Virtual Reality for Digital User Experience and Interactive Learning Based on User Satisfaction: A Pilot Study

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***Abstract*—Virtual reality (VR) technology has been applied successfully in a wide range of fields, as mobile devices and wearable electronics have become popular commercial products. In this pilot study, we apply the VR technology with seven main steps to reconstruct a historical site (i.e., a nonextant historic east Taiwan railway station) to develop a VR simulation system. It provides an interactive environment for users to experience and appreciate historic east Taiwan railway stations and railway culture. 70 participants are engaged in user experience testing to verify if the VR simulation system can ensure usability and increase user satisfaction. The result indicates that the VR simulation system contributes to higher satisfaction on user interactive learning and operation efficiency and thus can be used to enhance user experience. It is arguable that the proposed VR simulation system could provide valuable insight into digital user experience in relevant fields.**

Keywords—Virtual Reality; User Experience; User Satisfaction; Interactive Learning; Usability

I. INTRODUCTION

As both 'ambient intelligence' and 'ubiquitous computing' grow and mature, mobile devices and wearable electronics have become some of the most desirable and popular commercial products [1, 2]. Virtual reality (VR) technology has been applied successfully in a wide range of fields, including Digital Marketing, Online Games, Product Design, Biomedical Engineering, and Interactive Learning [3-5]. VR is a system that allows users to interact, move, watch, and get immersed in a 3D environment [4]. VR has been defined as "the component of communication which takes place in a computer-generated synthetic space and embeds humans as an integral part of the system" [6, 7]. However, in the field of Interactive Learning or e-Learning, how to apply new technologies to increase user learning satisfaction remains a critical issue for researchers to address [1].

In recent years, Taiwanese railway culture has been catching on. Moreover, the trend toward cultural preservation further inspires the public and the government to preserve traditional railway culture. As historic east Taiwan railway stations boast a meaningful, significant and historical background, the project "East Railway Overall Performance Improvement Construction" initiated in 2010 to renovate old railway stations [3] should follow the modern principle of preserving historical sites well. Given that several historic east Taiwan railway stations no longer exist, it is a delicate task to render the appearance of these buildings to enable people to experience and appreciate them. The task also involves effective application of new technologies to this trend, which remains a critical issue and calls for more research attention.

Therefore, in this pilot study, we apply VR technology to reconstruct a historical site (i.e. a nonextant historic east Taiwan railway station) to develop a VR simulation system which provides an interactive environment for users to experience and appreciate the old east Taiwan railway station and railway culture through time. In addition, user experience testing is conducted to verify if the VR simulation system can ensure usability and enhance user experience and satisfaction.

II. VR TECHNOLOGY FOR HISTORICAL SITES RECONSTRUCTION

VR presentation in a heritage application was first used in 1994 [8], when a museum visitor interpretation system provided an interactive "walk-through" of a 3D reconstruction of Dudley Castle in England as it was in 1550 [9]. Following in these footsteps, we show how VR technology can help develop a VR simulation system. In light of Higgins et al. (1996), seven main steps are involved in the process [3] as follows:

Step 1: Review the literature and relevant studies.
Step 2: Define the boundary of the historic railway station, as shown in Figure 1(a).
Step 3: Sketch the outline of the main buildings of the historic

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railway station, as shown in Figure 1(b).

Step 4: Build 3D models using 3D software (e.g. 3D Max and Sketch Up), as shown in Figure 1(c).

Step 5: Render the 3D models using Sketch Up and Lumion software, as shown in Figure 1(d).

Step 6: Complete the VR simulation system, as shown in Figure 2(a).

Step 7: Conduct user experience testing for usability and user satisfaction regarding the VR simulation system, as shown in Figure 2(b).

