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The Interactive Building Projection on Heritage Based on Game-Based Learning—A Case of "Red Building in National University of Tainan"

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Abstract: Although Taiwan has abundant culture of history and heritage, people seldom be interested in learning the cultures of history. We hope to combine the history with digital technology, so we design Processing programs to implement the Building Projection that contains the technology of Projection Blending and Projection Mapping and combine the App to add immediate interaction. Thus, the user can achieve the Game-based Learning via the interactive game. In this research, by taking the Red Building in National University of Tainan as an example, the users can utilize the Mobile Device to interact with Red Building, and carry on through three stages of interactive game; that is, becoming the defender, designer and eyewitness to experience the past history of Red Building. In the interactive game, the people can learn the history and culture; furthermore, it can inspire the concept of heritage protection and increase the identity about local culture of Taiwan in people. In this research, we use Expert Evaluation Method to improve our system and game mechanics based on the opinion of experts to increase the foundation of Game-based Learning. Besides, we use System Usability Scale (SUS) to analyze the usability and satisfaction of the system. The results of the scale showed that the users give a good evaluation about the usability and satisfaction of the system. We expect that the interactive technology can combine with more culture of heritage to enhance people identification of the culture of history. It's aimed to keep the meaningful culture of history forever.

Keywords: Game-based Learning, Building Projection, Projection Mapping, Projection Blending, Mobile Devices

1. Introduction

Tainan is a city with abundant history and culture in Taiwan. There are many heritage that had stayed hundreds of years and left many traces. As now, we can learn the history guided by the narrators or the words. But we are not just learning the history, we can also be the protector of the historical culture of heritage. Although the Building Projection is amazing now, but it seldom interact with the viewer. Therefore, in this research, by taking the Red Building in National University of Tainan as an example, we hope to transfer the amazing Building Projection from one-way article to a two-ways digital art article, so we combine Building Projection with the App for the users to see the process that Red Building be rebuilt and interact with the building by the game. By this way, the users can learn the history and know the importance of heritage protection, also can achieve the Game-Based Learning.

In this research, we use Expert Evaluation Method to improve our systems and make it better. Besides, the server and the Mobile Device should operate in coordination to create immediate interaction on the image of Building Projection. After that, we should make a film that can match the structure of the building. At the end, we use System Usability Scale (SUS) to analyze the usability and satisfaction of the system.

2. Literature Review

Game-Based Learning

Marc Prensky (2001) had proposed the concept of Digital Natives and Digital Immigrants in 2001. Digital natives grew up in the digital world. Their life was surrounded with Internet, television and other digital tools. They are good at using technical products. Digital Immigrants are quite distinct from Digital Natives. They were born in the age without completely information environment, and went through the transition when the typewriters gradually developed into Internet. Prensky (2001) even claimed that the section of the population of Digital Immigrants, which included most teachers, had to adapt themselves to unfamiliar technology for communicating with Digital Natives. The disparity of technological skills and interests between students and educators is easier to generate alienation and disaffection among them. (Sue Bennett, Karl Maton and Lisa Kervin, 2008). How to apply information technology to enhance Digital Native' learning motivation had became a important question to solve. That is why that Game-based Learning had been highly regarded. Game-Based Learning is precisely about integrating computer games into educational contents (Marc Prensky, 2001).It can raise learners' interest in participation, and solve the disadvantage that traditional education can't attract learners into learning (Mark Griffiths, 2002).

Building Projection

Building projection is an amazing projection technique that can project the movie on the irregularly shaped surface and make it fit perfectly on the building surface via Projection Mapping (INTEGRATED VISIONS, 2013). It combines the door and windows of building with the movie to display a stunning effect that change the structure of the building. It is superior to the ordinary projection technology. It allows buildings to move, transform and even communicate with people (Ryan Lum, 2010). Building Projection can give the building a new life, and show fantastic effects to surprise people. Most Building Projection shows visual effects with the movie, but the interaction is insufficient. Therefore, the breakthrough is the applications of interactions. Both the voice interactive Building Projection which can produce structural changes of building via people's sound exhibits in France in 2010 (Laughing Squid, 2011), and NuFormer Company's design: "Mocap Mapping" which merged of video mapping and live motion capture had shocked the field of Building projection(NuFormer Blog, 2013). Motion capturing is also a goal we'll actively achieve.

Mobile Devices and Mobile Learning

Due to the invention of the technology and the wireless networks , the functions of mobile device are more inclusive of everything such as playing online game , browsing on Internet , receiving the e-mail and so on. It makes a new style of learning: Mobile Learning. Quinn (2000) thought that mobile learning is e-learning through mobile devices. Hoppe, Joiner, Milrad, and Sharples (2003) were proposed that mobile learning is the style that using mobile technology and wireless communication for learning. There are at present many mobile devices, for instance, laptops, personal digital assistants (PDA), e-book reader, smartphones, etc. Because smartphones have the characteristics of powerful functions and portability, most mobile devices for mobile learning is taking smartphone in current. Motiwalla (2005) thought that if the application of mobile learning was suitable, it can make up some deficiencies of learning styles or increase its value. It can't show the superiority of mobile learning with only presenting original written materials to the mobile device. History of building is designed into an interactive learning game in this research. We are looking forward to combining multifunctional mobile devices with building projection. So that when learners interact with building by using the mobile device, they can understand the history of rebuilding, and enhance the learners' learning motivation of history and culture.

