International Journal of Engineering & Technology, 7 (3.33) (2018) 37-40

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Implementation of Online and Offline Building Information System based on Virtual Reality and Augmented Reality

Asilbek Ganiev[1], Ho-Sun Shin[2], Kang-Hee Lee[3]*

[1]Department of Digital Media, Soongsil University, Seoul, Republic of Korea, 06978
[2]Department of Digital Media, Soongsil University, Seoul, Republic of Korea, 06978
[3]Department of Digital Media, Soongsil University, Seoul, Republic of Korea, 06978
**Corresponding author E-mail:kanghee.lee@ssu.ac.kr*

Abstract

Modern people can use navigation on the outside to save time and get to the destination well. Likewise, in order to find out more information about a destination building, such a system is increasingly needed both in front of the computer (on-line) of the house and after reaching the destination in the building (off-line). Accordingly, we employ Building Information System (BIS) as a system that provide users with content related to a building like BIO and BIM. The Building Information Online system (BIO) is an interactive map application designed to assist customers in finding parcels and building on a map online. The Building Information Modeling (BIM) allows nD information to be visualized simultaneously by architects, engineers and constructors to gain a synchronized understanding viewing from different perspectives. Inspired by above researches, we implement a service that provides online and offline Virtual Reality (VR) and Augmented Reality (AR) content for a building. This system can provide users outside the building with information within the building via devices with VR and AR support regardless of space restrictions. The system is designed to operate across scenarios requiring offline, online, offline-online collaboration, etc., and the corresponding experiments are carried out.

Keywords: *Augmented Reality; Virtual Reality; Markerless; Scenarios, Online; Offline; Users; Building information.*

1. Introduction

The concept of Virtual Reality (VR) came from the French playwright, Rôalité virtuelle, written in 1938 by Antoine Haut Arte [1]. At that time, Although we are reproducing the actual actor's figure, we have noticed that the viewer is facing light and images that are realized by the projector. Nowadays, applications using AR technology combined with VR technology are intensifying. Among them, this paper proposes a system that provides users with content related to a building via virtual reality and augmented reality. Related to the building content information system, BIO and BIM are representative examples. The Building Information Online system (BIO) is an interactive map application designed to assist customers in finding parcels and building on a map online [2-3]. The Building Information Modeling (BIM) allows nD information to be visualized simultaneously by architects, engineers and constructors to gain a synchronized understanding viewing from different perspectives [4]. Inspired by such researches, a user can obtain information for the building by using the proposed system regardless of space limitations. In Section 2,we present the system process, and in Section 3, we design user scenarios based on the system process and present the role of the system corresponding to user scenarios. The experimental results proves the effectiveness and feasibility of the proposed system. Finally, concluding remarks follows in Section 5.

2. Related Research

2.2. Virtual Reality (VR)

Virtual Reality encompasses the process to make virtual objects in the real world, the results of that process, and the experiences people have within such spaces [5]. Virtual reality allows people to interact with virtual spaces and to have realistic experiences using virtual reality devices [6]. Applications areas for virtual reality include education, remote manipulation, scientific visualization, games, and training.

Fig. 1: MindMotionPro from MindMaze (top) and Scenarios based on VR from XVR platform (bottom)

Copyright © 2018 Authors. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

For example, as shown in Figure 1, MindMotionPRO from MindMaze is a rehabilitation system for paralyzed patients that can be used in actual medical settings, helping patients rehabilitate by seeing and interact with virtual content [7]. Another example is the XVR platform, which provides scenarios to train first responders to safely address emergencies. Through hypothetical scenarios, trainees can learn how to take control of emergencies [8].
Virtual reality can also be used for applications that stimulate auditory and tactile senses provide more vivid experiences, and the number of such applications is gradually increasing.

2.2. Augmented Reality (AR)

Augmented reality (AR) refers to live direct or indirect viewing or experiencing of a physical, real-world environment with augmented (or supplemented) elements via computer-generated sensory input, such as sound, video, graphics or GPS data (refer to Fig. 2). By utilizing the real world as an environment, it takes a much shorter time to develop applications and enhance the accessibility to users[9]. Therefore, augmented reality technology has advanced faster than that for virtual technology. A user can enjoy augmented reality using a head mounted device, a smart phone, and so on[10].