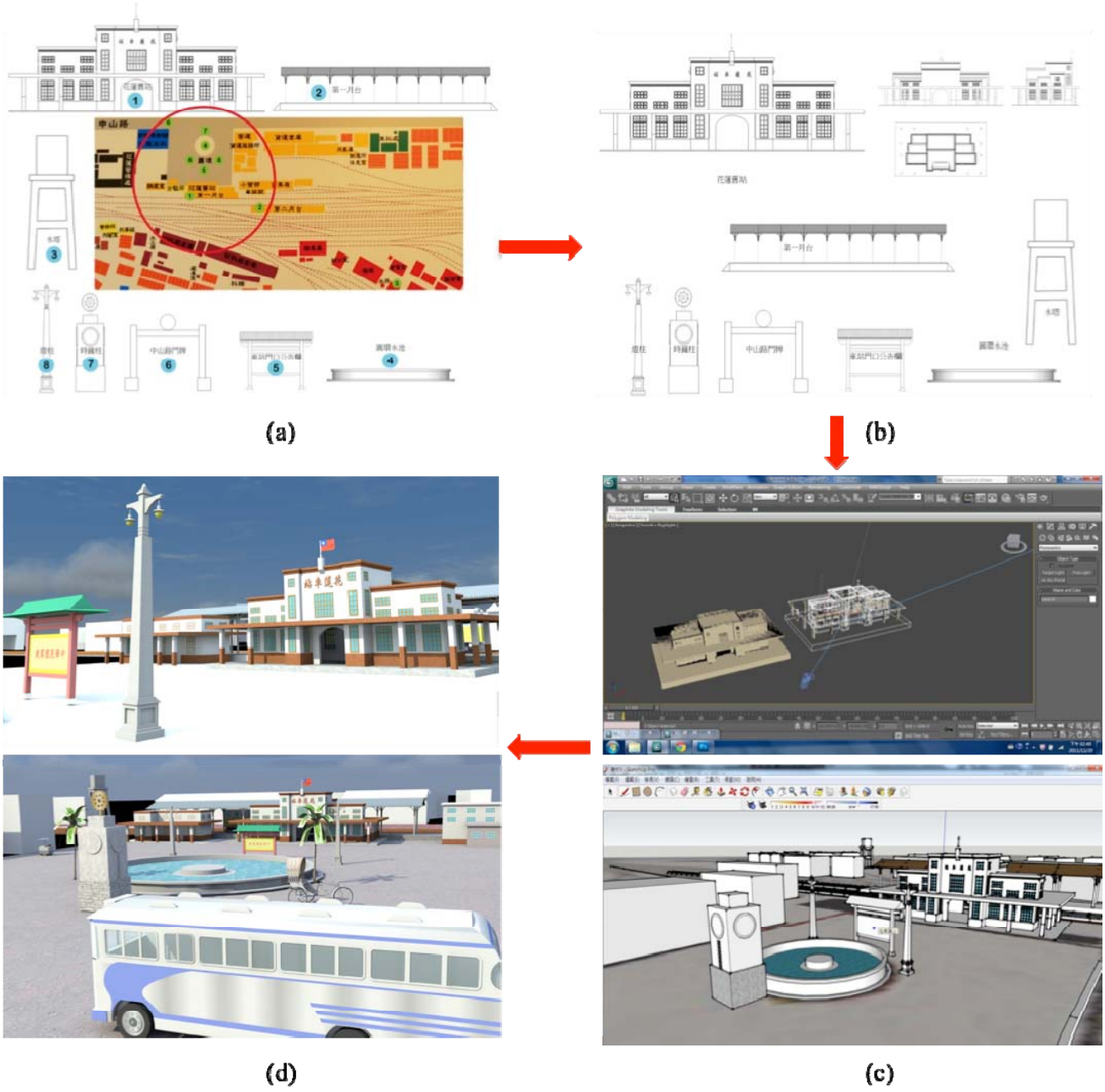

Fig. 1. The VR simulation system development process

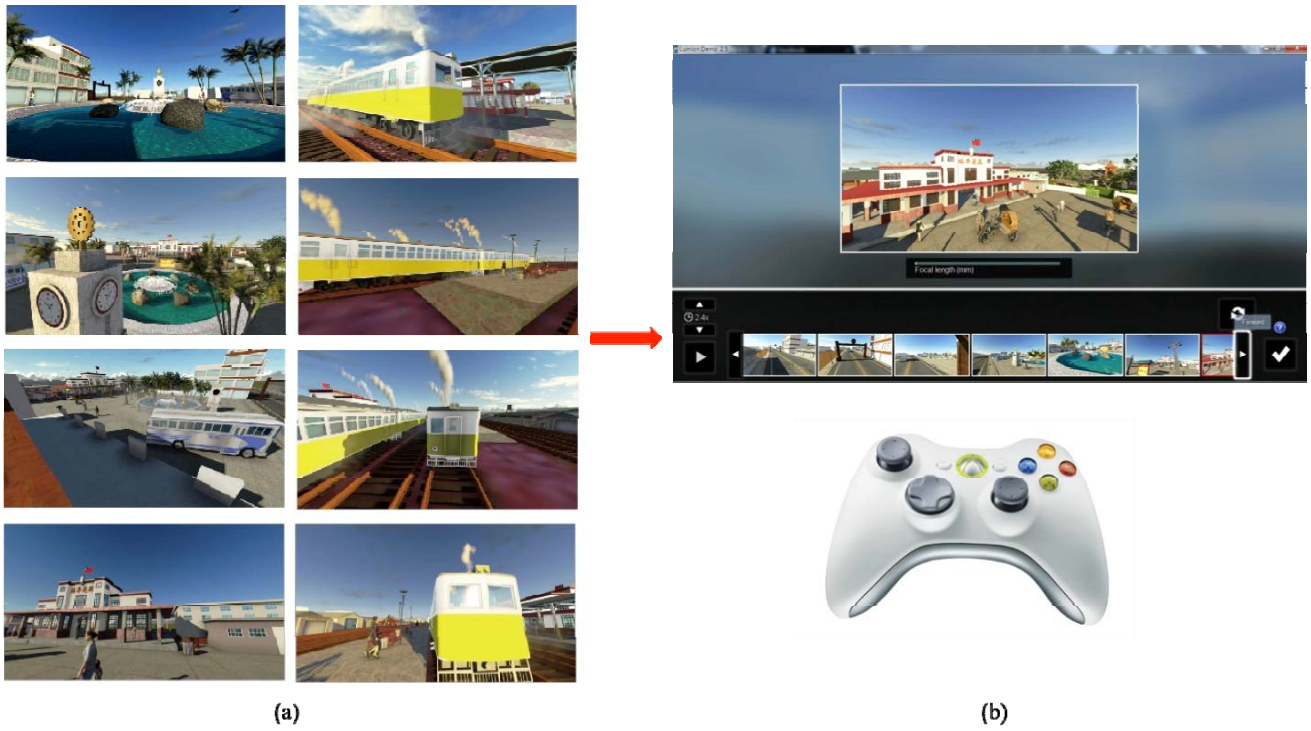

Fig. 2. The VR simulation system and the user experience test

III. User Experience Testing to Verify Usability and User Satisfaction

In order to verify if the VR simulation system can ensure usability and increase user satisfaction, we conducted a user experience testing which engaged 70 participants. We recorded the entire experimental test on video as we could use the video recordings to back up notes. After user experience testing, a semi-structured questionnaire was used to collect quantitative data (i.e. the 'subjective satisfaction' of operating the VR simulation system) and qualitative data (i.e. the participants' suggestions regarding the VR simulation system). The participants were asked to assess the VR simulation system through five questions, as follows:

Q1: How do you feel regarding the operation (ease of use) of the VR simulation system?
Q2: How do you feel regarding the visual and aesthetic style of the VR simulation system?
Q3: How do you feel regarding your interaction with the VR simulation system?
Q4: How satisfied are you overall with the VR simulation system?
Q5: How do you feel regarding the difference between the VR simulation system and traditional presentations? (Is the VR simulation system better than traditional presentations to help you to appreciate historic railway stations and railway culture?)

A 5-point scale was adopted for the semi-structured questionnaire, ranging from 1 (the lowest) to 5 (the highest). Figure 3 shows the result of the 70 participants' subjective satisfaction (Q1 to Q5), in which Q3 reports the highest satisfaction (4.39 out of 5), followed by Q4 (4.29), while Q2 has the lowest satisfaction (3.83). Except for Q2, the others have a promising outcome (scoring above 4). The score for Q3 shows that the VR simulation system achieves good satisfaction on interaction. Furthermore, the overall satisfaction of the VR simulation system (Q4) is also reported higher by the participants. The result for Q1 (4.06) indicates that the participants feel the VR simulation system is easy to use/operate. This easy accessibility implies that the usability or operation efficiency of the VR simulation system is also good.