3. Research Methods

Research Architecture

In order to find the research questions out, we face many technique problems. These problems are about projecting correct scale images on irregularly surface of building, interactions between projection and mobile devices. We set a two-port-two-projection system, including input port and output port. Input port is mobile device port, and output port is server port. The following Figure 1 is shown.

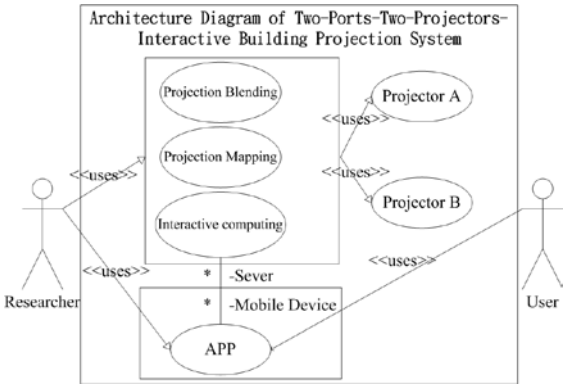

Figure 1. Architecture Diagram of Two-Ports-Two-Projectors-Interactive Building Projection System.

There are three purposes in the server port: Projection Blending, Projection mapping and Interactive computing. Projection Blending should be used when multi-projectors played at the same time. In order to make ranges of Building projection maximum, we overlap the areas of projection. The area of luminance is brighter, so we make their luminance unanimous by using Layer Mask. And Projection mapping is used to project correct scale images on irregularly surface of building. We can't put the projectors high enough so that the angle of projecting will become bigger. So we separate the areas of projection by Mapping. We map every separated areas on correct positions, and they will match with the building. In the end, we finish server with making specially good effect films by using Adobe After Effects and making real-time effects by Processing.

The Application of mobile device port is major tool for user. This research will employ Processing in two respects. Make real-time images about defending building, drawing the wall, etc, and connect mobile device port with server port. We connect mobile device port with server port via oscP5. OscP5 is a library written by Andreas Schlegel for the programming environment processing. It is a network communication protocol put forward by CNMAT(Center for New Music and Audio Technology). We make two ports as input and output. Then, the two ports can transfer instructions and position (which is keyed by the user) to each other. After that we can use the information to generate the display of the building projection, and output it to two projectors port in the end.

Game design

This research chooses Red Building of National University of Tainan for example. Red Building is the national historical building in Taiwan and the historical site for Tainan. Red Building has built since 1922 and now has more than 90 years of history, which there were five times change of building reconstruction. This research shows five reconstructions by "Interactive Building Projection Based on Game-Based Learning ". The game procedure can be divided into three major stages mainly such as Figure 2.

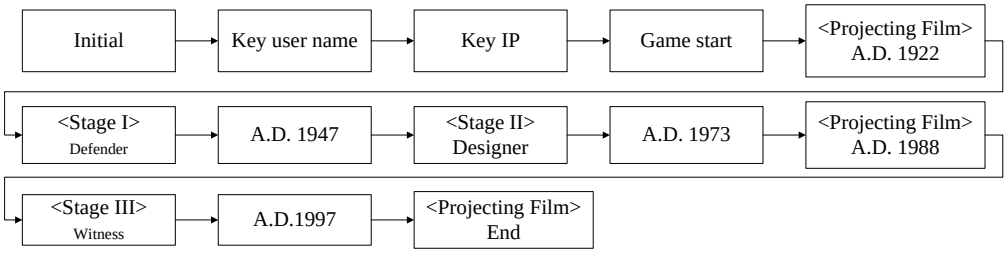

Figure 2. Game design procedure

Before the game starts, the user should key his/her name and IP of server. It projects a starting movie on Red Building after the game starts. Then, it is going to being the first stage game: "Defender". The background of Defender is World War II. The user should prevent people and Red Building attacking by allied forces. The user needs to make protection casings to protect peoples and Red Building by clicking coordinates on mobile devices. If protection is successful, the honor will increase. In this stage, defender symbolizes that people maintain heritages and protect heritages from damage. When time is up, server will compute honor and project it onto Building. The user and audiences will watch honor of user. It will produce the blanket bombing and totally demolish the Red Building in the end.

After the Red Building is totally destroyed, server will broadcast a short film about Red Building rebuilt in 1947 on the projection. And it is going to enter the second stage game: "Designer". The honor from Defender will be changed into Designer's game time. The processes will all show in the Building Projection to make the user and audience understand game rules. The interface of mobile device will be changed into a interface that the user can use tools to design his/her own picture. Tools include painting brush, special-effect, change the color etc. As the following Figure 3 is shown. Designer makes the user have more interactive with the heritage. Different users will have different intentions and ideas so that the Designer makes users create one's own bright memory to Red Building.

