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Educational Effectiveness of Virtual Museum

YoungJe Yu[1], Woo Hyung June[2], Sun-Jeong Kim[3], Chang Geun Song[4]

Hallym University
[1]YYJ0716@hallym.ac.kr, [2]M18058@hallym.ac.kr, [3]sunkim@hallym.ac.kr, [4]cgsong@hallym.ac.kr

Abstract

The museum is one of the tourist resources that many tourists visit. In a typical museum, the curator will explain and deliver information to the visitors taking the visitors age and level of background knowledge into considerations. However, it is true that there are few curators in most museum. Audio guides have been used to help visitors understand and appreciate exhibition instead of curators. Recently, NFC tags have been used to improve the facility of old audio guide. In this paper, we use virtual reality, which is actively being used not only in movies but also in education to configure a virtual reality museum environment. We compare exhibition methods in a virtual reality museums and in actual museums. First, a survey is conducted for subjective evaluation of museum exhibition and actual museums. Second, a post-exhibition quiz is used to determine the objective effects of museum exhibition. Based on these results, we show the validity of the virtual reality museum.

Keywords: *Virtual reality, Curator, Museum, Education.*

1. Introduction

The visitors can tour the museums with the guidance of museum curators. The museum curators guide them in considering their characteristics, such as age or education level. In this way, the curators can intrigue visitors and facilitate their understanding about exhibits. However, all the visitors cannot enjoy such benefits because of the lack of curators.

Recently, virtual reality (VR) has been well appreciated by a number of fields other than computing field. This research focused on the recent situation which VR has been utilized in various areas, such as education, military, and medical simulation. VR is famous for its immersion inducing user's active participation and interest. Therefore, the current research aims to examine whether the new type of tour in the museum through VR can replace the existing types of museum tour (e.g. guidance of curator and smartphone application of NFC technology).[1]

Based on the assumption that VR could replace the existing ways, the following hypothesis is suggested.

Hypothesis. The museum tour using VR provide the amount of information enough to replace the existing way of the museum tour.

To test the hypothesis, the experiment is conducted with 75 participants. After the tour, each participant is asked to answer subjective survey questions, objective survey

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questions (exams). With the survey data, statistical analyses are processed and the analyses results are used for testing the hypothesis.

2. Related Work

There have been studies using RFID equipment and virtual reality to describe the exhibit [2]. Studies have been conducted linking exhibits, places and themes through the Mobile Virtual Reality Museum [1]. There was a study that created the Virtual Reality Museum using 360 degree photographs taken with two Go Pro Hero 3. The study focused on creating the Maria della Scala Museum of Virtual Reality [3]. Studies have been done to create a system that will experience exhibits in a virtual environment, using equipment such as Oculus Rift, Microsoft Kinect, and Leap Motion [4].

3. Virtual Museum and NFC Systems

3.1. Virtual Museum

Virtual reality system was produced using Unity 3D [8] 5.3.2f1 version with Windows 7 64bit computer (intel core i7-2600 processor, 8GB ram, GeForce GTX 560ti). Oculus Rift DK2 was used for the Head-mounted display [7]. Navigating between exhibits, video and audio contents are available within the virtual reality system. For such function leap motion [6] was attached in the front of Oculus Rift DK2. Leap motion is a sensor device that recognizes hand motion as input without any hand contact or touching. The exhibits for the VR museum was created with 3D max2010 [5].