Fig. 2: AR navigation example

In addition, markerless tracking technology is used to provide a more natural experience to users. This technology extracts points of interests to target the location of real objects to locate virtual content. Based on markerless tracking technology, an augmented reality system can display virtual content as soon as the points of interest are detected without the need for markers such as QR code, color markers, and so on [11-13].

2.3. Vuforia

Vuforia is an augmented reality Software Development Kit (SDK) developed by Qualcomm Tech-nologies, which enables the creation of augmented reality applications. Vuforia uses computer vision technology to recognize and track 2D image targets and 3D objects such as boxes, cans, and masks in real time. Vuforia SDK can be run on Android, Windows, and iOS platforms. In order to build applications, it can be used with Xcode, Android Studio, and Unity game engine. In addition, Vuforia has an object scanner application that enables visualization of 3D objects in a target format. In our project, we used Vuforia integrated with Unity to create and track 2D and 3D image targets and Vuforia Object Scanner for 3D scanning masks. As shown in Fig. 3, Vuforia AR Starter Kit hits the Unity Asset Store for free [14-15].

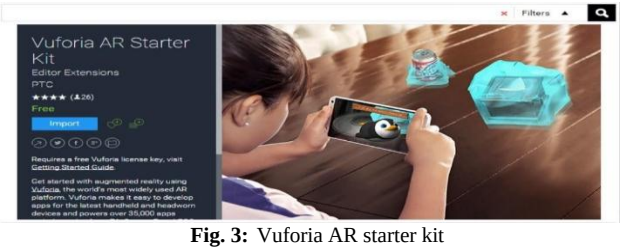

Fig. 3: Vuforia AR starter kit

2.4. Unity 3D

Unity 3D is multi-platform game engine used to create 2D and 3D imaging features, such as animations, physics, objects, and audio and video games. Unity3D has a simple and easily understandable interface for users and is relatively easy to script with C# or JavaScript. Unity3D is available on the Mac OS X and Windows 7, 8, and 10 operating systems. Developed applications can be run on An-droid, Windows, iOS, WebGL, Windows Phone, PS4, etc. devices. In this project, we used Unity3D with a web camera to recognize and map images in real time.

3. Design of on & Offline Building Information Service Based on VR and AR

The proposed augmented reality system adopts a markerless tracking system, and the system process consists of three steps. Fig.4 shows the overall architecture of the proposed system process. The first step is to choose recognition target objects to extract points of interest. For example, the outline of a building or an advertisement can be the target objects. The second step is to produce a target from the chosen objects and the AR content. Vuforia is used in this second step. In this step, the points of interest are extracted from the chosen objects. In the third step, the AR content are produced using Unity 3D, which is mapped to the points of interest.

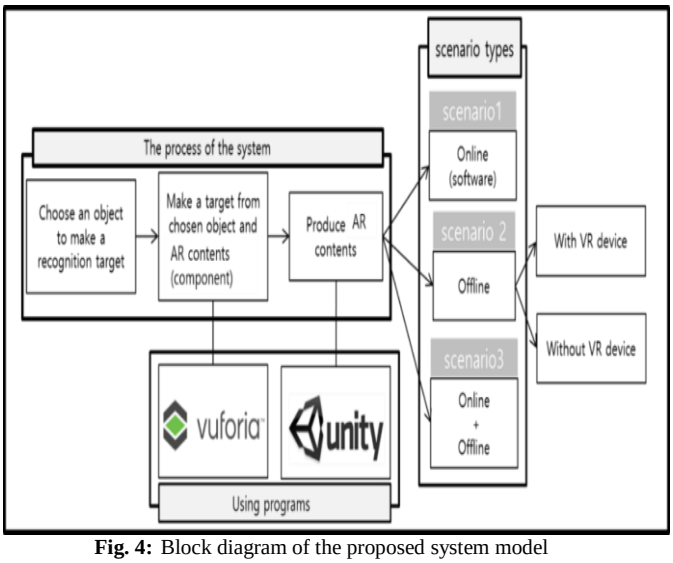

Fig. 4: Block diagram of the proposed system model

The proposed system will be served to users online and offline individually or at the same time. The user scenario is designed for both cases. Also, there are two prerequisites. The first prerequisite is to target the outline of the building that the user visits. The second prerequisite is for the user to hold an AR supporting device.