Figure 3. Designer

Figure 4. Witness

After the second stage finishes, the server will show that Red Building which is Chinese style building in 1973 and Red Building which is rebuilt in 1988 by broadcasting a film. The film will display the building characteristics of this two years, including green glaze pan tile and golden yellow glaze semicircular tile in 1973 and ceiling and plastic steel doors and windows placed an additional in 1988. Then, enter the final stage game: "Witness". The final stage is easier to the first two stages. The user will daub the mobile device that Red Building which is view today display gradually. The following Figure 4 is shown. The user will witness the history of Red Building through masks. At the end of the game, we will project an ending film that the game end in the integrity.

Prototype evaluation

In order to understand the research value of this research and the system usability about the interactive building projection. We design the prototype to assess System Usability Scale (SUS) and experts evaluation. The prototype is made up of using presentation and mobile device. We explained research contents by presentation and simulating the game procedure by mobile device. It makes experts and testers can clearly understand our research contents.

4. Results

In this research, we collect the opinion of experts from various domains to improve our system and the effects in the process of the interaction by using the Expert Evaluate Method. We achieve the Game-Based Learning by add the elements about the games to make the interaction more interesting. In the game, everyone use different method to protect the heritage and they got the different feedback. Therefore it increases the pleasure of viewer to join the interaction. Furthermore, we achieve the Game-Based Learning by the interactive game that makes more people to learn the history of Red

Building and the meaning of heritage protection. At the end, we invited the viewers to fill the questionnaire that using the System Usability Scale to analyze usability and satisfaction of the system. We will explain the results of Expert Evaluation Method and System Usability Scale.

We invited four experts from various domains and collected their opinions to improve our system. One of them is artist, and others are professors who are good at digital learning technology. As the Table 1, we classify the opinions of experts by various items. According to the opinions of experts, we improve many things and increase different interaction in the game, for example, sliding the screen, increasing the tools and giving the users more feedback. We benefited greatly from the opinions of the experts so that we can make our system better and attractive.

Table 1: The opinions of experts

Item	Opinions
System Design	• The program should control the situation so that can prevent the mistake. • Use the program is more complex than 3D modeling. • Should emphasize main concept-"Heritage Protection"
Interact Design	• More than one user can interact at the same time, different user get different feedback. • Swinging the Mobile Device can make the effect of breaking • Add the Kinect to increase the interaction • Do not limit the interactive effects, it should be immediate,
Interface Design	• Can slide to appear the new building, also let viewer know the history in the process.
Film Design	• The film should be lifelike, it cannot have the aside.
Game Mechanism	• Can play more different kind of the game. • The viewer can keep the memory after interaction. • Changing the game mechanism, let users protect the heritage, can attract more people.

System Usability Scale (SUS) is a subjective feeling scale often adopted in use research. The result of this questionnaire is using the prototype evaluation of 3.3 Research Methods. There are 32 testers. We converted the system use scale to actual scores via formula. The Table 2 is the converted scores of descriptive statistics. The average score is 73.75, the standard deviation is 10.8824, and the median score is 72.5. To use the average score to follow the example of Figure 5., the score is about at the "good" level. It reveals that users have a good evaluation for the usability and acceptability of interactive building projection.

Table 2: Describing statistic of the mark after the System Usability Scale is changed.

Sample number	Average	Median	Standard deviation	Minimum	Maximum
30	73.75	72.5	10.8824	57.5	97.5

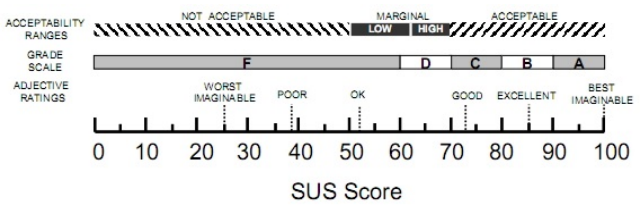

Figure 5. The score of System Usability Scale (Aaron Bangor, Philip Kortum, and James Miller, 2009).

5. Summary and Future

In this times, people seldom cherish the historical culture in Taiwan; moreover, they hardly have the concept of preserving the heritage. Therefore, in this research, we hope to create a new type for viewer to learn the history and know the meaning of heritage by combining the interactive Building Projection with the interactive game. According to the result of Expert Evaluation Method, we add more game mechanism to the interaction so that the users can achieve the Game-Based Learning by playing the interactive game and knowing the concept of heritage protection.

In this research, we use the tablet to interact with the building, in the future, we hope to add the technology of Kinect so that the users can interact with building via their movements. Furthermore, we hope that more than one people can interact with the building at the same time. Thus, it can be more attractive via the mode of Cooperative Learning. In the future, we hope to make use of the Building Projection on various heritages until we have more skillful technique, giving the heritage guide a new style Thus, it can attract more people to know the historical culture of Taiwan and inherit the culture of the heritage forever.

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