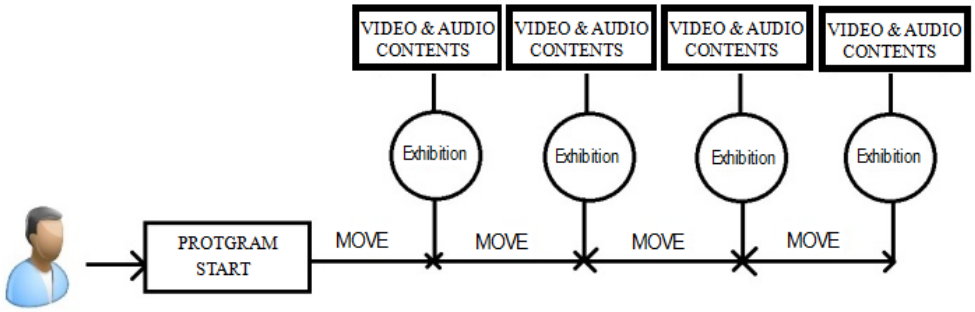

Figure 1. VR museum usage process

Left and right hands can be recognized in lip-motion (left hand recognition : moving to the previous object ; right hand recognition : moving to the next object) to be moved forward. When the user is placed in front of an object, video and audio content is selectable. For the method to select contents, Gaze method, which moves to the menu after staring at it for 3 seconds, was used.

The VR museum program is started, participants are placed in the starting position Figure 1. Participants are able to navigate between exhibit 1 ~ exhibit 4 according to their preference. In other words, one may be observing exhibit 2 and can move from not only to exhibit 3 but also can return to exhibit 1. Once moves towards the exhibit, they are able to select either video or audio contents.

3.2. NFC System

NFC system is produced with the Android Studio (compile SDK Version 11, build Tools Version "24.0.1). NFC system is composed with an Android app that displays artifact's information and streaming server that transmits information. The streaming server is used with a Windows Server 2008 64bit computer (Intel Xeon processor, 4GB RAM). Android app is installed onto Google Nexus7 and used for the study.

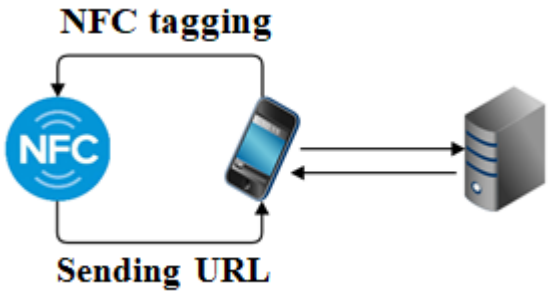

Figure 2. Diagram of the NFC system: when a NFC equipped phone is tagged to the NFC tag, image for the applying artifact is requested and later shown in the app

As shown in figure 2, NFC system's main function is streaming relevant artifact information. HLS(HTTP Live Streaming) method is used in order to create the streaming server. Android app allows video clip, audio and images transmitted from the streaming server to be presented onto the screen. There are three types of contents: video clip, audio and image. Participants are able to select the type of content to be streamed from the option window.

4. Experiment

75 participants gathered for the experiment. All participants are students of Hallym university. All participants are instructed about the study before the experiment. In the case of NFC experiment, participants are informed about the NFC app instruction, NFC tagging method, option settings and how to manipulate the VR gear. For the fairness of the experiment, participants are given 30 minutes to explore considering curator's explanation time being 30 minutes. After VR museum tour, participants are given a simple assessment to test how accurately the information is delivered to the percipients. Also, a subjective survey is given in order to collect participants' emotion towards the system. Certain amount of participation fee was provided for the participants.

4.1. Museum curator experiment

For an efficient experiment, 25 participants are divided into four groups. Each group, arranged with 5-7 people, is instructed to tour the museum with the guidance of a museum curator. Script for the tour is pre-arranged and equally presented for each group. After the tour, a quiz about the exhibition and a subjective survey is conducted.

4. 2. NFC System & Virtual museum experiment

NFC participants were able to get information about the exhibit through video clip, audio and full image, by tagging the NFC sticker, which was placed in front of the glass window of each exhibit. After the NFC experiment, a quiz about the exhibition and subjective survey is conduct. And virtual museum participants are given 30 minutes to tour four exhibits with the VR contents. Facilitator is on standby for any questions about controlling the VR system.