3.1. Scenario 1 (Case: Online Users)

The target for the first use case is online users. The user can approach the building thorough mapping services, such as Naver, Daum, and Google as shown in Table 1 and Fig. 5. The proposed systems extract the points of interest, detects the building outline as the target, and provides the content of the building.

Table.1: Scenario 1

Scenario 1 (case: online user)	
1	User approaches the image of the building online
2	The device extracts the points of interest and detects the building outline as the target
3	Virtual content (information of the building)is mapped onto the building outline in the images
4	Service completed

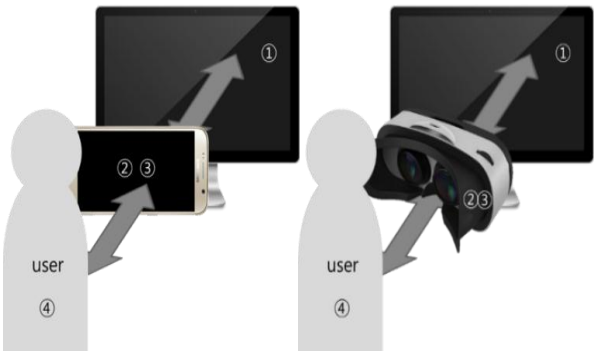

Fig. 5: Flow of Scenario 1 (Left: Android device, Right: VR device)

3.2. Scenario 2 (Case: Offline Users)

The second use case is that of an offline user. In this case, the user approaches the building in real time, and the proposed system is used as shown in Table 2 and Fig . 6.

Table. 2: Scenario 2

Scenario 2 (case: offline user)	
1	The user approaches the building directly
2	The device extracts the points of interest and detects the building outline as the target
3	Virtual content (information of the building)is mapped into the building outline
4	Service completed

When a user views a specific building through a device that supports AR, the device finds the points of interest and detects them in the building overview. At the end of this phase, users outside the building can see virtual content mapped to the exterior of the building, and users inside the building can obtain virtual content in greater detail inside the building. The virtual content includes text, images, video, and so on.

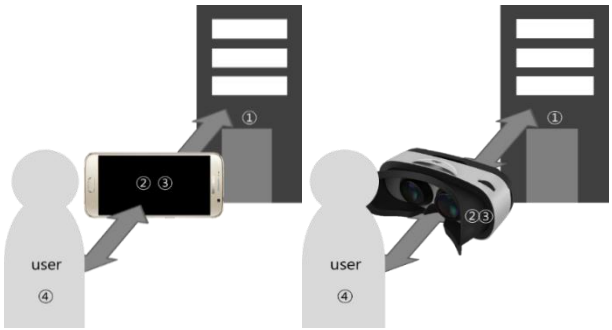

Fig. 6: Flow of Scenario 2 (Left: Android device, Right: VR device)

3.3. Scenario 3 (Case: Online Users + Offline Users)

The third scenario integrates Scenarios 1 and 2, meaning both offline and online users. Users who experience the proposed system in either way can experience the system in other ways as well. This means that a person who has experienced an online service can, of course, experience the offline service.

4. Experiments

In this section, we tested how the actual system works based on the proposed system and the user scenarios that follow.
Our experiments were conducted at Soongsil University. We conducted two types of experiments 'online' and 'offline'. In the online experiment, the user can find the target building by using NAVER or Google maps. The results of the experiments 2 and 3 are for offline scenarios. The target should be located in place that is visible to the camera, and then the Android device detects the target and maps additional information in real time. The results of experiment 2 are similar as those of experiment 4, but in this experiment we used virtual reality glasses to obtain more realistic results.
The results of the experiment are presented in two layers. The first layer offers a real-time view from the camera that was used to recognize target. After recognizing the target, the second layer is mapped to show a prerecorded movie clip or image.

