

Augmented and Virtual Reality Application in Traditional Architectural Project Presentation - Case Study of “MH Petra” House

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The traditional method of architectural project presentations involves the use of a printed material on which the building is presented by using of two-dimensional drawings and images. The main problem is the presentation of three-dimensional space on two-dimensional paper. The development of smart portable devices with special sensors and greater processing power and contemporary methods of augmented and virtual reality motivated authors to investigate possibilities of their applications in architectural presentations.

The main focus of the paper is the development of modern, portable systems for architectural project presentations which will be presented on a case study of the house. For this purpose, a method of virtual and augmented reality is used for upgrading traditional printed catalogue of the project.

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.

Keywords: Computer graphics; Virtual Reality; Augmented Reality; Architectural projects.

1. INTRODUCTION

The traditional method of architectural project presentations involves the use of a printed poster or elaborate in which the building is presented by using two-dimensional drawings and images [1]. The main traditional approach problem is the presentation of three-dimensional 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 a 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 [1].

For a better understanding of the 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” [2]. In case of architectural project presentation this means that a user can interact inside of a virtual environment and choose which part of the building want to see. The problem with Virtual Reality presentation is a need for higher-quality 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 [1]. 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” [3] and “Sketchfab” [4]; and application based on Had Mounted Displays like “Oculus Rift” [5], “HTC Vive” [6] and “Samsung Gear VR” [7].

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 [8]. The resulting mixture supplements reality, rather than replacing it [9]. According to Azuma [10], Augmented Reality represent a variation of Virtual Environments, or Virtual Reality

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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 [11]. 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 foreknowledge. Basic IT knowledge is enough to preview 3D model of the building from all angles using an adequate combination of hardware and software. The biggest problem represent need for most demanding hardware. Besides the basic components Augmented Reality system must have at least a camera, whereas it is desirable, because of the presentation stability, that it additionally has a gyroscope, an accelerometer and an electronic compass. The complexity and elaborateness of 3D models directly affect the complexity of the necessary calculations and the need for hardware with higher processing power [1]. The focus of this paper is a comparison of traditional and contemporary architecture project presentation through a case study of "MH Petra" house project. Paper present traditional printed project with technical drawings and rendered visualisation and possibility for upgrading it by using contemporary portable devices and methods of Virtual and Augmented Reality. Created system for presentation of architectural project of "MH Petra" house 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

Single store, single family house "MH Petra" is presented for the purpose of analysis in this paper. The starting material for the case study is 3D model (Figure 1) and architectural project of the house in printed and digital form:

- Site plan (Figure 4-a);
- Floor plan (Figure 5-a);
- Elevation (Figure 6-a);
- Cross section (Figure 7-a);
- 3D Visualisation (Figure 9-a);

Two-dimensional drawings and three-dimensional model of complete house are used to create additional material for mobile application. From 3D model on the basis of floor plan, 3D model of the interior is created and rendered as textures for spherical Virtual Reality tour (Figure 2).

The main idea is to create additional digital content which will provide a better understanding of

architectural project and compare it with traditional printed drawings and visualisations. Therefore, mobile android application based on methods of Virtual and Augmented Reality is created. For development of the Android application, the development engine "Unity" was used [12]. Each two-dimensional drawing is connected with additional digital material which provide better spatial explanation of the house. Two dimensional drawings work as a marker which trigger additional content and function as a reference point for Augmented Reality presentation. Markers are connected with 3D models of entire or part of the house, video animation and Virtual Reality presentation of the interior.

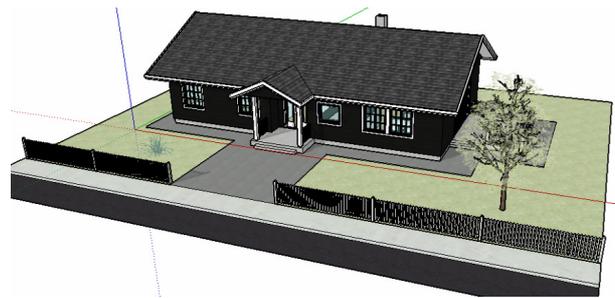


Figure 1. 3D model of MH Petra house



Figure 2. Spherical Virtual Reality texture of interior

3. MOBILE APPLICATION

Created android application is tested using "LG Nexus 5X" mobile phone and "Project Tango" tablet 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 3).



Figure 3. Mobile application testing

3.1 Testing

The test is conducted for all traditional two-dimensional drawings and perspective images. In parallel testing result of the application is presented as device display picture during work.

Every architectural project contains site plan (Figure 4-a) which presents object position on parcels in top parallel projection. When created mobile application detects the location of the marker (Figure 4-a), on the display of the device we can see a 3D model of entire house on parcel connected with marker (Figure 4-b). Moving the marker will cause joint move of both the marker and the 3D model of the house on the device display. In this way, the user can perceive the appearance of the entire building on the parcel, not only the position and appearance of the roof.

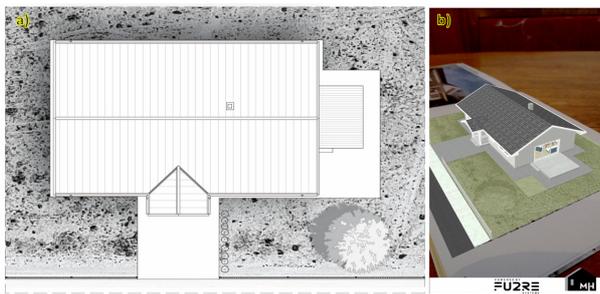


Figure 4. MH Petra: a) Site plan (marker); b) Augmented Reality presentation of entire house 3D model

Similar approach is used for floor plan (Figure 5-a) which is used as Augmented Reality marker in this case. When created mobile application detects the location of the marker (Figure 5-a), on the display of the device we can see a 3D model of detail floor plan connected with marker (Figure 5-b). In this way, the user can perceive the spatial appearance of the entire floor in detail together with furniture.



