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Implementation of a Virtual Archives System using Virtual Reality Technology: A Case Study of the National Archives Administration Taiwan (ROC)

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ABSTRACT

The article describes the virtual archives system developed using virtual reality technologies in National Archives Administration (NAA), Taiwan, Republic of China. The project was launched in 2004 and consisted of three parts: a projected virtual reality system; a virtual archives website; and a virtual archives kiosk. This paper also discusses related issues during system development along with concepts, criteria and solutions. Finally it provides the experience of how to implement a virtual reality system for the archives.

Keywords: Virtual archives, virtual reality, virtual museums, online museums, NAA.

1. INTRODUCTION

The intention of implementing a virtual archives system was to simulate mandatory functionalities of a public records preservation repository employing computer technologies, instead of expanding existing property. After conducting a year of feasibility study for establishing a virtual archives system, Virtual Archives Project was launched in 2004. The system was opened to the public in the month of June 2005.We took advantage of computing technologies to create innovative archival services without any physical restrictions such as shelving, locations and opening hours, etc.

Conceptually, we designed an ideal virtual archival system that was able to satisfy users' individual demands, share archival information and hold online exhibitions in cyberspace. Besides, we operated the system as an experimental marketing tool, which was able to attract potential users to access archival resources. The combination of virtual reality technologies and archives would be an ideal alternative for promoting archives application.

One of most attractive features of virtual reality is that users can interact with objects in cyber space[1]. Furthermore, every user can organise his personal interests profile to design the system the way he/she likes. For instance, the way a user using a car driving simulator can emulate to control handler, to accelerates, to change direction, to read indicators on dashboard and so on. All detailed driving behaviours during roaming in a virtual space are same as steering a real car on the road. Furthermore, there are successful instances on high-level learning behaviours, which include motion control, perception for a real world, etc. As for retrieving records, it seemed to be more sophisticated than driving in mind. Generally, information retrieval is complicated and hard to be programmed. A proposal to draw a blue print for an ideal archives house was submitted as the very beginning of our virtual archives construction. Then groups of virtual human figures and related events were created in advance. Just like to compose a movie script, the scriptwriter made possible reactions of all characters. Lastly, characteristics of every virtual figure reactions were deliberately designed

so as to make the virtual archives more realistic[2]. These included:

(i) What types of high-level behaviours regarding intelligence, motivation, social communication and decision-making can be presented in the virtual archives?

(ii) What kinds of sensors does a user receive message from the real world?

(iii) How to control motions of virtual figures flexibly?

(iv) How to use graphics to present every aspects of a real world object?

2. TYPES OF VIRTUAL REALITY TECHNOLOGIES

There are many definitions of virtual reality[3-10] in the literature. Whereas, virtual reality is a synonym to immersive reality in which users are surrounded by artificial 3-D images created by computers[3]. In practice, there are lots of obstacles for accepting a fully immerse virtual reality solution for archives. Most of archives do not have an appropriate room suitable to set up related equipment. Besides, most sensory devices require isolation from noisy signals of other electric appliances and carriers, or it won't work properly. It is also very difficult for existing archives to expand for accommodating extra equipment.

In addition, it is arduous for regular users to distinguish the reflection on drape whether from a virtual reality system or a 3-D animation program. In fact, both of them are able to provide similar stereo visual effects. Users don't care what a virtual reality is. Technically speaking, whether the system has an interactive interface or not is the distinguishing feature. Since a virtual archives system is not merely for applying virtual reality technologies, it should also create more attractive environment for users. Virtual reality can be classified into four basic categories:

(i) Fully Immersive: A user who wears particular display devices is a part of the virtual environment. Display devices like head-mounted display and stereo spectacles; provide a 3-D virtual space in user's vision. The user never feels himself as an outsider or audience in the virtual environment. It is necessary to block any other visual contacts from the real world for approaching absolute immersive.

(ii) Semi-immersive: There are attached 3-D display devices that augment on existing objects. For instance, a pilot seat of an actual airplane was set up as the position for a virtual reality system. To keep the feeling of authentication is to use part of real objects. The view of a user created using computers. A number of vehicle control simulators, such as car driving, ship steeling and airplane controlling use this kind of environments to practice manipulating skills.

(iii) Projected Visions: A system projected 3-D images to a glass-beaded draper on the wall from different directions, which can serve a group of people view the same content simultaneously. Sometimes, it can allow multi-screens to surround users for obtaining better visual effects.

