APPLICATION OF AUGMENTED AND VIRTUAL REALITY IN RESIDENTIAL COMPLEX PRESENTATION, CASE STUDY: ENERGOPROJEKT SUNNYVILLE

Abstract: The traditional method of residential complex project presentations involves the use of a printed poster or elaborate on which the building is presented by using of two-dimensional drawings and images. The main traditional approach problem is the presentation of three-dimensional space on two-dimensional paper. The main focus of this paper is the development of contemporary, mobile systems for residential complex presentations which will be presented on a case study of "Energoprojekt Sunnyville" using a method of virtual and augmented reality. This approach enables easier and better understanding of all types of architectural objects and urban complex, allowing the user intuitive spatial overview of architectural work.

Key words: Augmented Reality, Virtual Reality, Residential Complex, Mobile applications, Energoprojekt, Sunnyville.

1. INTRODUCTION

The traditional method of architectural project presentations involves the use of a printed poster or elaborate on which the building is presented by using of two-dimensional drawings and images [1]. The main traditional approach problem is the presentation of threedimensional space on two-dimensional paper. This is possible only by using photo realistic render of building 3D model and presentation as a perspective image.

Beside the presentation on printed media, it is possible to present architectural projects in digital form, using different kind of appropriate hardware and software combination. In this case most often the presentation of future building look is done using perspective images and video animations. This type of presentation is limited in terms of the freedom to choose the viewing angle. In perspective images and videos the angles predetermined by the author are displayed and there is no possibility for the user to change them. Therefore, it is often impossible to view the entire facility from all angles and in particular to view the most interesting details [2].

For a better understanding of project it is necessary to present three-dimensional spatial models of the building or part of a building in the way where the user can choose what to see. This is possible to achieve using methods of Virtual or Augmented Reality for presentation of 3D building model.

Virtual Reality can be defined as "A human-computer interface in which the computer creates a sensory immersing environment that interactively responds to and is controlled by the behaviour of the user" [3]. In case of architectural project presentation this mean that user can interact inside of a virtual environment and choose which part of the building want to see. Problem with Virtual Reality presentation is need for higherquality hardware and specific software because of the manipulation of 3D content. The downside compared to the presentation of prospective images and videos is the need for prior knowledge in the field of 3D content manipulation [2]. Previewing of Virtual Reality can be made simpler for user by addition of specific sensors which can track user movement and made the experience more intuitive. This approach made Virtual Reality system more complex and require greater processing power to handle operations in real time. The commercially most popular approach for the presentation of three-dimensional architectural content this day is: 3D web based services like "3D warehouse" [4] and "Sketchfab" [5]; and application based on Had Mounted Displays like "Oculus Rift" [6], "HTC Vive" [7] and "Samsung Gear VR" [8].

Augmented Reality is an emerging computer technology where the perception of the user is enhanced by the seamless blending between a realistic environment and computer-generated virtual objects coexisting in the same space [9]. The resulting mixture supplements reality, rather than replacing it [10]. According to Azuma [11], Augmented Reality represent a variation of Virtual Environments, or Virtual Reality as it is more commonly called. In these so called Virtual Reality the user is completely surrounded by a synthetic environment. In that state, the user can not perceive the real world and the real environment that surrounds him. On the contrary, the Augmented Reality allows the user to perceive the real world while the virtual elements are superimposed upon or composited with the real world [12]. In this manner, the Augmented Reality is enriching user's perception of the reality rather than totally replacing it like in the case of the Virtual Reality. The ultimate goal of the Augmented Reality is to convince the user that the two environments, real and virtual, coexist.

Augmented Reality presentation of architectural projects is completely intuitive and does not require any kind of prior knowledge. Basic IT knowledge is enough to preview 3D model of the building from all angles using an adequate combination of hardware and software.

