PUTTING THE AR IN ARCHITECTURE;

Integrating voice recognition and gesture control for Augmented Reality interaction to enhance design practice

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Abstract. A large part of the architectural design process involves understanding and developing design concepts through visualisations, often in the form of explorable 3D models. While it is possible to produce multiple design iterations and animations in a range of computer-aided design (CAD) software, the desktop computer screen is a limited medium for communicating information to large teams and clients. Augmented Reality (AR) and Virtual Reality (VR) is the closest way to replicating our world and how we see it, however the technology is still in its early stages and is constantly under development. The research presented in this paper suggests a new method where AR is used to present and edit project models using both hand gestures and voice recognition software. AR technologies and VR headsets are alternatives that have offered extended ways to allow multiple stakeholders to effectively immerse themselves in 3D representations of design projects. However, to interact with these immersive 3D spaces and to explore design modifications requires the development of new workflows to address the interoperability between (CAD) design software, visualisation software and AR/VR hardware. While numerous projects have addressed software interoperability issues, user-interaction in an AR space remains a developing area of crucial research. Although hand-gestures are the typical form of model-state control employed in such systems, voice-control is emerging as a highly desirable and everyday form of human-computer interaction.

Keywords. Augmented Reality, Architecture, Design Workflows, Human Computer Interaction

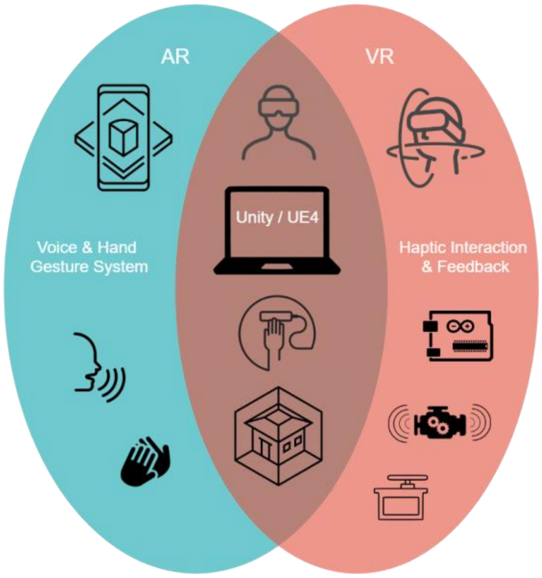

Figure 1. Aron Sheldon and Daniel Camacho

1. Introduction: Research Aims and Motivations

The aim of this research is to create a more intuitive and user-friendly interface to AR generated 3D digital architecture models, using voice command and hand gestures, to allow designers and architects to view *and* edit models of projects in real time.

In architecture, designers generally follow a similar process of design thinking and collaborating in projects. A large part of the design process involves collaboration and testing designs, however the current design process used by architects is lacking a fast and intuitive means of visualising their projects. The ease and diversity of design communication methods can significantly influence a project's success. The way in which the architects are able to see the project and the way in which they sell it, is pivotal to success.

Augmented reality (AR) offers a new tool in the architectural design process; a new layer in the design process, where designers have the ability to show their designs in a 3D space. Thanks to new research by Fologram, an AR research company based in Melbourne, designers can now see live updates of their designs in AR. This development in design visualisations and testing is starting to be used across architectural firms and is becoming accepted into practice as a tool for presenting projects to clients and fellow designers and architects. Constantly evaluating and iterating a design is crucial to its success, and with the help of this technology it can be done with more ease and depth.

However, the way humans currently interact with this new powerful tool is limited.

Currently users utilise hand gestures in order to control elements in the software, such as to select and move things. The hand gestures themselves are useful and intuitive to human behaviour, however there are other, potentially more accessible and easier ways to achieve human-computer interaction. When interacting and communicating it is natural for people to not just use their hands, but also their voice; it is this fundamental human behaviour that needs to become a more prominent aspect of how we interact with and present designs in AR. The impact of this development will help allow designers and architects to present and evaluate work in more intuitive and simpler ways.

2. Research Observations and Objectives

Currently the AEC industry uses AR and VR systems for visualizing final renders of projects and is seen as a purely static tool. My research project suggests that this is an underutilisation of the technology, and proposes a new opportunity for the technology, and a in turn a new and more intuitive means of designing and editing buildings for architects and designers.