Figure 5. MH Petra: a) Floor plan (marker); b) Augmented Reality presentation of detail floor plan 3D model

The same approach is used for elevation (Figure 6-a) which is used as an Augmented Reality marker in this case. When created mobile application detects the location of the marker (Figure 6-a), on the display of the device we can see elevation as a detailed 3D model (Figure 6-b). In this way, the user can perceive the spatial appearance of the elevation in detail and understand better than two dimensional drawing.

In the case of cross section (Figure 7-a) which is used as an Augmented Reality marker, created a mobile application display more detail and colourful floor plan (Figure 7-b) with 360° button. In this way, the user can perceive detailed cross section and go to the second, Virtual Reality part of application by typing 360° button.



Figure 6. MH Petra: a) Elevation (marker); b) Augmented Reality presentation of elevation as 3D model



Figure 7. MH Petra: a) Cross section (marker); b) Augmented Reality presentation of section with 360° button

By pressing a 360 button, the user is transferred to second Virtual Reality part of the application which present 360 degree spherical panoramic images of the house interior. Virtual Reality presentation allows users of mobile devices to interactively "be inside of the interior and look around" with the full realism that digital photorealistic render can provide (Figure 8). Moving and rotating of device causing movement and rotation of a virtual scene on display in the same manner.



Figure 8. MH Petra: Virtual Reality presentation of interior

If the device camera detects perspective render visualisation (Figure 9-a) as a marker, on the display of device we can see video which is connected with the marker (Figure 9-b).



Figure 9. MH Petra: a) Perspective render visualisation (marker); b) Augmented Reality presentation video animation of house and its surrounding

4. RESULTS AND DISCUSSION

Traditional and contemporary way of architectural project presentation is demonstrated in this paper on the example of "MH Petra" house. 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. Comparative overview of information which provide each part of “MH House” project presentation depending on presentation type is presented in table 1.

Table 1. Presented content by pages of MH Petra project

	Presentation	
	Traditional	Contemporary
Site plan	2D (Top projection)	3D - AR (House + Site)
Floor plan	2D (Top projection)	3D - AR (Floor + Furniture)
Elevation	2D (Front projection)	3D - AR (Front house part)
Cross section	2D (Section)	2D - AR (Detail section) 3D - VR (Interior)
Perspective render	2D (Photorealistic image)	2D - AR (Video animation)

The case study demonstrates the capability for large scale information presentation using mobile applications based on Virtual and Augmented Reality technology. In the case of traditional architectural 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 two-dimensional medium. Using of mobile application allows freedom of angle choice for the user, more information through Augmented Reality 3D model presentation of house with surrounding and easier understanding of spatial information that are presented.

The similar problem is with traditional floor plan presentation, where users not used to see the apartment from top view, which lead to poor spatial information understanding. Augmented Reality presentation of floor plan with three-dimensional walls and furniture provides a much better understanding of the interior space organization.

Traditional elevation and cross-section is much understandable for non-advanced user, but with mobile application and Augmented Reality display of 3D model, more information and house details are provided. Presented “MH Petra” cross section, provide a Virtual Reality experience of user presence inside of the living room through 360 degree tours. Level of virtual tour visual quality is same as on photorealistic two-dimensional rendered images. Virtual Reality tour provide the possibility of intuitive angle choosing, so the user can see all parts of interior that they are interested in, not only predefined image angles. Contemporary digital approach and Augmented Reality methods, provide the possibility for upgrading traditional perspective image presentation with video animation. In the example of “MH Petra” house, mobile application present flight through video animation of house and surrounding instead of static rendered image. User can not choose angle of view, but can see much more information than usual on traditional two dimensional images.

5. CONCLUSION

This paper aims 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 “MH Petra” house 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 house interior that offers far more contextual information than a series of static images. This approach provides full intuitive preview of the house interior, 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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**ПРИМЕНА ПРОШИРЕНЕ И ВИРТУЕЛНЕ
СТВАРНОСТИ УЗ ТРАДИЦИОНАЛНУ
ПРЕЗЕНТАЦИЈУ АРХИТЕКТОНСКОГ
ПРОЈЕКТА**

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Традиционална метода презентације архитектонских пројеката укључује употребу штампаног материјала, на којем је објекат представљен помоћу дводимензионалних цртежа и перспективних слика. Главни задатак је презентација тродимензионалног простора на дводимензионалном папиру. Развој паметних преносних уређаја са посебним сензорима и веће процесорске снаге, као и савремених метода презентације као што је виртуелна стварност, мотивисали су ауторе да истраже могућности њихове примене у архитектонским пројектима. Главни фокус рада је употреба модерних, преносивих система за презентацију архитектонских пројеката, која ће бити представљена студијом случаја на индивидуалном стамбеном објекту. Метода виртуелне и проширене стварности која се користи у раду унапређује традиционалну методу израде дводимензионалних цртежа у штампаном материјалу. Овакав приступ омогућава лакше разумевање просторних односа у свим врстама архитектонских и урбанистичких пројеката, крајњим корисницима, односно инвеститорима.