The Application of Augmented Reality in Interior Design Education

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Abstract

This research is about the application of Augmented Reality (AR) in interior design education. AR has been a widely researched technology in many fields, and education is one of them, it is also regularly used in civil engineering, architecture, and interior design research. For interior designers, being able to think in three dimensions and visualizing projects is of great importance. The purpose of this study is to analyze the effect of using AR in design process to find the optimum space arrangement under the following criteria: the perception of 3D and 2D space, the visualization and analysis of the given space, and the usability of AR on mobile devices. For this research, a group of third grade interior design students in Arel University, who had already attended a project lecture, were selected. These 14 students, who were familiar with our traditional education process, were asked to use AR in their next project to design a specific area that they were not able to physically visit. These students were assigned with creating this space from instructions and measurements by computer-aided modeling (CAD) and start the design by using augmented reality with their mobile phones when they needed to. After their work finished, data was obtained via a questionnaire survey. The survey included the students' feedback on their learning experience, whether AR had been advantageous during the design process, whether the students had experienced problems with the interface, identification of the process where they preferred to use AR and if the learning method was motivating. This study is expected to contribute to knowledge on the advancement of Augmented Reality (AR) applicable to design education.

Keywords: Augmented Reality, Interior Design Education

1. Introduction

Augmented Reality Technology is an environment where the additional information created by a computer is added to the user's view of a real-world scenario (Milgram, Milgram, Colquhoun, & Colquhoun, 1999). This additional information, a 3D model, can be replaced, moved, rotated or scaled and it can be displayed via computers or mobile devices. In terms of education, according to the Horizon Reports from 2010 and 2011, AR will start to be implemented in the education systems of colleges within the next 2 to 3 years (Yuen, Yaoyuneyong, & Johnson, 2011). It is reported "Online, mobile, and blended learning ways are foregone conclusions." If institutions do not build strategies for integrating these approaches used in the right way, they will not survive in the future (New Media Consortium, 2017).

In this study, the interior design project lecture (design studio) that is given in Istanbul's Arel University is divided into steps, and basic AR technology is applied to the first step. The classic project lecture that is given is a weekly class that lasts 6 hours each day for 14 weeks.

During this process, students are required to complete an interior design project according to their grades. Originally, the first step of this class consists of finding a building plan, visiting that building and getting ready for a design process by removing everything inside except for the structure (clean version) using 2D plans but without using any 3D CAD (computer-aided design) programs. In this phase, students have no opportunity to see the original interior version of the project and sometimes they have no opportunity even to visit the buildings. In the proposed AR-based collaborative design system, the students can visualize a 3D model of the buildings via their own mobile devices. It is important for students to perceive the spaces in a comprehensible manner when starting an interior design project because they can understand the main differences in the space before and after the interior aspects are removed. According to Azuma (Azuma, 1997), "The information conveyed by the virtual objects help a user perform real-world tasks" which is predicted to help the student's perception of a 3D and 2D space and to trigger creativity.

The purpose of this research is to question AR's advantages under specific criteria to find the optimum space arrangement in a given plan, which is an essential step of an interior design project lecture. It also helps to introduce this technology to the students in a way where they can learn to apply basic AR models to their projects. Using AR technology can be an educational experience, as creating AR scenes can support learning (Wei, Weng, Liu & Wang, 2015). AR is found to be an impressive learning tool by the students, making it possible for students to interact with the learning content, improving their spatial skills and creativity (Billinghurst & Dünser, 2012).

2. Literature Review

2.1. Augmented Reality

Augmented reality is the augmentation of human sensory perception by superimposing virtual objects on the real world, which is a variation of virtual environments (Azuma, 1997). As illustrated below in the Virtuality continuum (Fig. 1), AR sits between reality and complete virtuality that is called Virtual Reality.
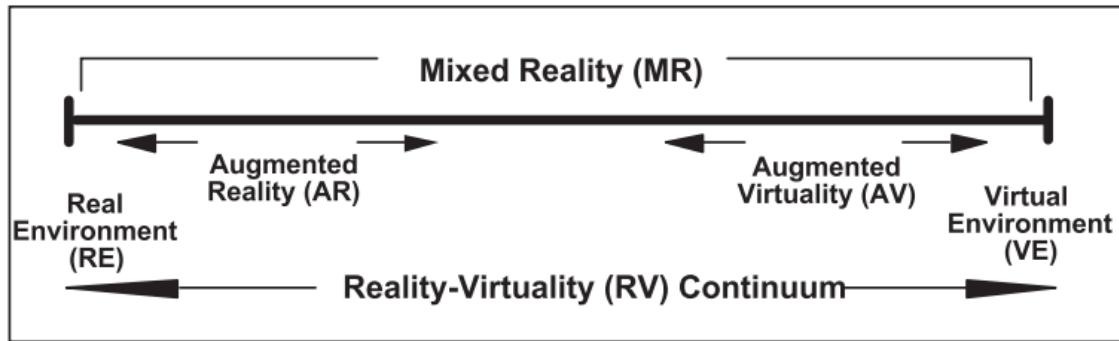
Fig 1: Reality Virtuality Continuum (Milgram, Milgram, Colquhoun & Colquhoun, 1999)

