concept.

Phase three would be the easiest and would be to create the windmills. This part would not be too difficult in terms of creating the shape. There was some intricacy when getting the fans to rotate but other than that, this would be the last step and the windmill would be our end goal as well.

At this midway point, we are working towards creating our minimal viable product (MVP). Up to this point we have shifted direction from our original intent of an Augmented Reality Campus Tour and started working on creating an Augmented Reality instructional experience that is intended for use in a classroom or other educational settings.

Our original design process involved us getting up to speed with using the Microsoft Hololens and well as using Unity to create Augmented Reality applications. We first used the tutorials provided in Microsoft's Mixed Reality Academy to design our first few sample applications on the Microsoft Hololens device.

Our first sample application involved us properly configuring our Unity editor to work on and deploy Microsoft Mixed Reality applications. We originally had an issue with the compatibility of our particular version of Unity and the Microsoft Hololens software development kit (SDK) that was provided to us by Microsoft. We circumvented this problem by simply using an older version of Unity that was known to be compatible.

After solving that issue, we were able to create a holographic image that we were able to deploy to the Microsoft Hololens using Visual Studios.

We continued to follow the tutorials which involved integrating various gestures, voice commands, and gaze controls into our starter application. This was a valuable step in our design process because it allowed us to see what additional features that the Microsoft Hololens offered us that other mixed reality platforms didn't offer. We wanted to make it a point to highlight these features and heavily integrate them into our final product.

We then explored the use of Vuforia in our Unity Projects. Vuforia is an augmented reality platform that offers features such as model targeting, image targeting, and object targeting. Our original plan was to utilize either model or object targeting to recognize the Gate of Hope sculpture in front of Holmes Hall in order to create an interactive experience with the Gate of Hope.

However, we decided to shift gears after listening to Professor Carlson's immersive education idea. We felt like we wanted to fit in with this vision, so we decided to design an interactive education experience. After conducting research on existing projects similar to ours, we found that we could design an experience that demonstrates how modifying the properties of a windmill affects it's efficiency, power generation, and cost.

We made the design choice to use a client-server model where we can run a web-based API as our server on a virtual machine and have the application running on the Microsoft Hololens be the client application. The reason we decided to make this design choice was that it allowed us to have flexibility on how we want our application to behave.

Currently, we have the server running one instance of a windmill and any client application that connects to our server will see the same data that any other client application sees. The reason we see this as being useful is that if the instructor of the experience wants each Microsoft Hololens application to see the same thing that they are seeing.

However, we can use this client-server model and have the server run multiple instances of windmills that are unique to each client. The reason we see this as being useful is that after the instructor is done demo-ing the experience, each individual client application can explore and experiment with the properties of the windmill. The data will still be stored on the server so the instructor can still view what each student is doing and for either scoring or grading purposes, the data for what the best windmill is and who created it, is stored on the server.

An issues that we have yet to solve is that when running the application in the Unity editor, we can connect to our server without any issues. However, after deploying the application to the Microsoft Hololens, we are having issues connecting our client to our server.

Using this design, we have our client application constantly hitting the server and getting the current status of the windmill. The status of the windmill can be changed through a web-based interface for ease-of-use. Every time our client application sees an update in the current status of the windmill, we change the displayed prefabrication to the correct windmill that the server is storing.

Some challenges we for see with this is that it generates a lot of network traffic. One way to get around this is to have the server notify the client when the state of the windmill changes as opposed to the client constantly checking the server. The reason that large amounts of network traffic could be an issues is that if we wanted to scale this idea up, we may congest a low-bandwidth network rather quickly.

Some of our future plans for the application is to integrate mixed reality into the experience. We plan to use image recognition provided by Vuforia to display the windmill prefab on the image. This would allow users to move the windmill and face it in different directions if they wanted to see more details or view the windmill from a different angle.