(iv) Desktop Display: A system merely displays a virtual environment on the screen of a user's monitor. Applying Flash is one of popular solutions to provide dynamic pages on websites with which player can be easily integrated with other browsers to offer animation features. Even it does not provide real immersive or semi-immersive interaction. Sometimes, we still convey significant messages in the virtual world without a real virtual reality. It is more important to suffice user's requirements than to apply a fancy technology. For example, R. Schmidt created "Virtual Reality Moon Phases" by ray-traced images of the Moon. A Clementine spacecraft mosaic of the lunar surface was mapped onto a sphere, and scenes were rendered as a virtual Sun "orbited" the Moon[11]. It is also categorised as a kind of virtual reality application.

3. THE VIRTUAL ARCHIVES IMPLEMENTATION PROJECT IN NAA

The initiative of the project was to add values to public records in virtual ways to satisfy individual requirements, instead of simply creating archives online exhibitions. Apparently, personalisation is a trend for application development in software industry. An advanced virtual reality environment depends on various sensory devices to collect and respond users' reactions with respect to stimuli from the virtual environment. However, there are some non-technical problems concerning the application of those devices in practice. Part of the users are not willing to share devices with others, such as left perspiration on head-mounted display helmet, electronic tracker and electronic gloves, etc., because of their personal hygiene and healthcare reasons. However, it is easier to employ visual simulation without expensive equipment for archives. Unfortunately, there are technical constraints for transmitting virtual reality images via Internet at present, because of bandwidth and additional devices

requirements. With the result, we adopted relatively cost saving alternatives were adopted to construct NAA virtual archives in the following three facets.

(i) Multi-users Projective Environment: Setting a multi-users environment on existing space is the most economic solution. For the reason of saving cost, we set up related equipment in our lecture hall, which can accommodate 60 people to view virtual reality shows, instead of using a dedicated presentation room (Fig. 1).

(ii) Virtual Archives Website: Is a desktop virtual reality website using Flash technology to drive virtual objects dynamically. It is ubiquitous service on the Internet (Fig. 2), with sub-titles in English, on the bottom right of the screen, to translate what the virtual figure says in Mandarin synchronically (http://va.archives.gov.tw).

(iii) Virtual Archives Kiosk: A virtual reality kiosk was positioned in front of information desk at the lobby of NAA (Fig. 3) It provides users do-it-yourself services that make users roam freely with a 3-D track ball instead of mouse clicks, just as using an automatic cashier machine.

4. CONSTRUCTION OF A VIRTUAL REALITY ENVIRONMENT

The main reasons for the construction of a virtual archives house include: (a) to present the physical structure of ideal archives house and interior decoration design in details; (b) presentation of preserved digital collections; and (c) to offer virtual archives services.

Construction of a virtual building is the skeleton of the project. There are two types of constructive frameworks: geometric and image models. Generally speaking, a geometric model was produced, which sometimes was created by designers without any real objects for reference. The similarity of simulation corresponds to the quality of models presentation. Both the delicacy of interoperation between objects and the visual granularity of images were associated with creativity and developing time. Basically, modelling is a matter of technology as well as synthesis of art. Fortunately, there are proprietary tools that assist to build 3-D solid geometric models quickly. All virtual objects can freely rotate without restrictions of movement angles for observing and modifying easily. Meanwhile, users can interact with any other objects in the space. Geometric modelling method was applied to build the main building as shown in Fig. 4.

Instead of building a 3-D geometric object, creators can apply scanned existing object images to model virtual objects. Definitely, it is an efficient solution for modelling with a 3-D scanning camera to capture the surrounded images of an object. Usually, there are not many event driven components on an image-modelled object. In business applications, the measure of image modelling is good at demonstrating the appearances of merchandises for marketing. It is also applicable for the quick usage directions of a product, such as how to assembly and disassembly it. In Taiwan, there are many virtual reality agents to build their clients' selling property 3-D models in this way. Compared with other kinds of virtual reality technologies, obviously it has weaker functionality. But, it is appropriate for visitor to introduce static features related to a building, such as interior compartments and organisational allocations. As a consequence, a hybrid model to construct virtual objects, which includes assembling the images of

Figure 1. Viewers with 3-D glasses viewing VR archives system.