5. Result

5.1. Subjective evaluation result

Table 1. One way ANOVA results for subjective assessment

	Curator	NFC	VR	Total	F	P
N	25	25	25	75	1.789	0.175
M	20.92	19.12	19.68	19.90		
SD	3.55	3.24	3.52	3.48		

After the experiment, a subjective survey was conducted about the tour method. Survey consists of six questions and each question was assessed with a five-level Likert scale. One way ANOVA is conducted to determine whether there are differences in subjective assessment of the three experimental methods (Table 1. $F = 1.789$, $P = 0.175$). As shown in Table 1, the differences in subjective assessment for the three experimental methods are not statistically significant. Therefore, the user's subjective evaluation of Curator, NFC, and VR is the same.

5.2. Objective evaluation results

Table 2. Results of one way ANOVA on objective assessment

	Curator	NFC	VR	Total	F	P
N	25	25	25	75	0.096	0.908
M	4.36	4.40	4.20	4.32		
SD	1.65	1.58	1.87	1.68		

For an objective assessment of the three experimental methods, 8 assessment questions are prepared for the exhibits showed in the museum. The 8 questions are all made up of multiple-choice questions. Assessment questions are the same as test questions, so higher scores are considered to get more knowledge. Each question is calculated as 1 point if correct, and 0 point if wrong, and then combined the scores to use them as indicators for an objective assessment.

One way ANOVA is conducted to determine whether there are differences in Objective assessment of the three experimental methods. As shown in Table 2, there is no difference in objective assessment scores depending on the three experimental methods (table 4. $F = 0.096$, $P = 0.908$). As a result, there is no difference in the degree to which curator

explains directly, what the user gets using NFC, or how much knowledge he gets by viewing artifacts in a VR environment.

6. Conclusion and Future work

We conducted a study to see if the virtual reality museum system could replace the traditional method of visiting the museum (curator, NFC). We developed an NFC App program among the existing museum viewing methods. We developed a virtual museum that looks like a traditional museum, and a viewing scenario. A survey was conducted to evaluate the effectiveness of the existing museum viewing methods and virtual reality systems. All two (subjective, objective) assessments yielded similar scores and showed no statistically significant differences. This supports the hypothesis we proposed, "The museum tour using VR provide the amount of information enough to replace the existing ways of the museum tour."

Future studies should focus on making virtual reality museums more realistic. Since all of the exhibits selected for use in this thesis were pottery, there were many limitations in scanning and modeling the exhibits. If they produce a virtual object composed of non-crushable objects such as bronze incense burners and bells, they can expect to get higher scores in objective assessments.

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Authors

YoungJe Yu
2017 Hallym University Dept. of Convergence Software,
B. S. (Chuncheon, Korea)
He is a master's course at Hallym University.
Research interest area are including virtual reality and HCI.
E-mail address is YYJ0716@hallym.ac.kr

Woo Hyung June
2018 Hallym University Dept. of Convergence Software,
B. S. (Chuncheon, Korea)
He is a master's course at Hallym University.
Research interest area are including augmented reality and virtual reality
E-mail address is M18058@hallym.ac.kr

Prof. Sun-Jeong Kim
1996 Korea University, Dept. of Computer Science, B.S. (Seoul, Korea)
1998 Korea University, Dept. of Computer Science, M.S. (Seoul, Korea)
2003 Prof. Korea University, Dept. of Computer Science,
Ph.D. (Seoul, Korea)
Her research interests include geometric modeling, scientific visualization, virtual reality and augmented reality.
E-mail address is sunkim@hallym.ac.kr

Prof. Chang Geun Song 1981 Seoul National Univ. Dept. of Computer Science and Statistics, B.S. (Seoul, Korea) 1983 Korea Advanced Institute of Science and Technology(KAIST), Dept. of Computer Science, M.S (Daejeon, Korea). 1992 University of Oklahoma, EECS, Ph.D. (U.S.A)
Research interest area are including virtual reality, 3D graphics and HCI.
He is a faculty member of Department of Convergence Software, Hallym University in Korea.
E-mail address is cgsong@hallym.ac.kr