The research will explore how users can interact with AR using their voice and hands. The project will improve how designers and architects can edit and view their projects in an AR environment, by implementing a joint voice and improved hand gesture control in the form of a software or system. In AR designers will be able to edit their projects in real time using their voice and hand gestures whilst having a clear and beautiful visual render of their designs. The end result intent is creating a voice and hand-gesture controlled AR system that is a clean interactive and intuitive way (for architects and designers) to work in real time within AR.

This research project is part of a collaboration between UNSW and PTW Architects Sydney. The research sits under an umbrella project which also involved research by Daniel Camacho; “Hands on Design: Integrating haptic interaction and feedback in virtual environments for enhanced immersive experiences in design practice”, who is producing a workflow that enables focusing on creating haptic feedback and interaction in virtual environments

3. Research Questions

The following questions represent my line of research inquiry and will direct my project focus.

What hand gestures are currently used in existing AR games and environments

How can further hand gestures be developed?

What are the limitations of hand gestures?

Is it possible to create a voice control index which can define a list of words that would relate back to certain layers in a model?
What are the limitations of voice control?
Is there a way to bring voice control into an AR environment?
Is it possible to mix a voice command to then work with and *trigger* a hand gesture command (or vice versa)?

4. Methodology

4.1 RESEARCH METHODOLOGY

I will use an action research methodology throughout this project.

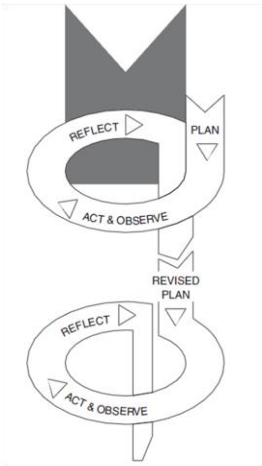

Figure 2. Kemmis and McTaggart (2000).

The diagram above, showcases the action-research spiral which is the basis for how I intend to proceed with the project. The method consists of numerous iteration cycles, the number of cycles can be whatever is deemed necessary to fulfil the needs of the user. The designer can then test a hypothesis, idea or product for a project and once the test is complete they can then reflect and re-evaluate their conclusions. The next step involves revising what was learnt and creating another test to refine the user's design.

For this project this process will be done three times for three iterations until the final system is created. I decided on three iterations as I believe that this would allow time for me to focus on the three key areas of the system I wanted to create; to connect the headset and software, to create a script for hand gestures and lastly to create a script for voice recognition. Each iteration however will have smaller iterations within its cycle as issues will inevitably arise during testing of each new piece of software.

The literature review will be focused on conducting online research into articles and reviews of AR as a technology, followed by researching how current architecture firms are implementing AR in their practice.

Understanding the history of AR; how and why it began, a thorough summary of AR's use in the architecture, engineering and construction (AEC) industry, as well as the opportunity and niche in which my project will fit. By researching online to find scholarly articles, as well as UNSW's library for the necessary articles to be sourced. Reputable websites and online blogs will also be noted as part of background research to gain a greater understanding of current and previous work done in AR in architecture.

Figure 3 illustrates the workflow I plan to implement for the system. This workflow utilises the visual studio C# scripting for the voice recognition and hand gestures and is reflective of the decision to no longer use the leap motion for hand gesture recognition in the final system.

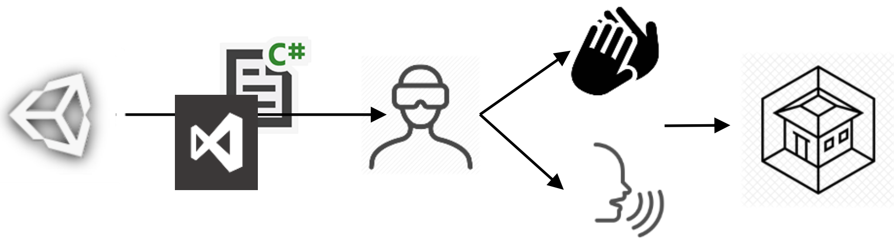

Figure 3. Aron Sheldon System Workflow DIagram

4.2 DESIGN METHODOLOGY: PRACTICAL

For the technical and practical side of the research a technology review will be undertaken as well as a comparison study of existing technology using Augmented Reality. This will be followed by prototyping workflows to explore user-intelligence combinations. These prototypes will test the use of hand gestures as well as voice control as a way of editing projects directly in an AR environment.