If we ask the participants "Is the VR simulation system better than traditional presentations?", we obtain in general positive answers (4.07 out of 5). This affirmation indicates that the VR simulation system is able to increase participants' interactive satisfaction and improve digital user experience. By the same token, this ability suggests that VR technology can be used in an interactive environment for users to get information and learn efficiently. Curiously, the result of Q2 (3.83) indicates that the visual and aesthetic style of the VR simulation system is not good enough for the participants and might need improvement. Indeed, we need to pay more attention to the system aesthetics, for Tractinsky et al. (2000) have found a strong correlation between a system's aesthetics and its usability, which persists even after users have used the system. In other words, aesthetic responses are closely correlated, even related, to usability (such as "a priori perception of ease of use") [10, 11].

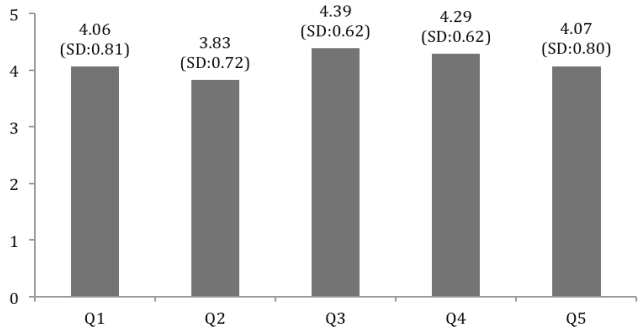

Fig. 3. Ssubjective satisfaction provided by the VR simulation system assessed by 70 participants

IV. Conclusion

In this pilot study, we have applied VR technology to developing a VR simulation system to reconstruct a nonextant historic east Taiwan railway station. 70 participants were recruited to perform user experience testing to verify if the VR simulation system can ensure usability and increase user satisfaction. The result indicates that the VR simulation system contributes to high satisfaction on interaction and operation efficiency. In addition, the participants perceive the VR simulation system as better than traditional systems to appreciate historic railway stations and railway culture. Accordingly, the present proposed VR simulation system could provide valuable insight into enhancing digital user experience, not least increasing user interactive satisfaction and optimizing usability/interactive operation.

Acknowledgment

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