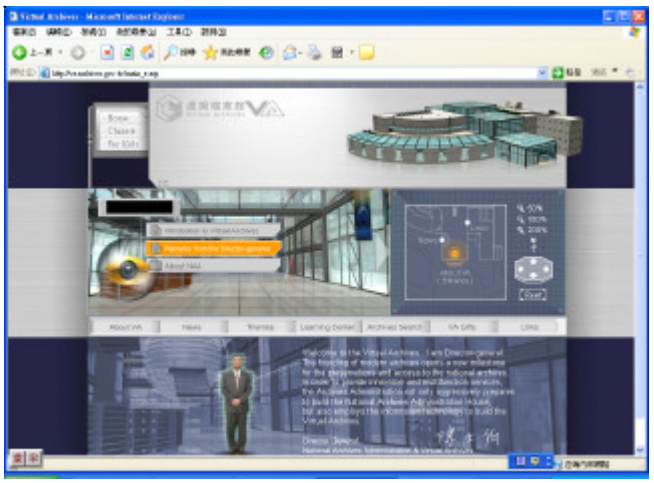

Figure 2. Virtual archives website of NAA.

Figure 3. A virtual archives kiosk with records exhibition windows.

Figure 4. The geometric model of virtual archives house.

real objects, and rendering virtual objects generated by geometric models was used at NAA. After completing the modelling, subsequently interactions among objects were started.

One of historic event settings made by hybrid model in NAA system is a real historic building photograph on painted marble floor behind virtual objects (Fig. 5). Similarly a virtual figure was modelled with real images of the Director General of the institution (Fig. 6) with a menu of themes behind him.

4.1 Figures Creation

It is important for visitors whom they meet in a virtual world, just like audience expects to see certain roles in a cinema. These virtual figures are similar to actors in a film who keep the storyline going, whether they are fully created by computers or transformed from real figures' images. In NAA system, both kinds of figures have been used. The image of Director General, NAA plays the major role to introduce all services. In the other themes, demonstration avatars being used instead. Whatsoever, all actions of virtual figures have got to depend on scripts, including background settings? In principle, there are three kinds of avatar operations:

(i) An avatar is a guide of the system, which directs a user to surf in virtual environment (Figs 7 and 8).

(ii) It is a substitute of a user, and manipulates all operations in the virtual archives.

A user is an audience who cannot manipulate figures in the system. An avatar is surfing automatically for presenting featured functions.

4.2 Interaction Design in Virtual Environment

It is too complicated to simulate all human reactions corresponding to what happens in a real world[12]. Therefore, it is necessary to narrow down

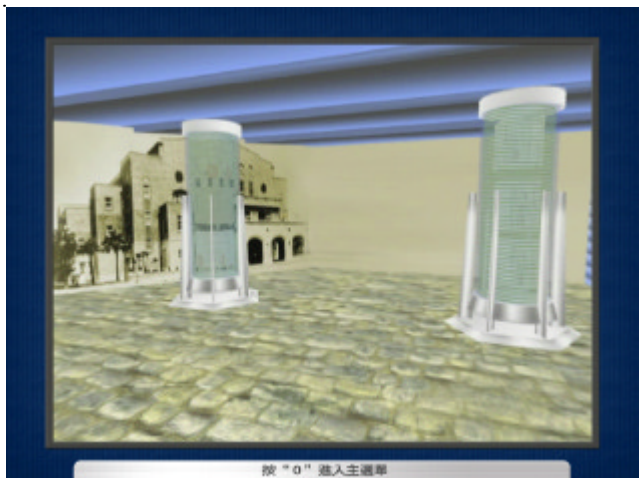

Figure 5. A virtual historic wall setting.

Figure 6. A virtual figure.

Figure 7. A user is controlling an avatar by a 3-D mouse in the lobby of NAA virtual archives house.

Figure 8. An avatar, named as Archives Gnome, is guiding the second floor of our virtual archives house in front of an elevator.

the scope of simulation in applications. On the contrary, a simulated environment has to remain the minimum essences of the real world. It is a dilemma for a system designer to trade off what the minimum is? The critical components of a virtual reality are how virtual figures in scenes react corresponding to the events. Just as filmmaking, all characters and settings have to follow a well-defined script to go through till the end. An archivist could play the role of a director to make the virtual system keep storyline forward. This includes where and when virtual figures are placed, what kind of events would be triggered, and their corresponding reactions. Theoretically, reactions are relations among virtual objects that have to be arranged in advance. They are also the presentation of objects interaction in a virtual reality environment. In details, there are different presentation layers of an event and corresponding responses. Generally, the quality of simulation affects users' perception. Since all interactions of avatars depended on existing definitions in a database, of which all movements and scenes require huge computing resources. It is necessary to restrict the number of reaction modes for obtaining performance efficiency. Hence, several types of working templates for presenting different themes were generated. In short, a virtual archives system at NAA is not just an application, but also provides a general framework for virtual exhibits. Therefore, contents can be easily modified in virtual exhibitions.