The focus of this paper is a comparison of traditional and contemporary residential complex presentation through a case study of "Energoprojekt Sunnyville" project. Paper presents traditional printed brochure with rendered visualisation and possibility for upgrading it by

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using contemporary portable devices and methods of Virtual and Augmented Reality. Created system for presentation of architectural project of "Energoprojekt Sunnyville" complex does not aim to substitute traditional methods of presentations, it upgrades presentation using contemporary technology. This approach enables easier and better understanding of all types of architectural objects and urban complex, allowing the user intuitive spatial overview of architectural work.

2. MATERIALS AND METHODS

Residential complex "Energoprojekt Sunnyville" (Figure 1) is located in the Belgrade on Visnjica field, near the Danube River. The complex consists of three residential buildings with more than 24 000 m² of space.



Fig. 1 Energoprojekt Sunnyville residential complex.

For the purpose of this research, mobile application based on technology of Virtual and Augmented reality is developed. The starting material for the case study is 3D model and brochure (Figure 2) of the "Energoprojekt Sunnyville" complex in printed and digital form.



Fig. 2 Energoprojekt Sunnyville brochure.

Two-dimensional drawings and three-dimensional model of complete residential complex are used to create additional material for mobile application. From 3D model on the basis of site plan, detail 3D model of the space between buildings is created and rendered as textures for the spherical Virtual Reality tour (Figure 3).



Fig. 3 Spherical Virtual Reality texture.

The main idea is to create additional digital content which will provide a better understanding of residential complex project and compare it with traditional printed drawings and visualisations.

Therefore, mobile android application based on methods of Virtual and Augmented Reality is created. Each two-dimensional image in brochure is connected with additional digital material which provide better spatial understanding of the complex and additional informations.

Two dimensional images work as a marker which trigger additional content and function as a reference point for Augmented Reality presentation. Markers connect with 3D models of entire residential complex and Virtual Reality presentation of the space between buildings.

3. MOBILE APPLICATION

Created android application is tested using "LG Nexus 5X" mobile phone combining with appropriate markers. After starting the application, the device camera records real surrounding, while the application is searching for predefined markers. When the application detects and recognise certain marker on the device

display, we can see additional content. Moving the marker will cause a joint move of both the marker and the additional digital content on the device display (Figure 4-a).

The test is conducted for all traditional twodimensional images. In parallel testing result of the application is presented as device screenshot during work.

3.1 Augmented Reality

First part of the application is presentation of complete residential complex on the top of the brochure cover page as a small scale model, using Augmented Reality (Figure 4-a). When created mobile application detects the location of the marker (brochure cover page), on the display of the device we can see a 3D model of entire complex connected with marker. Moving the marker will cause a joint move of both the marker and the 3D model of the Sunnyville complex on the device display. Beside this, the application provides interaction with 3D model in order to provide additional information to the user (Figure 4-b). Taping on any building will pop up additional menu with basic information about location (Figure 4-c), apartments, complex (Figure4-d), etc.



Fig. 4 Augmented Reality presentation of Energoprojekt Sunnyville residential complex: a) 3D model presentation, b) Adittional information, c) Location information, d) Complex information.

In case that user doesn't have a brochure, all content can be previewed using any flat printed plane with enough contrast as a marker. User generate new marker by taking a photo from the application (Figure 5-a). After that user is able to view 3D model of "Energoprojekt Sunnyville" complex as a small scale model on the top of new marker (Figure 5-b). In this case it is not required for user to have specialized printed marker in order to get additional information. While all additional functionality and information are same as in case of using predefined marker. Application of Augmented and Virtual Reality in residential complex presentation, Case Study: Energoprojekt Sunnyville



Fig. 5 Custom made marker Augmented Reality: a) Marker creation, b) 3D model presentation

3.2 Virtual Reality

Second part of the application is the photorealistic representation of space between buildings, using Virtual Reality.

Virtual Reality tour is possible to start by tapping on the yellow marker in the Augmented Reality presentation of complex 3D model (Figure 4-a). Taping on same marker in the brochure image of space between buildings (Figure 6) or choosing from menu.



Fig. 6 Starting Virtual Reality tour using brochure.