As part of the research, informal discussions will be done with the industry partner, PTW, to determine a common vocabulary for CAD software, this will then be used to formulate the index library for the voice control side of the AR program.

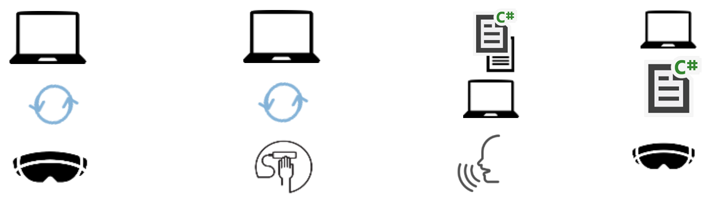

Figure 4. Aron Sheldon Project Methodology Diagram

Figure 4, above, shows the methodology I intended to work through for the research project. The initial software and hardware testing began with using a VR headset; the HTC Vive Pro HMD. Testing was done to test the performance of the AR/VR software. The headset was then used as a base to test other technologies relevant to the project, being Unreal Engine 4, Unity, Leap Motion as well as for testing plugins for hand gesture control and voice control. The second stage of testing on the final headset device for AR; the Hololens, then gave way to the three iterations. The testing of these elements will be used as prototyping for the final project. Three main prototypes will be produced to ensure the end product is optimised.
The first prototype and testing phase will cover the initial testing of the Hololens headset. It will also involve connecting the headset and software to Unity.
The second prototype will involve engaging the Leap-Motion as a technology for sensing hand gestures. Using Unity and the Leap-Motion Plugin, testing will be done to create a workflow between the two technologies and the headset. It was later decided after the testing of the leap motion that the visual studio scripting would be a more suitable system to capture the user’s gestures.

Then the third and final prototype will need to incorporate the voice control plugin for Unity and will then integrate with the Leap-Motion to create an optimised collaborative system combining all technologies together.

The final system will provide users with a new interface for their AR models, where they can interact and edit their models like never before; using their voice and simple hand gestures. The system will be fluid and will be simple and intuitive for all users.

5. Background Research

In order to understand the possibilities of AR I researched into the different types of AR currently being used and developed.
Types of AR currently being used are:
Marker-based
Marker-less
Projection
Superimposition-based

MARKER-BASED

Figure 5. Marker Based AR example

This type of AR is also known as Image-Recognition or recognition-based AR and involves using the camera on an AR capable device to recognise an image. The visual marker is read by the camera and in turn displays information for the viewer.

MARKER-LESS

Figure 6. Marker-less AR example

This form of AR is also called location-based AR and is the most used method of AR in Architecture.

It is the only type of AR system that does not require some kind of recognition system, it purely relies on locations tools in order to understand context. Location based tools being GPS, Velocity meter and Accelerometer.

PROJECTION AR

Figure 7. Project AR example

This method uses lights and visuals of information or data and projects these from the device onto any surface. This is a simple method however it doesn't work as well in well-lit spaces as the projections will be lost in the light.
One such method of doing this is by using lasers to project information onto the ground or any surface in the real world - this would be done with the help of sensors (for depth perception)

SUPERIMPOSITION-BASED AR

Figure 8. Superimposition-Based AR Example

This technology relies heavily on object recognition
The augmented image will replace the original image fully or in part - it is especially useful in the medical field
For architects it can be used for studying the structural makeup of a built building in order to see through the concrete. This allows for other stakeholders in a project to identify existing plumbing and electrical infrastructure.

Augmented Reality in architecture is a growing area of research and has been developing at a fast pace for the last 3 years. During this time there has been considerable discourse around AR's role and how AR can become more efficient and improve the design process for the AEC Industry. This literature review will identify and analyse articles in this area of research. The history of Augmented Reality, how it's being used in Architecture, how it could be developed and ways it can be improved will be covered in this review.

