VR EXPERIENCE DESIGN IN TANGIBLE SPACE: HERITAGE ALIVE!

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This paper shows a framework of VR experience design that has a value in both business and social meaning by the user centered design process of this Heritage Alive experience. We interviewed each technology players (TA, TI, RCS research group) to understand possible technologies and to define best system setting of VR experience, then observed and participated a real (off line) heritage exploring event. Based on this real experience, we explored more economic, safe, and effective learning experience in Tangible Space. We developed a system model of Heritage Alive! and a usage scenario of Heritage Alive experience. Various user interactions are designed and tested to leverage immersiveness and entertainment in application scenario of Heritage Alive!.

INTRODUCTION

Tangible Space Concept

Tangible Space Initiative (TSI) is a new initiative led by Korea Institute of Science and Technology (KIST) to explore novel integration framework for next generation Human Computer Interaction (HCI) issues. TSI explores how users may interact with 3D virtual environment that is situated in the physical interaction environment. The initiative involves experts from diverse related fields such as virtual reality (VR), intelligent control, human robotics, image processing, multimedia database, and artificial intelligence.

There have been numerous research efforts focused on a generic interface metaphor for 3D virtual environment that is comparable to a desktop metaphor in 2D window-based computer interfaces. However, many VR interfaces used today are still awkward and specific to application contents.

In TSI, more effective VR interface metaphor is sought: a user may experience an interaction environment that is realized by both physical and virtual means. TSI effort is led by three parallel and cooperative components: Tangible Interface (TI), Responsive Cyber Space (RCS), and Tangible Agent (TA). TI covers how the user sees and manipulates the 3D cyber space directly. RCS creates and controls the virtual environment with its objects and behaviors. TA may sense and act upon the physical interface environment on behalf of any components of TSI. (Ko, 2002)

Design Objectives of TSI Experience

We designed a scenario framework of TSI experience with which satisfies following design objectives. First, The scenario should be based on three parallel and cooperative technologies components: Second, When the scenario is implemented, it should contribute to business, society and especially education., since education market in Korea has big business opportunities and social impact. Finally, The scenario aimed at bringing wow effect of technology and science to the users of Tangible Space who may not understand every element of technologies involved in creating Tangible Space, but will evaluate the experience as a whole in terms of emotional impacts.

Design Process of TSI Experience

For the social value and emotional appeal of our design objectives, we followed user centered approach to find and study target experience in real world. For the first stage, we interviewed each technology groups (TA, TI, RCS research group) to understand possible technologies and to define best system setting of TSI experience, then explored suitable target situation that can meet our design objectives. We observed and participated the target experience from the user's perspective. Based on this real experience, we explored more economic, safe, and effective learning experience in Tangible Space. We developed a system model and a usage scenario under the brand of 'Heritage Alive!'.

Various user interactions are designed and tested to leverage immersiveness and entertainment in application scenario of Heritage Alive!.

TECHNOLOGY SETTINGS OF TANGIBLE SPACE

From the interviews and information gathering on the three component technologies, we can draft basic roles and relationships among the components in user's side. As in figure 1, a user can sense and act upon on Tangible Space by TI. TI enables the user to access RCS that provides knowledge management and synthetic or synthetic-natural visual/haptic feedback displays. TA works for a user to overcome physical constraints of a human. So the advantage of Tangible Space is optimized when Tangible Space enables a user can experience the real world that have time, spatial, and physical constraints without TS.

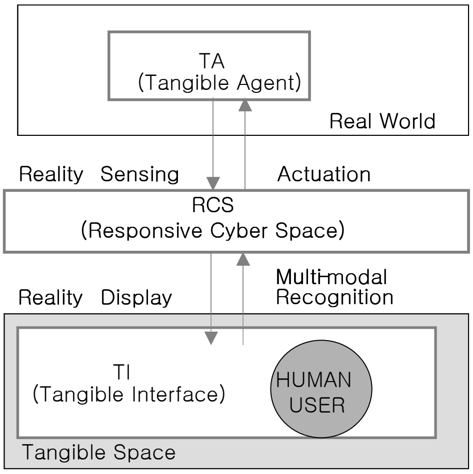

Fig 1. Concept diagram of Tangible Space

TARGET EXPERIENCE

We explored various possible situations that can match TSI technologies to enhance the quality of experience and are meaningful in both business and education. The target situation we found for TSI experience is 'exploring cultural heritage', and we named our designed experience as 'Heritage Alive!'. Exploring cultural heritage is an integrated experience of travel and learning, which involve constraints of time and space, and interaction between a group of learners or a tour guide. Planning and preparing physical tour program of cultural heritage is painful to arrange and spare time together among. In addition, it is hard to learn cultural heritage on site, since much of our cultural heritages are already ruined or perished. But still exploring cultural heritage on site brings one to realize the historic connection and to enjoy traveling. The educational contents in cultural heritage are various according to learner's interests, education level, and environmental conditions of the site, that means high contents productivity within limited physical environment. To study 'exploring cultural heritage' in real world, a full day guided group tour of cultural heritage in Gyeong-Ju, the physical site of ancient Shilla dynasty is done July 17th, 2002.