By pressing a yellow marker, the user is transferred to second Virtual Reality part of the application which present 360 degree spherical panoramic images of the space between buildings. Virtual Reality presentation allows users of mobile devices to interactively "be inside of the space and look around" with the full realism that digital photorealistic render can provide (Figure 7). Moving and rotating of device causing movement and rotation of a virtual scene on display in the same manner. While arrows on the bottom allow changing of position and virtual walking through "Energoprojekt Sunnyville" residential complex.

4. RESULTS AND DISCUSSION

Traditional and contemporary way of architectural project presentation is demonstrated in this paper on the example of "Energoprojekt Sunnyville" residential complex. Created mobile system for presentation of architectural projects does not aim to substitute traditional methods and systems of presentations, it upgrades presentation using contemporary technology. Using a mobile platform based on Virtual and Augmented Reality methods provide additional information.

The assumption in this study is that the user, the observer of the presentation, has basic computer literacy, as well as that his/her only task is to review the previously prepared presentations of residential complex. Based on these assumptions, the analysis of the positive (+) and negative (-) factors of the presentation was conducted (Table 1).

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Fig. 7 Virtual Reality presentation.

Table 1. The	positive/	negative	factors	of	presentations

Presentation	Traditional	Contemporary	
	(brochure)	(mobile app)	
Availability	-	+	
Necessary hardware	+	-	
Complexity of use	+	+	
Presentation quality	+	+	
Presentation details	-	+	
Informations provided	-	+	

Mobile application for viewing the presentations of "Energoprojekt Sunnyville" residential complex is available on Google Play store [13] for free download and use. Therefore, it is much more available to users, then a printed brochure.

For users it is easier to get information from printed brochure then from mobile application which require the use of the device. Use of the mobile application is completely intuitive thanks to Virtual and Augmented Reality methods for presentation of the residential complex. Both, traditional and contemporary presentations use photorealistic visualisation with maximum quality. But contemporary Virtual and Augmented Reality presentations provide more details and additional information about presenting complex then printed brochure.

Case study demonstrates the capability for large scale information presentation using mobile applications based on Virtual and Augmented Reality technology. In the case of residential complex presentation, users with no experience and with the limited spatial ability can be confused. In the case of traditional site plan presentation it can be hard for the user to figure out the top view of the building and spatial information presented in a twodimensional medium. Using of mobile application allows freedom of angle choice for the user, more information through Augmented Reality 3D model presentation of entire complex with surrounding and easier understanding of spatial information that are presented

Presented "Energoprojekt Sunnyville" mobile application, provide a Virtual Reality experience of user presence inside of the complex through 360 degree tours. Level of virtual tour visual quality is same as on photorealistic two-dimensional rendered images. Virtual Reality tour provides the possibility of intuitive angle, choosing, so user can see building facades and experience of future arrangement between buildings that are interested in, not only predefined image angles.

5. CONCLUSION

This paper is aimed to demonstrate contemporary approach in traditional architectural project presentation using mobile devices and methods of Virtual and Augmented Reality. Mobile application used in a case study for "Energoprojekt Sunnyville" residential complex presentation is a cutting-edge tool. This approach enables the spatial presentation of the 3D model within the real environment. It allows the user to view the building as small scale models in the real surrounding. Virtual Reality tours allow users preview of 360 degree visual environment of complex that offers far more contextual information than a series of static images. This approach provides full intuitive preview of the residential complex, from a user perspective angle, on the contrast of traditional presentation.

The use of the created mobile application itself is completely intuitive. The quality of the 3D model presentation is at a good level, but it is much worse than the rendered images. It is caused by the limited processing capabilities of the mobile devices and complex calculations needed for the proper functioning. Virtual Reality tours are on the same visual level as rendered images, but provide less information than 3D models in Augmented Reality presentations.

Use of Virtual and Augmented Reality methods in architectural project presentations is very positive for users with no experience and with the limited spatial ability. It provides a better understanding of architectural structures because the user can choose which part of the structure and from which point of view of the architectural structure he/she wants to see completely intuitively.

Future research should cover practical testing with a larger group of all types of users with and without experiences in order to quantitatively measure impact of contemporary Virtual and Augmented Reality methods applications in architectural project presentations.

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