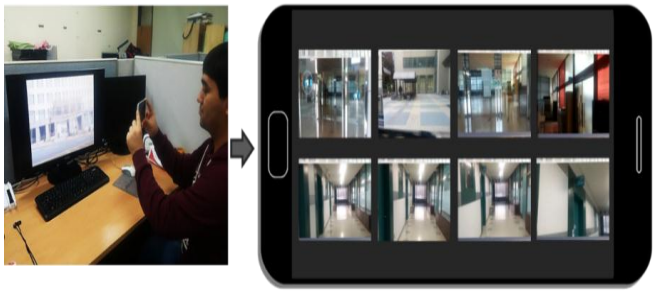

Fig. 7: Results for Experiment 1: Recognizing the target on the screen and mapping additional information

Fig. 7 shows an online experiment in which the user can find the target building by using NAVER or Google maps. After finding the image of the target building, the user can recognize the target by using our application on an Android device. The user will obtain more detailed information by watching a movie clip that is mapped onto the target building, and this movie clip can show the inside of the building: corridors, elevators, rooms, and so on.

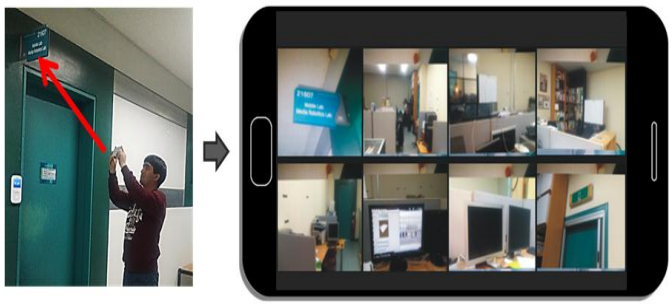

Fig. 8: Results for Experiment 2: Real time recognition target and mapping additional information

Fig.8 shows the results for when the user is inside the building. The target recognition and mapping additional information occur in real-time by using an Android smartphone. After recognizing the target application, a prerecorded movie clip is mapped to demonstrate the equipment, computers, doors, etc., located inside of the target room.

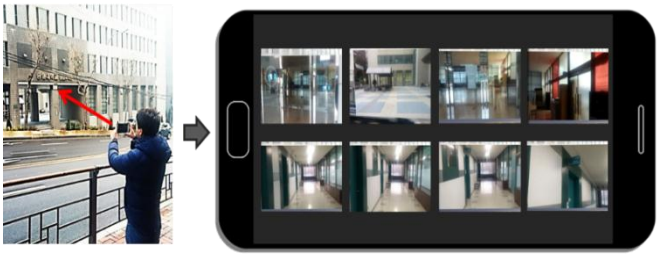

Fig. 9: Results for Experiment 3: Real time recognition target building and mapping video information

Fig. 9 shows the results when users are located outside of the building. The users can use their Android devices to recognize the target building, and a prerecorded movie clip will be mapped when the target is recognized. The movie clip will show a complete overview of the interior of the building, such as the lobby, elevators, corridors, and rooms that are located inside the building. Using this method, users can get obtain more realistic and understandable information of the inside of the target building.

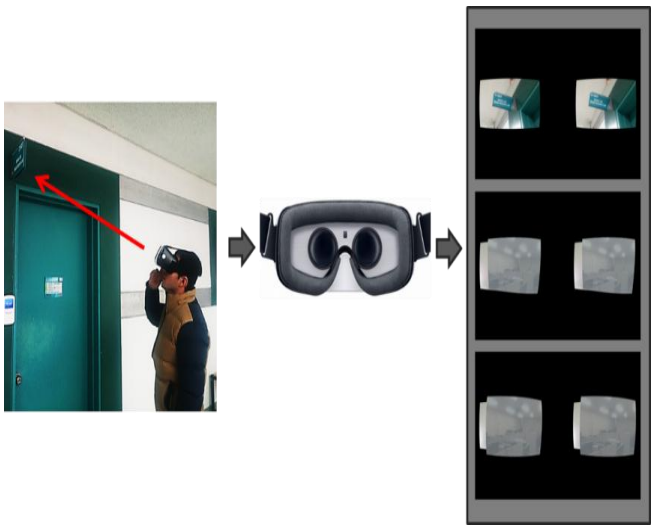

Fig. 10: Results for Experiment 4: Real time recognition target and mapping images using VR glasses