We also have ideas of creating another entity like mountains or towns that can affect the windmill. For example, the distance of the windmill from the town that its trying to power will affect the amount of energy that the windmill can deliver, or if the mountains are in the way of the wind, the windmill must be taller in order to catch the wind and generate power.

We want to make our design and final project as modular as possible so that it can be applicable to other educational experiences as well.

EE491F Multimedia Programming knowledge and skills was helpful for this course by learning how to program in Unity using C#. Most of the project itself is in Unity and the content was heavily used in this project. Using basic coding techniques such as conditional statements, dot operators, abstraction, and classes were used in the project.

We also took some information from the EE438 Renewable Energy to get a little more insight on windmills. We learned about how the height of the windmill as well as the number of blades affect the efficiency of the windmill. By taking this knowledge, we could accurately measure how much faster or slower a windmill would be by changing parameters of the windmill.

Dylan, being more familiar with the API would focus more on the server side and web-based application. Keane, being more familiar with Unity would work with Unity and attempting to get working holograms on the Microsoft Hololens. There were a lot of areas that we were both unsure of and with that being said, we would both try to do research whenever we could stuck. For example, when looking into Vuforia and knowing the cost of the program, we started looking into cheaper alternative methods in order to accomplish our goal. After looking up some alternatives, Dylan suggested using an API for the project. We eventually want to integrate Unity and a way to see Holograms by looking at certain objects but the API was definitely a major turning point in the project.

For this project, we want to make this as cost efficient as possible as we are limited in the amount of resources that are applied to use. Costly programs such as Vuforia were not in the budget so we would have to find an alternative method in order to accomplish our goal. Also, we want our project to be used by most people and if they would want to replicate it, they would not need to buy a costly program. However, with that being said, we are hoping that devices such as the Microsoft Hololens will become more affordable in the future and be a few hundred dollars rather than a few thousand dollars.

The main environmental impact of our current windmill educational experience would be that it could generate interest in renewable energy. By providing a fun and interactive experience that both young children and adults could enjoy, we can promote and demonstrate the usefulness and applications of renewable energy sources.

This ties in closely with the environmental impact, that by providing a fun and interesting way to teach people about renewable and sustainable energy, we can generate more support or interest in the topic which is especially relevant in Hawaii.

The idea of immersive education could change the way that we educate and train people. If ideas and concepts of mixed reality can be pulled from our project, it can change the way that children begin to learn in the classroom and the way that we can re-train the large amount of displaced workers that will come due to the increased availability and efficiency of technological systems.

According to the IEEE Code of Ethics, we do not run into issues such as conflicts of interests, malicious actions, or bribery. Our project is being done in the best interest of the public by helping students learn more efficiently as well as helping displaced workers. As technology becomes more advanced, more workers will tend to be displaced and they may need to learn new skills sets fast in order to find a new job and sustain their life. If there is any unethical situation to arise, Dylan would acknowledge it and come forth with it to avoid danger to the public.

We would not recommend that anyone who becomes dizzy or disoriented continue using the Microsoft Hololens and to take it off immediately to rest the individual's eyes from more strain. We would hope that the reason we are using augmented reality versus virtual reality would cause less motion sickness because you are still able to see the world around you. In terms of safety, if moving around with the Microsoft Hololens, we would ask people to be aware of their surroundings when using the Microsoft Hololens so that they do not trip over anything possibly causing injury.

The mixed reality concepts from our project can be used to change the way that we interact with people and distribute information to others. A large scale augmented reality network could revolutionize the way that we communicate, both for fun and for work. Having an interactive experience with someone outside of your close proximity could change the way humans work, have relationships, and go about their daily lives.

Our end product would be used for educational purposes only so that we could avoid the abuse or overuse of augmented reality. There were issues with people using augmented reality in public such as the phone application Pokemon Go where people would put themselves in danger using the application while crossing streets or driving. Our application would be only used in classroom type settings to avoid any litigation possibilities. As for accessibility, we are hoping that augmented reality devices such as the Microsoft Hololens will become more accessible to the public in the future as well as to compensate for people with disabilities.