Virtual Reality for Real Estate – a case study

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Abstract. This paper presents a particular VR implementation done for a real estate developer. This implementation focuses on increasing immersion and is most suitable for properties that are to be built. It is the latest development of the VR4RE (Virtual Reality for Real Estate) project, which aims at saving time and money for both real estate sellers and buyers by employing modern technologies. VR4RE is one of the innovative projects developed by Bluemind Software. This paper also summarizes the history of in-house technological attempts at creating appropriate presentation tools.

1. Introduction

Sutherland presented the key concepts of immersion in a virtual world in “The Ultimate Display” [1] in 1965. The paper also introduced the challenge to make that virtual world look, act, sound and feel real. Brooks defines a VR experience as an experience in which a person is effectively immersed in a virtual world. The virtual world is responsive by means of a control of the viewpoint [2]. Immersive virtual reality is defined by Andries van Dam et al. as technology that gives the user the psychophysical experience of being surrounded by a virtual environment. This experience is created with a combination of hardware, software, and interaction devices to establish a human rather centric point of view, as opposed to a computer-determined point of view [3].

The authors do benefit from existing research done in our university regarding haptics [4] and from several years of experience in developing VR applications of Bluemind Software. VR technology is currently entering the Real Estate market (it is one of its many application areas) worldwide through various companies which develop applications. As [5] also concluded, with the continuous reduction of costs it does gain a bigger and bigger role to play in the real estate market.

VR4RE (Virtual Reality for Real Estate) is one of the innovative ideas developed at Bluemind Software and it is one of the research directions in which the authors are involved.

Out of the other innovative projects of Bluemind Software (of which a few were created in collaboration with universities), we mention 3DCar (the first interactive 3D car configurator), ASIC Client (the first Android client application to access MIT’s iLabs Remote Laboratory Management System – with Charintia University of Applied Sciences and MIT) and Lab Configurator (a simple and secure method to use mobile devices to configure embedded devices which run online laboratories – with UPORTO). The recent Museum MR project (created in collaboration with the Casa Muresenilor museum of Brasov and Transilvania University of Brasov) combines AR and VR to create a mixed reality solution which helps museums add a wow facture to their exhibitions and exhibit more in the existing physical space.
VR4RE is focused on helping real-estate owners by teleporting visitors from anywhere (in VR) directly to the property that is for sale or rent and helps visitors save time and money by visiting a broad range of properties from only the most compelling ones in person.

This paper presents a brief presentation of implementations done so far and focuses on particular VR implementation done for a real estate developer. The focus of this implementation is the better immersion of the visitor by using recent hardware.

2. The history of in-house VR attempts
The starting idea for VR4RE emerged during discussions with a real estate developer in 2008. After having seen 3DCar, the real estate developer asked if the same technology could be used to present real estate. After working on a simple prototype, the 2008 real estate crisis, along with the fact that the tools to develop solutions were much more expensive, interfered with creating a finished solution. The first good looking prototype came out during a Startup Weekend event in Brasov, Romania, in 2013.

It was an apartment visualization application used of real time 3D model rendering for PC. The application included interactive doors. The first finished application was developed to run in a web-page (in Chrome and, with the help of add-ons, also in other browsers).

![Figure 1. Online VR apartment tour demo in the browser using 360 degrees images (on smartphone).](image)

TimeWalk [6] will be presented in more detail in a subsequent paper. It is important to know that, among others, TimeWalk involves creating a virtual copy of the world to enable virtual tourism.

The apartment prototype (at that time called 3DGate) was included in TimeWalk’s proof of concept during the next couple of years, thus enabling VR with Oculus Rift for the first time. The inclusion also facilitated the first window view on the surroundings of the apartment. In this case, the apartment was placed in one of the skyscrapers of Times Square, New York.

In 2015, we started experimenting with creating mobile apps for smartphones used together with Google Cardboard devices. The results were good when using a better Google Cardboard, such as the Dive’s one.

We started experimenting with these simpler devices because our existing HMDs (head-mounted displays) were great but just too expensive for possible users. Involving Cardboard devices (including Gear VR users) helps us reach many more people because of its lower hardware cost.
Also in 2015, we integrated a new apartment and made it accessible for smartphones with Google Cardboard. For the first time, we added exterior views using 360-degree photos, in a successful attempt to replicate the results achieved during the integration in Timewalk.