4.3 Selection of Auxiliary Devices

The source for triggering events among real objects is not only from human vision, but also from their other sensory organs. However, current multimedia technologies still focus on audio and visual effects primarily. That implicated that extra senses in a virtual environment have to be assisted by auxiliary devices. BOOM (Binocular Omni Orientation Monitor) is one of very famous output devices for watching virtual reality environment. It is very similar to a head-mounted display, but is like a binocular to observe images. Display screen and related devices were integrated into a viewing box with an arm like sensor to perform all movements.

Nowadays, there are tangible devices capable to response specific stimuli form the real world. In manufacturing industry, people use haptic operation mechanism such as robotic arms to deal with dangerous works. It is helpful for some of learning activities to apply haptic simulation equipment [13]. If a virtual archives user can feel to flip pages of virtual records, it would be more realistic than just viewing the content of a record. However, this kind of device allows one user at a time. Therefore BOOM solution was not implemented at NAA even though it provides a higher resolution. It is less practicable for archives, especially for a non-profit oriented organisation. If there is an advanced virtual reality environment in which several users can involve simultaneously with their bare eyes, it would be much more convenient for viewers. Unfortunately, it is necessary to use additional devices for achieving high visual effect at present, so 3-D spectacles were used to generate optical 3-D visual effects. It is the simplest way to reach visual virtual reality.

5. THEMES DESIGN IN THE VIRTUAL ARCHIVES SYSTEM

If a computer could utilise historic records to simulate parts of facts, it would be most fascinating for researchers. For instance, Revival of Life in Ancient Pompeii[14], which is a very attractive application.

It successfully emulated ancient Pompeian life in Italy with the virtual reality technologies. The results filled the gap of historic records, and then made viewers cross over historical lags consequently. Similar concept was followed to select historic incidents at NAA as themes to demonstrate in the system. One of the merits for simulation is that the system never makes a real event happened. So a video war game is not a real war. But all scenes inside the game absolutely make user realise what a war is like. The users of a war game also get some exact experience without casualties. For instance, the 921-earthquake occurred on 21 September 1999. It was a catastrophe in Taiwan's history; thousands of casualties took place in that earthquake. No one can ever think of this kind of earthquake to happen again, but simulation technologies were used for reminding people and to preserve such important incidents in Taiwan's memory by using partial investigation data to synthesize artificial imagination, subsequently to simulate certain phenomena, such as instantaneous earth surface contour changes. For the reason of simplifying system implementation, core collections at NAA were extracted as descriptive targets of which attributes decided what would be in the virtual world. Finally, decided were themes to be presented. In practice, simplifying colour pixels would make the environment easier for readers to understand. Moreover, abstracting records also shrinks storage space effectively. Since the simulation was treated as a simplified abstract of real object reactions, it might be useful for some educational purposes to refine some complicated concepts.

The system simulated the earthquake of Richter scale 7.3 which destroyed Shih-Kang Dam, one of hydroelectricity plants in Tai-Chung County, Taiwan, on 21 September 1999(Fig. 9). Themes in the virtual archives system are filled with educational intentions.

Figure 9. Simulated earthquake picture.

In other words, the virtual archives system is also a new instrument for archives education; however, developing an educational system is different from a general one. As per our experience, there are six factors for designing educational virtual reality software:

(i) Verbal Linguistic: In the real world, only concise semantics are able to express sophisticated mind. Textual messages may not be a key point for implementing a virtual reality system, but it would be unavoidable to convey some complicated concepts. Especially in archives, most of collections are textual records. Therefore, less or more, it cannot help using words to present certain intents. It is useful for enhancing system's accessibility to refine verbose description. For example, we put on some subtitles into parts of scenes to make foreign users understand easier.

(ii) Logical Deduction: All events and propositions have to be inferable logically in virtual scenes. It would make users feel more realistic in the cyber world. Usually, pattern-matching methods are used as mathematical thinking processes to artificially simulate themes in real archives. Basically, it is difficult to define event patterns to express intents of archives even in spoken languages. All events in themes have to be reviewed by archivists for sure.

(iii) Spatial Allocations: All objects in virtual reality are represented in 3-D modes. Therefore, all messages among objects should be considered a spatial interactive relationship. Therefore, allocations of characters and triggered events would influence accessibility and friendliness to users.

(iv) Bodily Kinesthetic: Default object procedures should be designed by reasonable manipulation schemes. The closer the movements of real objects, the more users feel realistic. Even certain actions of an avatar could be much better than what an ordinary person can do.

(v) Musical: Dub in appropriate background music could make the system more attractive. A good incidental music always accompanies with a perfect atmosphere[12].