There are several ways to display AR according to Broschart and Zeile
(Broschart & Zeile, 2014):

- *Projective Augmented Reality (PAR)* where digital information is projected onto the real world and the user does not need to use any visual aids

- *Video See-Through (VST)* where projection glasses are needed to display content for the user's eyes

- *Optical See-Through (OST)* where a semitransparent mirror is generally used augment the environment. Users use their own eyes to perceive the content

- *Monitor Augmented Reality (MAR)* which s a version of AR that needs a screen to display material, a rendering unit, and a camera

The display method used in this research can be referred to as an Advanced Monitor Augmented Reality, which uses tablets and smartphones similar to the study of Wang (Wang et al., 2014). It allows users to move freely in the real environment.

2.2. Augmented Reality in Education

Within subjects like chemistry, mathematics, biology, physics, and astronomy, AR is applied to classroom-based learning, K-12 education adapted augmented books and student guides (Lee, 2012). AR has been used to improve students' understanding of science, (Hsiao, Chen, & Huang, 2012), it has been applied to medical science to increase motivation and originality (Rosenbaum, Klopfer & Perry, 2007) also used to enhance the experience of visitors to museums and archaeological sites (Martin et al., 2011). Adoption by urban planning of this technology consists of discovering architectural culture and exploring cities by implementing stories in the urban space and offering an audio walk (Broschart & Zeile, 2015).

There are several advantages of using AR in education (Cerqueira & Kirner, 2011):
"Students are more motivated because they live an experience supported by the application, and the use of new technology, AR, can illustrate processes and characteristics that are not usually viewed by the user; AR allows the students to recreate the experiments out of school, the students become more active due to the interactive application and AR encourages creativity, improving the experience."

2.3. AR with Interior Design

Just as in many other fields, interior design is another one where researchers implement AR technologies. For instance, with Ikea's augmented furniture catalog, people became familiar with AR; however, in the background, AR needs a lot of trials to be effectively used in interior design. Siltanen & Karvonen presented a diminished reality solution aimed at interior design applications (2014). Another application by Wang allowed students to investigate specific buildings and their various systems with additional information using a phone or tablet (Wang et al., 2014). The IOS application Magicplan has gained a lot of attention as a leading tool for architectural and interior design for use in creating floor plans quickly, dimensioning interiors and developing 2D Plans using mobile sensors (Vaai & Vaai, 2014). Also, Unity and SketchUp programs enable the user to venture into the building as a walkthrough. The first person controller is an asset that allows the user to explore a building. AR has been seen as a way to present projects and show a better understanding of customers' needs. "The augmented reality technology is the way of interior design future so that the cooperation of designers and consumer can be convenient and efficient" (Hui, 2015).

3. Method

The first step of this research was to create an easy application for our students to use AR. Using the Unity program (Kim et al., 2014) we created two main different AR applications for mobile phones. To build an augmented reality program like this needs a computer with appropriate software and a rendering unit, a tracking system which locates the position of the object and an android phone. A tracker is used for positioning the virtual image onto the real world. The applications we made consisted of two different models with the same tracker for a plan of some flats.

In this case study, we used twin flat plans (Fig. 2) and simply modeled them in a 3D CAD program. This case adopted manufacturer-based tracking to give students a good user experience because of the stable tracking. For this process, we built two different models of the building. The first one contained all the features, separators and walls of the building as shown in Fig. 3 and the second one with all the features removed apart from the main structure shown in Fig.4.

On the day of the workshop, 14 students from the third grade of the interior design department of Arel University were given the 1/50 scale plans and the instructions. The overall study lasted for 2 hours. They installed the applications on their mobile phones and tried to understand how the system worked and how they would use the app during the study. After the setup, the students were asked to design a real-estate office within the given instructions over 45 minutes. They were asked to perceive the space via their mobile phones, using the AR apps when they needed to (Fig 5 A & B).