In early 2016, we developed our first project for a real estate developer. It included a whole level of the in-construction residence in Brasov, Romania. The project was conducted with the assistance of a real-estate agency.

The result consists of an Android application for Google Cardboard and a Windows application, which can work both with and without Oculus Rift.

Because of the bigger and more complex scene and the limits of mobile devices, it required the development of better optimization capabilities.

The feedback that we got with the assistance of our partners showed that our 3D VR technology is suitable for presenting in-construction and expensive real estate.

We have also learned that, for wide adoption, less expensive solutions are needed. We realized that creating VR tours using 360-degree photos makes them accessible to common apartment owners and the technology suits existing real estate property.

In 2017, we created an in-house 360 degrees VR technology to provide the cheaper alternative:

- it can be deployed online as a webpage to make it easily accessible;
- it can be switched to VR mode and it works with smartphones together with Google Cardboard, Samsung Gear and other similar devices. Additionally, it can be used even without any VR headsets or goggles, directly on the PC or smartphone.

Figure 1 presents an implementation done using JavaScript VR solutions.

We continued to improve this technology but also continued to focus on the more expensive but also more immersive solutions. The most recent implementation is presented in the next chapter.

3. Case study

The most recent implementation consists of creating a VR application, in which visitors can visit a one-bedroom apartment. Its layout can be seen in figure 2. It consists of a hallway from which a living room, a bedroom, a kitchen and a bathroom can be entered. Both the living room and the bedroom have balconies.

![Figure 2. Apartment floorplan (top view of the scene).](image)

The apartment had to be an accurate replica of a real one found in an in-construction block of flats owned by a well-known real estate developer located in Brasov, Romania.

For this to happen, the first step was to find out the date related to the apartment (footprint, sizes, layout etc.). It was decided that there was need to involve the architect who designs the apartments for
the real estate developer. This was done with the hope that we can get not only accurate data, but also a clear floorplan and maybe even 3D models.

The ideal envisioned workflow was:

• get 3D models from the architect;
• import 3D models into the VR application development environment;
• set up lighting;
• integrate VR;
• build test versions and test/fix;
• build the final application.

This workflow was followed and we managed to get 3D models from the architect. ArhiCAD was used to design the apartments and, with some efforts, we managed to obtain the models in a format which can be used to import them in the application development environment.

A scene was setup in the development environment and the 3D models were imported. Lighting was set up. However, during these steps, the first problems were noticed: the 3D models contained too many polygons to be able to use them for real-time renderings (in VR, we need to be able to render the model many times per second not only from one but from two simultaneous viewpoints corresponding to the two eyes of the viewer). Many visible mesh-related errors were also found.

A long period of trial and error followed while we experimented with several ways of decimating and recreating the 3D models.

Expectations of the real estate developer and of the architect related to keeping the ArchiCAD models used during design were a supplementary hindrance.

In the end, in order to be able to deliver a working result with a good quality, the application development workflow included an additional and time-consuming step, where a part of the 3D models was recreated from scratch using 3D modelling software and the other part of the 3D models was kept, but only after undergoing decimation procedures executed with various software tools. The testing and fixing step also took considerably longer than anticipated.

HTC Vive (SteamVR) was used for the VR implementation as it is the most immersive recent consumer-level VR hardware available). It creates the best immersion by allowing the user to move and walk freely in a pre-setup space. The two controllers allow to track and represent movements of the hands as well.

One of the controllers was programmed to be used so as to enable the visitor of the apartment to teleport himself in the apartment when the real-world available space is smaller than the size of the apartment (which is usually the case) (see figure 3). The other controller is programmed to offer a menu with various options in VR.

![Figure 3. Controller used to teleport (VR view).](image-url)
The following images display various views in the apartment. Figure 4 shows the living room, while the user is initiating the teleport to the hallway.

![Figure 4. Living room.](image)

Figure 5 displays the bedroom. It can be noticed that the exterior views using 360-degree photos mentioned in [7] have been used also in this project.

Figure 6 shows a view from the balcony of the bedroom.
4. Conclusions and further research

This paper presented a summary of the evolution of the VR4RE research direction and its latest developments. For more details and images regarding the history of real estate VR application development at Bluemind Software please see [7].

This paper shows that efforts are being and will keep being directed towards both of the research directions and market segments identified in [7]. It focused on 3D VR used to achieve a much more complete immersion with haptics (the Vive controllers do feature very basic haptic feedback) and positional tracking. The solution is ideal for properties to be built.

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