We found that there are two main design factors in target experience. The first design factor is a variety of activities in target experience such as observation, touching and sensing, conversation, experiment, and evaluation. Heritage Alive! should support those activities interactively in an intuitive way. The second design factor in Heritage Alive! is that the quality of the experience depends on the ability of a tour guide. So our design includes learners to meet with the guide and interact with the guide in Tangible Space.

HERITAGE ALIVE! FRAME WORK

The three main players in Heritage Alive are learners who want to experience and learn cultural heritage, content providers that generate virtual objects of cultural heritage through TA and RCS technology, and education providers who guide the learning experience in Heritage Alive. Learners in VR theatre meet a guide in a remote VR CAVE and experience cultural heritage through TI, while RCS coordinates the main players and TSI elements.

Followings are frame of Heritage Alive scenario:. A family that has an elementary school kid wants to explore cultural heritage of Shilla dynasty in both educational and enjoyable manner. They registered Heritage Alive program via home networked platform and then visit VR theatre in neighborhood instead of taking a long trip to Gyeong-Ju, the physical site of cultural heritage of Shilla dynasty. At the VR theatre, they meet a competent guide who leads interactive learning experience, and have hands-on experiences on virtually generated cultural heritages through intuitive TI support. There is no time, place and physical resource constraints in Heritage Alive experiences. Learners can visit the building, which collapsed thousand years ago, and touch or even destroy virtual objects instead of genuine one in special preservation.

APPLICATION VERSION OF HERITAGE ALIVE!

Scenario of Royal Yellow Dragon Temple Ver.1

Royal Yellow Dragon Temple (RDT) Ver.1 is an application scenario of Heritage Alive!. It is a test bed of guide-learners interaction and group collaboration among learners in Tangible Space. The story of RDT Ver.1 is a time travel back to explore down town Sorabol, Gyeong-Ju of 1,000 years ago, where they go through cultural heritages while the vehicle drives or flies. The guide of remote place in real world leads the learners' exploration via video avatar. They experience collaborative navigation in Anap-Ji, the artificial pond of Sorabol. When they come to Royal Yellow Dragon Temple, completed in 553. The temple was ruined after Genghis Kahn invasion in 1238. The time travelers collaborate to revive the pagoda of RDT that was over 80 meters high. They appreciate the beautiful pagoda while they fly around it then travel back to the present, with vivid memory of Sorabol.

System Setting

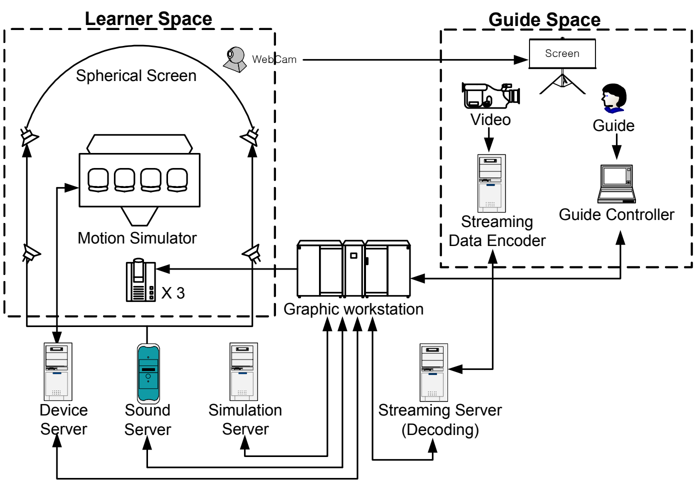

Fig 2. System Configuration.

Figure 2 shows our system configuration for a scenario of RDT Ver1. *Learner space* located at KIST Reality Studio includes spherical display system, motion simulator and 3D sound system. Graphic workstation performs visual rendering of stereographic multi-channel display and communicates with external modules such as a device, sound, simulation and streaming server in order to coordinate various functionalities for the target scenario. Summarizing a role of external modules, *device server* takes charge of peripheral devices such as a motion simulator and input devices. *Sound server* plays background music or generates a 3-dimensional sound effect according to the scenario and requests of the graphic workstation. Realistic animation necessarily improves a quality of the scenario. However computational cost can be expensive enough for the graphic workstation to simulate all the animation. The problem is remedied by delegating physics based simulation for realistic animation to *Simulation server*. Our scenario requires a close interaction between guide and learners. A guide who is far away should intervene in learners' environments naturally. To provide both interactivity and visual realism, a video avatar using image based rendering by way of streaming the video sequence is widely applied in our scenario. *Streaming Server* decodes the MPEG video sequence streamed from a guide space and generates texture information used for video avatar.