Augmented reality was only introduced into the Architecture, Engineering and Construction (AEC) Industry in the 90s. In 1991 Augmented Reality was introduced as a tool to the AEC industry. It was an unknown technology at this time, however Feiner and McKeown believed that its usage and [1]potential impact...on architecture and structural engineering will increase. They saw the opportunity it presented as a form of data visualisation, however due to its limitations AR wasn't taken up as an industry standard at this time.

The larger spectrum that AR is a part of is known as the "Virtuality Continuum", this term was first coined by Milgram and Kishino in 1994. It showed that AR was part of a mixed reality where [2]"real and virtual world objects are presented together on a single display". This was a highly important focal point in the history of AR as it represented a solidifying of AR as a tool.

The benefits of AR initially served as an extra visual aid to show a model of a project. Further development of AR overtime has since started to shift away from being a static model towards a more dynamic and detailed visual representation of data.

The design process used by Architects currently utilises AR as part of the final stages of a project. A model of a project can be created and visualised in AR and is effective when communicating ideas, however it isn't highly used during idea generation or when multiple design iterations are occuring.

Currently AR can be viewed and used on multiple devices, such as Mobile Phones, Headsets, Laptops and Tablets. The preferred and more often used device would be the headsets however there has been research looking into the benefits and drawbacks of using mobile devices as an easier and more convenient method of viewing AR. Broschart and Zeile of the University of Kaiserslautern in Germany tested out multiple apps within the University campus in order to summarise and define the most useful apps for Architects

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[1] Feiner&McKeown 1991 (from "Augmented Reality in Architectural Construction, Inspection and Renovation by Webster, Feiner, Macintye, Massie and Krueger

[2] Wang Xiangyu Wang, University of Sydney, Accessed July 23 2018, <https://pdfs.semanticscholar.org/0663/5a53723f8caa726693ac3cb6fd339afbf433.pdf>

and Planners. Their conclusions showed that there were definitely benefits to using a mobile app as it allows multiple users to be using it at the same time, and also allowed for professionals and non-professionals to be able to access certain information about on-campus infrastructure that were otherwise unknown. This method of viewing AR is limited by the size and power of the device being used and therefore is useful for sharing information and data visually to users, however it is not useful in the context of Architecture and Planning where high levels of detail and editing functions are necessary.

Another way AR is being explored in Architecture is as a teaching and mentoring tool. Milovanovic, Moreau, Siret and Miguet researched into VR and AR as tools of visual representation of data and models. They conclude that [3]"VR and AR….offer alternative types of design representations and have a high potential to enhance architectural ideation and design". Through testing systems such as CAP VR, HYVE-3D and SDAR they prove the power of AR as a tool in the AEC industry. It is clear that users find benefit in it as a visual learning tool, but can it be improved?

David Pasztor a UX Design enthusiast undertook a number of experiments researching how humans communicate and interact with Graphical User Interfaces (GUIs). His research proved that Human's main source of absorbing information is visual, and the second is verbal. Despite this fact, his research found [4]"that people are more likely to follow voice instructions than visual ones", and that certain apps that have used a combination of verbal instructions with visual gestures were more effective at communicating information than one using a single method of communication. This suggests that a combination of visual and verbal gestures could be the optimal method for interacting with Architecture in AR.

As shown above it is clear that AR is highly useful in Architecture, users often interact with augmented reality using hand gestures or controllers, however these methods are not necessarily the easiest nor the most intuitive. Voice control however is a much more effective way of interacting with a model. By joining voice control and hand gestures, users can find the most efficient means of displaying and editing their AR models.

Webster, Feiner, MacIntyre, Massie and Kreuger suggest that through testing AR it can be used for more practical purposes such as viewing buried

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3 https://www.researchgate.net/publication/319665970_Virtual_and_Augmented_Reality_in_Architectural_Design_and_Education_An_Immersive_Multimodal_Platform_to_Support_Architectural_Pedagogy

4 David Pasztor *Combining Graphical and Voice Interfaces for a better User Experience*

infrastructure such as electrical wiring and structural elements. They conclude that [5]"the continued evolution and integration of these and other technologies will yield systems that improve both the efficiency and the quality of building construction, maintenance and renovation". The x-ray vision capabilities of AR are useful for Engineers and for onsite use of Architects and other consultants in a project, and therefore is relevant however it is not worth continuing research into this specific use of AR.