At the end of the study, the students were given a Likert Survey that contained 10 questions to measure their opinions on specific themes as follows:
- Perception of the given space
- Motivation
- Creativity
- Effectiveness and functionality of AR on space arrangement
- Equipment preferences.

Table 1 below was created from the results of the feedback from the survey. Based on the results of the table, the given themes were evaluated.
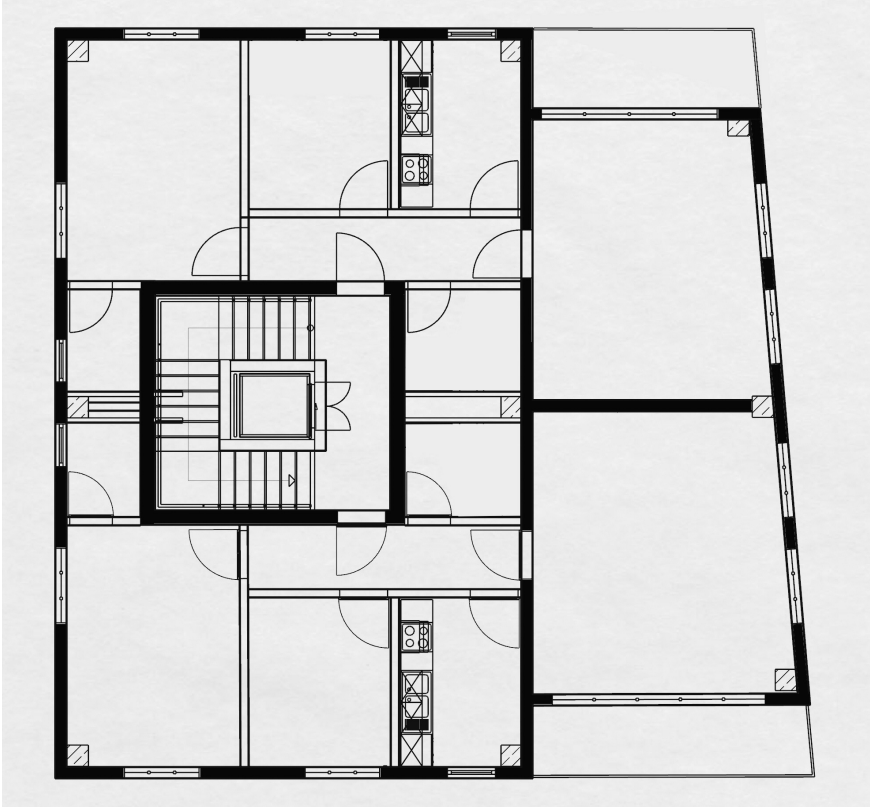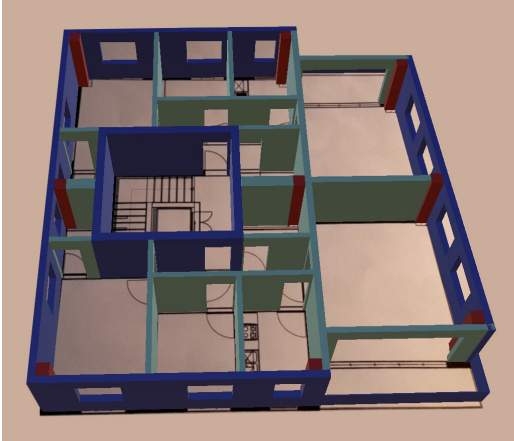