To obtain more realistic results when using our system, we developed a VR version of the application for Android devices. Figure 10 shows the real-time recognition of a target by using virtual reality glasses. In this experiment, the user has to be located inside the building next to the room that the user wants to preview. By using an Android device and virtual reality glasses, the user can see an image showing how the office is equipped. The user can then obtain more detailed information regarding the size of the room, the number of seats, number of computers, and so on.

5. Conclusions

In this paper we present a system that uses VR and AR to provide users with information regarding the interior of buildings by viewing the exterior. The system allows users to access buildings online and offline, and scenarios are designed based on such an approach. Then an experiment was carried out based on such scenario. When the users view the outside of the building through the device, both the online and offline modes, the VR and AR content provide information inside the building, and it is possible to provide a more realistic experience. The system that was proposed and developed in this paper allows the user to access information about the building through VR and AR without space restrictions. Also, our system can be used in other buildings. To use our system in other buildings, we just have to add the target image and movie clip to our system. There is a possibility for these outcomes to be further developed by combining with other technologies.

Acknowledgement

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(NRF-2017R1D1A1B05036028).

References

[1] Réalité virtuelle, https://fr.wikipedia.org/wiki/R%C3%A9alit%C3%A9_virtuelle
[2] Building Information System, https://www.youtube.com/watch?v=ZC1kLWKsmL0
[3] Building Information Online - ladbs, http://lacitydbs.org/buildinginfo
[4] Xia Sheng Lee, Mohd Faris Khamidi, Zi Siang See, Tim John Lees, Changsaar Chai, "Augmented reality for ndimensional building information modelling : Contextualization, Customization and Curation," in IEEE 22nd International Conference on Virtual System & Multimedia (VSMM), Oct.17-21, 2016.
[5] J A.Y. Kim, W.S. Chae, G.H. Zhang, H.L. Choi, B.S. Kim, J.W. Lee, Trends Analysis on Virtual Reality, *Electronics and Telecommunications Treads*, Vol. 31, No. 4, 216, pp. 23-25.
[6] K.Y. Won, [Technical Commentary] Virtual Reality as Computer Science, *Korean Institute of Information Scientists and Engineers*, **(1997)**, Vol. 15, No. 11, pp. 5-13.
[7] http://www.mindmaze.com/healthcare-and-neuro-rehabilitation/, **(2016).**
[8] http://www.xvrsim.com/en/XVR_Platform/ , **(2017).**
[9] Azuma, Ronald, T, A survey of augmented reality, *Presence: Teleoperators and virtual environments*, **(1997)**, Vol. 6, No. 4, , pp. 355-385.
[10] Jong-Sung Han, Geon-Ho Lee, VR Tourism Content Using the HMD Device, *The Journal of the Korea Contents Association*, **(2015)**, Vol. 15, No. 3, pp. 40-47.
[11] Min Woo Park, Jung Pil Park., and Soon Ki Jung, An Implementation of QR Code based On-line Mobile Augmented Reality System, *Journal of Korea Multimedia Society*, **(2012)**, Vol. 15, No. 8, , pp. 1004-1016.
[12] Juhyun Oh, Kwanghoon Sohn, Real-Time Camera Tracking for Markerless Augmented Reality, *Journal of Broadcast Engineering*, **(2011)**, Vol. 16, No. 4, , pp. 614-623.
[13] Kyoung-Hwa Song, Hyun-Ju Lee, A Case study on physical factors of emotional experience design reflected brand identity in augmented reality advertising, *Proceedings of KSDS Conference*, June 3, **(2016)**, pp. 24-25.
[14] Developing with Vuforia, available online: https://developer.vuforia.com/library/getting-started/
[15] Next Reality- How to install & Set Up Vuforia in Unity, https://hololens.reality.news/how-to/hololens-dev-102-install-set-up-vuforia-unity-0175898/