Another way in which AR can be developed is through improving its domain. Wang believes [6]"there needs to be an automatic and intelligent domain information extraction mechanism to always provide most critical and relevant info with respect to the task at hand". He identified that there was a lack of a well organised integrated 3D database that can be used for AR systems. This would certainly be useful to Planners and Engineers for viewing physical infrastructure in a building or city, however in order to create one at a city scale would require major digital infrastructure. Current AR systems utilise their immediate context and overlay that with a model, for Architects this is all that needs to be required. To improve AR there are a number of options, however the most relevant and vital to today's AEC industry is the interaction between the user and the system; making it as fluid and intuitive as possible. The findings show that there is an opportunity that hasn't been tapped into yet, where voice control and hand gestures are the improved interface within AR.

6. Case Study

6.1 ITERATION 1

The first iteration for this project focused on hand gesture recognition and aimed to link the leap motion hand tracker to the Unity software. Prior to this first iteration there was basic content creation within the Unity software such as downloading of the main software as well as installing plugins created to improve the interoperability between Unity and leap motion. A large amount of time was used testing which versions of either program worked best with each other. I did not anticipate this being a problem during my initial research however I quickly adapted. Three tests were undertaken, firstly to test the leap motion could detect our hands and digits accurately, secondly to test that Unity

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[5] Webster, Feiner, MacIntyre, Massie and Kreuger

[6] Xiangyu Wang "Augmented Reality in Architecture and Design: Potentials and Challenges for Application"

could connect with the device and have objects in the environment be interactive, then lastly test the device with an app called Blocks which allows users to create baic geometry. All tests were successful however it did prove that when in use the leap motion should be connected to the headset. It also revealed that the leap motion technology is still young and not as accurate and fast as originally thought.

6.2 ITERATION 2

The second iteration focused on linking Visual Studio, C# scripting, with Unity. This iteration also required background content creation such as installing further plugins that could help communication between the software. From the testing it became very clear that interoperability between each software would be a major issue throughout the testing phase of this project. A large part of the success of the scripting came from doing a large array of research into existing scripts that prior researchers and developers had created in order to understand the scripting process and to test what codes worked best to do what I needed them to do.

A major pivot occurred between iteration two and three, after doing further testing with the Hololens I realised that there was no longer a need for the leap motion hand tracker as the Visual Studio C# script was a much more flexible platform to be able to program and understand gestures.

The second part of this iteration was developing and testing the creation of a dictionary of keywords for the script to detect within the AR environment.

Between these iterations, thanks to testing of the hololens device and Visual Studio C# scripting I realised scripting a hand gesture component would be much more accurate and editable than using the leap motion. Therefore going forward I created a script in Visual Studio to replace the leap motion for hand tracking and gesture detection.

6.3 ITERATION 3

The third and final iteration was a culmination of the previous iterations; where all software worked together fluidly as one system. Given the leap motion was taken off the project new scripts were created in Visual Studio to be able to control the hand gestures within the AR environment. Making sure that the multiple scripts didn’t clash with each other was an issue however after separating them into 2 different script files it became easier to work with them and edit them. Further research was also done into existing work by Microsoft in order to aid me in how to create new keywords and definitions for the script.

6.4 UNITY

The use of unity as the major software for this project was crucial to its success. For creating content in the project, I used Unity. It was the most ideal choice for this project as the interoperability of the software means it can be used for Augmented Reality as well as multiple file types and other software.

Unreal Engine; This software is excellent for creating VR environments. This was used for testing and content creation however it is not as good at creating environments for AR.

6.4.1 UNITY COMPONENTS

Cursor; A cursor was created and used to give the user a way to interact with the environment. Having a point of reference in 3D space makes it easier for people to navigate and interact with the assets in the world.

Gaze Gesture; This component is used for

Speech Manager; the use of a speech manager for instructiveness. “Drop Sphere” and “Reset World” were used for initial testing of the voice recognition in the HoloLens environment.

6.5 LEAP MOTION;

This technology was tested however the HoloLens has a UI system capable of recognising and learning hand gestures more accurately and quickly, thus rendering it useless for further testing.

