Improving the effectiveness of design meeting in projects with smartphone AR

Project Number: #140
Group: Construction Management
Department of Civil and Environmental Engineering

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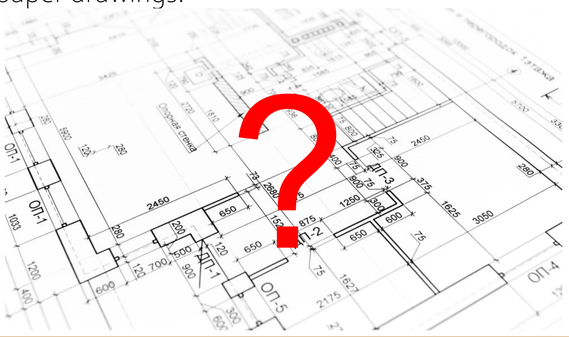
Introduction

AR shows promises in its application to design meetings in the Architecture, Engineering and Construction (AEC) industries due to its ability to substantially enhance user visualisation capability, without any major alteration on the user's interaction with the physical world and other people. This is vital as the AEC Industries involve complex collaborations amongst different parties. The standard medium for design meetings is paper drawings, which are liable to misinterpretations. A smartphone AR prototype has been developed to investigate and trial the improvements in comparison to paper drawings.



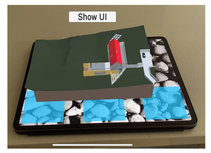
Objectives

1. To measure the prototype's ability to facilitate the visualization process
2. To assess the effects of smartphone AR on the user's mode of communication
3. To investigate whether mobile devices provide similar benefits as HoloLens (Head mounted AR)

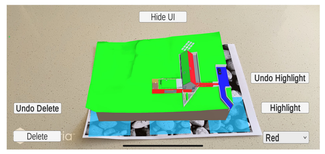
Development

The AR prototype was developed for Android and IOS devices using the Unity game engine with Vuforia engine. The main objective was to develop intuitive interaction with a building model by providing features relevant to design meetings, as shown:

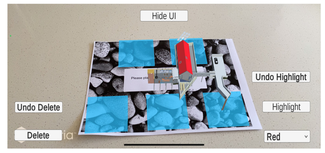
- Translating, resizing and rotating
- Highlighting and deleting
- Switching rooms and floors of the model



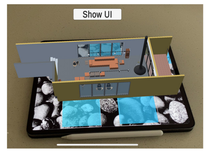
House Model



Highlight



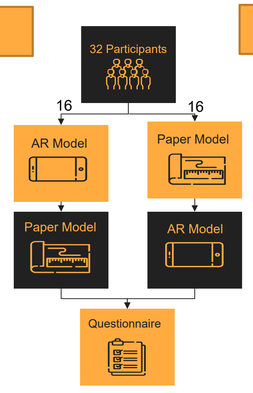
Delete



Switch Rooms

User Trials

- Ethics were approved for a period of 3 years
- Participants were asked to perform the experiment with both Paper and AR
- Trials involved searching for errors in each model, indicating faulty elements then giving impressions of their affinity for each design.

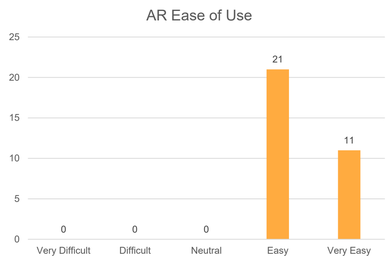


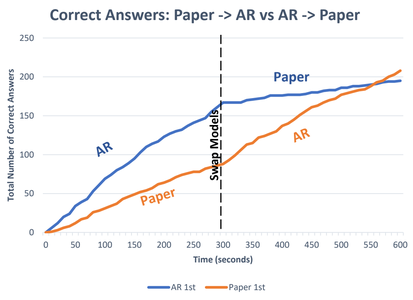
Data Collection

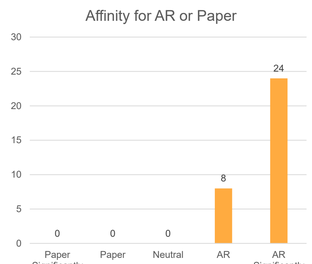
- Data was collected based on the accuracy of answers, speed, observed behaviour and a post-questionnaire
- Analysed data using McNemar, Fisher, Mann Whitney, and Wilcox signed rank test

Results

- Smartphone AR enables users to visualise faster, more accurately and with more confidence than paper drawings, evidenced by p-values < 0.05.
- Users also reported increased affinity for the design and greater ability to maintain focus in the AR system.







Conclusion

Smartphone AR shows potential to improve the effectiveness of design meetings in the AEC industries due to its ability to improve the user's visualisation capability while maintaining natural communication. Smartphone AR also has much lower monetary costs than Head mounted AR devices such as the Microsoft HoloLens, while boasting similar benefits. Feedback indicated that there are still aspects that can be changed to improve the AR system, such as implementing an annotation and collaboration feature.

Future Works

- Future experiment with collaboration feature allowing multiple users to view and manipulate the same model
- Annotation Functionality for each element
- Similar trials with more complex models to emulate a more realistic design meeting experience
- Marker-less based AR allowing the model to be placed on any surface
- Using HoloLens as part of the experiment for a more comprehensive comparison between the two mediums