Mid-Year Technical Report

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1.0 Model Development

1.1 Software

The software that was used to develop the prototype was Unity. The Unity software allows the user to create 2d and 3d games and projects, giving easy access to many useful tools and add-ons. This was also suitable because the project that was being continued from 2019, also used the unity software for the HoloLens development. Unity also allows projects on multiple different platforms ranging from PC, to android devices, to iOS devices, to universal windows platforms. This made it possible to import assets from the previous year's project into the current year's project.

The intended target device this project was an android device due to it being easier to upload apps onto the play store, making it easier for trial participants to access.

Initially, AR Foundation was used to develop the software. This was chosen due to it giving the user the ability to create an app that would be compatible with both android and iOS devices (Unity, 2019). This was essential due to the members in our project group having different devices. After developing the model to a certain extent using AR Foundation, it was found that some devices were better at using their camera to detect surfaces than others. For example, some smartphone devices had multiple cameras which significantly improved their ability to sense depth. As the project was aimed to be usable by anybody with access to a smartphone, it was decided that using AR Foundation would not guarantee a certain level of usability for the user, depending on what type of device they had.

Therefore, a switch was made to Vuforia, which was a unity add-on that allowed the use of image targets for the camera to detect and then produce a model in a position relative to the image target (Vuforia, n.d.). This proved to be much more effective as any device with a camera was able to track the image reliably.

Using Vuforia also provided more resources online due to it existing for a longer period of time than AR Foundation (Circuit Stream, 2020). More forums and discussions around certain development subjects proved to be useful.

The model used in the project was imported from the previous year's project so that the trial and experiment results from last year, and this year would be comparable.

1.2 Features

1.2.1 Drag, Rescale and Rotate

The final application had a variety of features that allowed the user to manipulate the house model by resizing and rotating it about its axis using a two-finger touch mechanism that would be intuitive to the user. A single finger drag allows the user to move the model around relative to the image target. Both the rescale and Rotate functions are intuitive and easy for a smartphone user to understand.

1.2.2 Highlight and Delete

The application also gave the user the ability to highlight, delete and undo the individual components of the house model such as the roof, walls, or pieces of furniture. These functions are turned on and off through the use of UI buttons, and there are also undo buttons to correct any accidental delete or highlight actions. The delete and highlight functions were developed with C# using visual studio's integration with Unity.

1.2.3 Virtual Buttons

Virtual buttons are where the user can hover their finger over a certain portion of the image target which will trigger an event. In this case, the virtual buttons can be used to switch between different versions of the house model. In total there are five virtual buttons on the main image target, which will each cause one of the following to show up; the full house model, the house with the roof lifted upward, the house with the first floor lifted upward, the kitchen and the lounge. This could be useful to the user if they were to be more interested in one particular room or floor of the house.

1.2.4 User Interface

UI buttons on-screen are used to change between the delete and highlight modes. Another undo button is present for each of delete and the highlight functions. There is also a UI button that can be used to hide the rest of the UI buttons to clear up screen space and give more room to view the model.

1.2.5 Tutorial

All of the features of the applications were intuitive and could be understood without the need for a tutorial. However, one was put in by having a separate image target that would give the reader text to read that would explain how the different features worked. The user has the ability to switch between the different blocks of text by using virtual buttons.

2.0 Experiment:

The aim of the experiment is to compare the ease of understanding between the paper drawings and the Augmented reality application that was developed. The intention is to compare the results with those of last year and see whether smartphone AR would be a suitable alternative to a goggled AR device such as the HoloLens.

The experimental method was disrupted by COVID-19 and was changed so it could be completed away from campus and without the need for the project group members to be present.
The experiment will be similar to the previous year's experiment where the participant will answer questions that will be related to certain features in the house model, and whether there are any errors such as fewer lighting fixtures than there should be.

The design that is used in the model has inconsistencies that are built into the model which are visible on both the paper drawings and the AR app. These mistakes are categorised into general and specific. The general mistakes are things which would not be right in any house. For example, there is a toilet out on the deck in the open; the television is facing the wall, the fireplace is facing the wrong way, along with others.
The specific mistakes are where there are more or less specific items that are specified on the specific criteria. This could include things such as there should be more than eight lights in a particular room, or there should be less than ten items to sit on in this room.

This task is used to test the user's ability to visualise the house model and compare how efficiently they can detect the errors using the paper drawings or the AR application. Finding errors would be similar to what some parties would have to do in an AEC design meeting, so this task would be a good way to measure it.

The second task is to get the user to delete and highlight a certain window in a room. This task is also carried out on paper by annotating the drawings. It is expected that the ability to freely see inside the house model in AR would make it easier to find the specified window when compared to the orthogonal drawings provided on paper.

Another task is to ask the user to explain what they like and what they don't like about the kitchen of the house. This requires the user to visualise for a different purpose than to find specific errors or inconsistencies. The participant will have to visualise what they see in the house and also communicate the different aspects which they like and dislike. This would be an essential part of AEC design meetings as clients would want to be able to communicate with the architects and engineers what they like and what they do not like about a particular design.
Finally, the participant is then asked to answer a series of questions about which medium they found easier and how difficult they found the experiment. These questions are to be answered using a linear scale from 1 to 5.

2.1 Pilot Test

After developing a reasonably usable prototype for the experiment, it was tested on a small number of selected people, who were able to give constructive feedback. It was found that the app was generally usable, although the frame rate would still drop when certain parts of the model were generated.

Another issue identified was related to the undo button. The undo button function was supposed to undo the last object that had been deleted or highlighted. However, it was found that the button was undoing the altered objects in the wrong order, with the first deleted or highlighted item being restored first.

An issue was also found where the buttons didn't stop the app from picking up a touch input on the area hidden by the button. This means that if the user wanted to push the highlight button again to turn off the highlight function, it would actually highlight any object that was hidden behind the button before turning the highlight function off.

Users also found that the on-screen UI buttons were overcrowding the screen and making it difficult to view the model. To solve this problem, another UI button was added, which hides and unhides all the other buttons making the screen less crowded.

2.2 Future Trials

In the future, the experiment will be carried out entirely, and once the data is gathered, it can be analysed. The analysed data can then be compared with the previous year's results, and a conclusion can be made regarding whether smartphone Augmented Reality would be a feasible alternative to the HoloLens.

2.3 Limitations

This application is a significant simplification of what would be occurring in real-life design meetings which should be considered when considering the validity of this research. For example, the simple highlighting and deleting of a window would not be a complete and accurate representation of all possible annotations or comments that could be made in a design meeting.
Another limitation would be that the participants of this study would all be engineering students of the university. Although they may have some experience, they may not be fully competent with the usage of design drawings and AR technology.

3.0 References

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