6.6 VISUAL STUDIO

C# (C Sharp) scripting was used for editing the Unity components. C# is the scripting format behind all of Unity’s components and assets. Scripting allows for minute editing and development of the content in my project.

Visual Studio; This software was used for its connection to Unity and because it’s an industry standard for editing C# Scripts

MonoDeveloper Unity is a plugin software for viewing C# scripting however it doesn’t work as effectively for editing and debugging as Visual Studio.

For further content creation I used Rhino and Revit to make basic geometry and buildings. I used these two programs because they’re industry standard for model making and BIM. Once the models were created they were then exported to a Unity compatible file and tested in the AR environment. File types, OBJ and FBX were the two file types best suited for use in AR.

6.6.1 VISUAL STUDIO SCRIPTING

For each 3d model in the world the *rigidbody* component was used to make it “touchable” and interactive in the augmented environment

spatial mapping tool was used to orient the virtual space with real space. This was to place the AR graphics in their real setting.

raycast function was used to constantly be relaying spatial information from the headset so it can orient the user in the AR environment so that when the user is in environment and turn their head in reality it turns the camera in the AR environment too.

The *Quaternion* function helped stabilize the scene when ‘placed’ in the user’s reality.

6.7 FOLOGRAM

Melbourne’s design company Fologram has done groundbreaking researching and testing of Augmented Reality in the design process. For example, connecting Grasshopper scripting with Augmented Reality to be able to view a model in AR and edit it in either views in real time. This inspired me in my research testing as the company really pushed my thinking around what the opportunities and limits are as well as what can be done using AR.

6.8 PRISM 3D

This app is an excellent example of how the model could look and how the user may interact with it. It was also used as a test for the HoloLens. For example, the use of a table as well as a rotating menu that follows the user is something that I aimed to reproduce in my own design.

6.9 BLOCKS (APP)

The Blocks app was used during testing for iteration 1, it was a basic app that used hand gestures to create simple 3d shapes such as squares, rectangles and tetragons. It also had a gravity and non-gravity setting. The app was used to test the leap motion’s effectiveness and accuracy.

6.10 WINDOWS DEVELOPER KIT

The windows developer kit is an open source page which has a large warehouse of scripts for visual studio for developers. These scripts can be used to help improve scripts and improve their effectiveness.

6.11 HOLOLENS

Figure 9. Hololens AR Headset

For viewing and working on AR projects the Hololens is the industry standard for AR headsets. It has a 40gb memory and 2-3hrs of battery life. It can be easily paired with your laptop or computer via an app and links to Visual Studio and Unity for App development.

The only down-side of the Hololens headset is the small viewport, which makes it harder for users to see and interact with the Augmented environment easily. Development in this area however is being done, headsets such as the META2 have begun to open up the horizon for how immersive our headsets can be. Nevertheless, further testing is needed before the META2 can be integrated fully with Windows and its resources.

7. Significance of Research

The significance of the research presented in this paper shows the potential of how AR can improve the design process. Through research and prototype development this paper adds another chapter to the annals of architecture and AR in the 21st Century. The prototyping and testing was done in a controlled environment however it showed how hand gesture and voice recognition can help simplify model development in a complex system. Conversing with others is a simple and intuitive form of interaction and thus seemed logical to use this form of interaction when designing. The base coding and system created by this script is something that can be further developed in the future to become more complex for larger scale projects and more options when editing. The testing done throughout the project proved that the scope and timeline of this project was not enough to cover the breadth and depth needed. It suggested that in order to create a more comprehensive and fluid solution more time would be needed for user testing and development.

The research in this paper provides a consolidation of the written history of AR as well as how its been used in architecture thus far. The final prototype represents a new way of improving how the design process can be improved in architecture using AR, voice and hand control. The research presented in this paper represents another step forward and aims to promote further development in AR within the architecture industry.