Fig 2: Twin Flat 2D plan
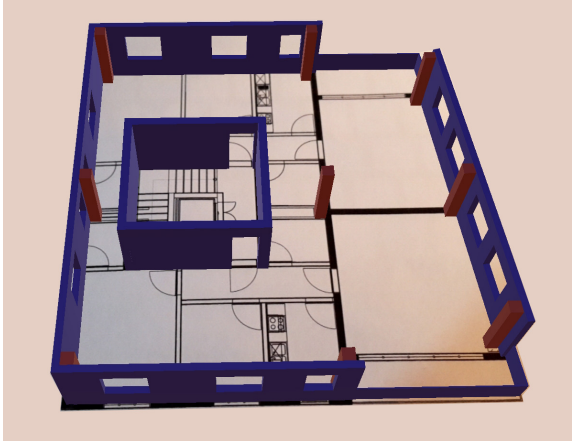

Fig 3: Flat with all of the features
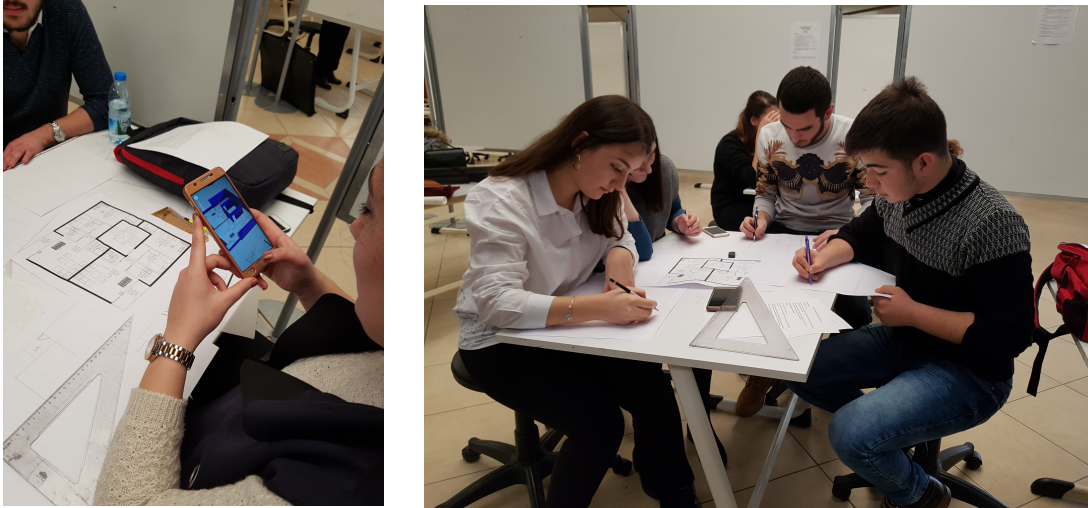

Fig 4: Flat without the features

**Fig 5 A & B: Students from the third grade of Interior
Design Class during the workshop.**

4. Results

Table 1 (themes and their percentages)

Theme	Disagree	Neutral	Agree
1. Improved Perception of the given space	0%	7%	93%
3. Improved Motivation	7%	21%	72%
4. Improved Creativity	7%	28%	65%
5. Effectiveness and functionality of AR on space arrangement	5%	14%	81%
6. Mobile phones preferred as Equipment	7%	21%	72%

One of the main goals of the research was the first theme, which indicated the optimized perception of the students about the interior by looking at the 2D plan along with the augmented model. Ninety-three percent of these students agreed that AR helped them in this matter; they were able to see the features of the building and the spaces in more meaningful proportions.

As for being motivated during the workshop, the results are less conclusive, as for the theme of improved creativity. This step of the lecture was more about practical thinking rather than creative thinking so the fourth theme is considered parallel to this need.

The effectiveness and functionality of AR would cover the general use of the application as well as the effects of the application on the students' work. For 81%, AR makes the design process easier when it comes to defining spaces.

During the study, only mobile phones and computers were used as equipment, 72% agreed that using their mobile phones was more practical than using a computer.

Student's comments during the workshop:

Student 1: "It is better to view a 3D model over AR instead of a computer screen."

Student 2: "I wish I had the chance to use AR last year. It helped me understand the place rather than seeing it only on paper."

Student 3: " It helped me to clear my mind when my creativity was blocked."

The students' first reaction to Augmented Reality showed that they were interested in and were eager to try the technology. However, extra training time was spent to make every person involved understand this new technology in depth. In addition, it took time for them to synchronize using the applications along with the process.

5. Conclusion

The survey that carried out with a limited number of students indicated that using the AR application had a positive effect on making the optimum space arrangement by improving 2D and 3D perception. AR enables "instant visualization", which can particularly ease communication and decision making.

Focusing on architectural information visualization, this research investigated a new approach for perceiving spaces. It was presented to validate the effect of using AR during a project lecture. Feedback from the students indicated AR was useful and efficient for visualizing the architectural design.

Even though the students did not have any previous experience of AR technology, they easily adapted to it. Within the given 45 minutes they started to create solutions once they had figured out the application. AR can be easily used by students when starting to study interior design and for students who have problems understanding complicated structures and spaces. The research suggests a way to use AR in the interior design process, which can be useful to develop new techniques for further studies.

6. Further Studies

The overall research suggests that through continuing research in AR technologies, a software supported application where AR enables an interaction with virtual elements would be more useful. Also being able view more than one plan over the tracker would save students a lot of time. This research provides a basis for future applications where students interact with 3D elements through their augmented vision via a single application.

In other research, applying AR in different phases of the lecture like presentation or modeling will be considered, and this will be followed by another workshop including more students from different schools.

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