(vi) Interoperation: It is difficult to define general interoperated reaction rules with respect to individuals. In principle, the defined behaviours among users and avatars have to follow regulations in human societies by default. For generating reasonable results, all interoperated behaviours

have to be designed and validated in advance. Subsequently, essence of large size contents is beneficial for education; it should be encapsulated in related themes during the phase of system designing.

6. DIFFICULTIES IN IMPLEMENTATION OF VIRTUAL ARCHIVES

There are lots of difficulties in implementing a virtual archives system. For instance, there are many actions that are permitted in the virtual world, but illegitimate in the real world. Since a virtual archives system is without physical restrictions, the result of simulation might be different from what happens in the real world[15]. Apparently you cannot jump from the rooftop of a skyscraper and kill somebody you dislike, but you can do it in the virtual cyberspace. On the other hand, doing what you cannot do in a real world is the key attraction for regular users. It is considerately difficult to create appropriate events and scenes for constructing a virtual reality application. A virtual reality system is an aggregation of triggered events, scenes and scenarios. Circumstance information surrounded users that provided by sensory devices for transmitting human sensation reaction to events. All virtual scenes are actually created by experience, including the estimation of each avatar's movement duration and located positions during process. If a virtual scenario is embedded with human experience, it would make viewers feel friendlier. Highly recommended is to pay attentions to the differences between natural human senses and sensor devices, which might influence how to design triggering points but it seems not to exist in any standard to make decisions.

The first step for building up a virtual archives system is to define accurate requirements. It is very difficult for a system developer, because user's requirements always fluctuate. Lots of concepts were adopted at NAA from computer game designs, especially in scenario planning. The features which impressed game users were applied to attract users to archives. For example, a series of virtual training courses for archivists and regular users were established in this way. The critical points of success on a virtual archives system are: (i) functionality should exactly satisfies users' requirements; (ii) expectation is not over technical limitations of virtual reality, such as levels of behaviours of a virtual figure, and similarity to real characters; and (iii) reusability of virtual objects, including behaviours, collections and services, for keeping contents updated easy. In addition, the effective sensory area of sensor devices is different from each other. For example, fingertip touching control would be more concise than a mouse pointing to trigger an event on screen. In contrast, it is more natural for using footstep-control movement directions to advance or step back in immersive environment. Sensory devices have to send back the result they have sensed during environment changes. Some devices pass signals via serial ports, such as RS232, of which metal carrier would be influenced by the distance of sensors and host. That means the location of a virtual reality system has to overcome existing possible transmission noise. Moreover, some equipment will occupy huge amount of space and consume high electricity. Archives might not afford those extra expenses to operate the system, without previously planning budget.

Theoretically, a perfect 3-D image was generated by six-directional projections such as a cube. In contrast, every projector has corresponding demand for space and cost. For remaining, the functionality of the lecture hall coexisted with the fundamental visual effects in our virtual reality archives system. We designed an elevated rack on the ceiling to place two projectors, which projected different directional images for generating 3-D visual effects instead. Consequently, we spared an extra space for dedicating the related equipment. Certainly, we scarified the quality of virtual reality (Fig. 10).

7. CONCLUSION

The reasons for employing virtual reality technologies in archives are: (i) simulation is cheaper than constructing a real building; (ii) capability of offering new services that are not provided in a physical archives; (iii) a virtual archives system could partly substitute during suspension of real services; (iv) online visitors can browse and retrieve records in a virtual 3-D space without physical restrictions such as transportation, opening hours, allocation and so on; (v) an alternative

Figure 10. 3-D image projection facility at NAA.

to satisfy readers to apply precious records without any possibility of any malicious or coincidental violation; (vi) it is easy to change exhibits arrangement in a virtual archives without schedule conflicts for different themes. A virtual reality system can integrate with digital contents management, which saves coordination of labour works. Even we can use it to promote a real exhibition; and (vii) a user can play any roles in archives, such as an archivist to make his own online exhibition.

Establishing a virtual archives system is to fulfill the existing service gaps instead of replacing completely, even though a virtual archives system might provide better services under certain situations. The virtual archives system cannot diminish the value of existing archives. In fact, the purpose of the project was to advance virtual circumstances to demonstrate eminent archival contexts inside collections and complement traditional archival functionality in virtual ways. A wholesome strategy will shorten the time of implementation, including what kinds of activities should described in the system, how to present featured collections with respect to virtual objects, and what kinds of solutions for virtual reality technologies and so on. If your institution intended to implement a virtual archives system using virtual reality, it would be proper to draft your strategy for the first step.

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