8. Evaluation of research project

The research in this paper looks into Augmented Reality and improving how it is used in Architectural practice by integrating a voice recognition and hand gesture system. In evaluating the research project, it is clear that with more time made available to the prototyping and iteration stage, further development can be made in improving the complexity of the system. Going forward there should be more work into developing the voice recognition dictionary so I wider range of keywords and functions can be built into the system. Future work involves further development of the final prototype; creating a more streamlined system in collaboration with PTW Architects and Daniel Camacho's research study. This would involve a combined system for AR and VR that compliments improving usability and reducing complexity of systems, to improve communication between user and technology in design practice. Issues faced during the project specifically involved solving interoperability problems; due to the nature of the project, multiple software was used such as Leap Motion and Visual Studio which fed into Unity and then into the HoloLens for viewing. Improving the interoperability was a crucial component of testing and prototyping. When looking in the scope of my research there is a correlation between the understanding of AR to how well accepted it is in the industry. As research continues in this area, AR will become more integrated into the industry. The research from this paper can certainly help towards the discourse of architectural development, and further development and testing of AR will certainly lead to increased research and usage in industry.

9. Conclusion

To conclude the research conducted in this project suggests that architecture as well as engineering and construction as an industry have a strong use for AR as a visualisation tool and for working on digital project models. It is important to note however that there is further work that can be done to further test and iterate upon the use of voice recognition and gesture control, to make a more fluid system with a wider variety of gestures and voice commands to draw upon.

The research undertaken into augmented reality in architecture has shown how AR can be used in visualisation and now as a form of design development. Augmented reality as a form of visualisation was tested and proved highly effective in its display quality and usage of data, it is evident that especially in the AEC industry there is a major opportunity in using AR. Research into voice recognition and hand gesture tracking has proven the technology is at a point where it can be applied and harnessed in AR. It is crucial users and developers are encouraged to further this research and iterative design process to help push the industry into a more collaborative and user-friendly space in which technology such as voice recognition and hand gesture tracking can help improve how we interact and create our designs with AR.

Acknowledgements

This project was done in collaboration with UNSW and PTW Architects Sydney, thanks to the Computational Design lecturers, tutors and alumni; Professor Mathias Hank Haeusler, Nicole Gardner, Alessandra Fabbri, Ali Siddiqui and Harris Paneras for their support and inspiration throughout the project. Thanks also to my supervisor Tiara Dobbs at PTW Architects for her guidance. Also, to Daniel Camacho for his assistance with research and the testing of technology for the project. Lastly, to my friends and family for the endless support.

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Figure 2: https://research-methodology.net/wp-content/uploads/2012/04/New-Picture.png

Figure 5: <https://res.cloudinary.com/practicaldev/image/fetch/s--6tqgmwmL--/c_limit%2Cf_auto%2Cfl_progressive%2Cq_auto%2Cw_880/https://thepracticaldev.s3.amazonaws.com/i/vteh5sdhtm6dopjgalrq.jpg>

Figure 6: <https://res.cloudinary.com/practicaldev/image/fetch/s--QLQ2QCd4--/c_limit%2Cf_auto%2Cfl_progressive%2Cq_auto%2Cw_880/https://thepracticaldev.s3.amazonaws.com/i/6kr3vp8oifqw8v2pdkw3.png>

Figure 7: <https://res.cloudinary.com/practicaldev/image/fetch/s--QrttFZpW--/c_limit%2Cf_auto%2Cfl_progressive%2Cq_auto%2Cw_880/https://thepracticaldev.s3.amazonaws.com/i/4js8ex00y5hinnr25rty.jpeg>

Figure 8: <https://res.cloudinary.com/practicaldev/image/fetch/s--vnWgFmBz--/c_limit%2Cf_auto%2Cfl_progressive%2Cq_auto%2Cw_880/https://thepracticaldev.s3.amazonaws.com/i/am5smckcpi1hvygfxsfw.jpg>

Figure 9: https://vrodo.de/wp-content/uploads/2016/11/hololens_microsoft_finale_version.jpg

APPENDIX

1.Voice Recognition Dictionary (Index Library)

VOCAB	HAND GESTURES
Explode	Make hand into fist and then open hand
View	N/A
Hide	N/A
Move	Grab with hand and move
Select	Point finger at object or part of object
Menu	N/A
Expand (Push Pull)	Pinch with both hands and push/pull at points on object
Centre (Object, or View)	N/A
Delete	Point and then swipe to side quickly
Layers	N/A
Rotate	Pinch with one hand and move left to right
Flip	Pinch with one hand and move up and down
Save	N/A

2.Project Timeline