A tour guide at the *guide space* can fully control the scenario and learners' activity using a guide controller that communicates control commands to the graphic workstation. A view of the guide is decoded to MPEG video and streamed to the graphic workstation that combines video image in virtual environment context. Also a guide sees the learner space and the learners' response using web-cams.

Interaction

In this section, we briefly describe several interactions used in the scenario.

Guide-Learners interaction. Even if a guide and learners are located in separated areas, they can share a common experience of co-space by seeing and interacting with each other naturally. A guide shows up in learners' environment as a video avatar. On the other hand, a guide can be aware of learners' response using web-cams installed at learner space.

Collaborative interaction by learners. In order to start a journey, each learner presses a button that makes its own tone; When pressed simultaneously, the sound makes the perfect harmony and the journey starts. This kind of collaborative interaction has proved to be very effective for calling learners' attention at the beginning.

Competitive interaction amongst learners. Learners participate in an event for rebuilding the pagoda of RDT. There are 60 footstones at the foundation of the pagoda. Each learner can build pillars with one's own mark by touching the footstone and also remark an already built pillar with other's mark. This competition ends up with each learner's score when all the pillars stand.

Collaborative navigation. Learners can navigate the Anap-Ji pond by sharing a control of the vehicle (a rowing boat in our scenario). As intended, around beautiful scenery, learners naturally share their opinions and draw an agreement to prevent a dispersion of the control.

Interaction feedback. If necessary, a kind of dashboard, which shows each learners control and the resulting direction, appears at the corners of the screen. Learners can see choices of the others and determine to cooperator or compete each other. The motion simulator presents the sense of acceleration according to learners' navigation control. All these kind of interaction feedbacks have a significant effect on learners' choice.

Implementation

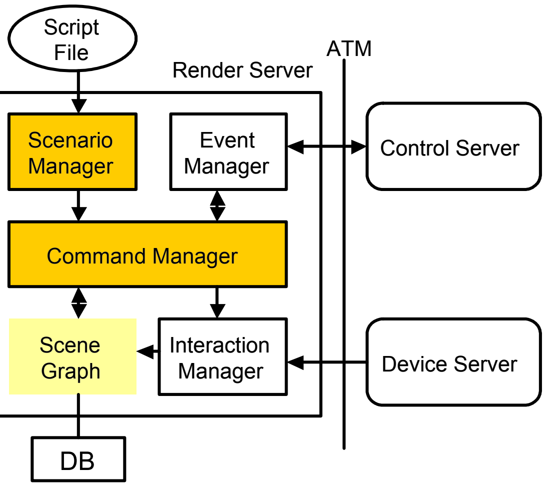

Fig 3. NAVER environment.

Our scenario Ver 1 of RDT is implemented using NAVER (Networked Augmented Virtual Environment aRchitecture) developed by KIST IMRC. NAVER is a flexible, extensible, scalable and re-configurable framework for diverse virtual reality applications (Park, 2002). NAVER environment (Figure 3) consists of Render Server, Device Server and Control Server. Render Server, a main kernel of NAVER, is a collection of managers that provide various functions such as scenario management, event handling, rendering process and networking, etc. Control Server is interfaced with an event manager on Render Server and communicates with Render Server in an event-based manner, while Device Server provides an interface to various interaction hardware devices. Because interaction hardware such as a motion simulator should be driven and monitored every rendering frame, Device Server is synchronously connected to an interaction manager on Render Server.

Among various managers in NAVER, Scenario Manager plays a role of validating and processing user-supplied script files describing virtual environments, multi-modal interfaces, their interactions and scenario description. In order to provide a human readable, modifiable and extensible description method, Scenario Manager supports script files of the extensible mark-up language (XML) format. NAVER scripting language facilitates an intuitive initialization of virtual environmental variables, a hierarchical construction of scene graph and definition of interaction between objects in a virtual world and interactive devices in a real world.

CONCLUSION AND FUTURE DIRECTIONS

The combined effect of motion and visual feedback were greater than individual feedback alone in driving a carriage through a gravel road, riding a boat in a pond, and flying in RDT version 1 of Heritage Alive!. The tangible effects had a multiplicative and wow effect. Furthermore, we observed visual only induced sense of motion created more dizziness than augmenting the visual with physical motion cue although some dizziness was reported after the experience.

Long term exposure to virtual environment would create additional after-effects. Tangible space research should find the right combination of tangibility and responsiveness to create the necessary realism with minimal after-effects.

Current group interaction is a first attempt; it needs to be improved with additional variations and comparison of effectiveness of carrying out cooperative or competitive group interaction types.

ACKNOWLEDGEMENTS

This reported work was partly sponsored by Ministry of Science and Technology fund under National Research Laboratory (NRL) program, Development of Gamsung Engineering Technology Project, and KIST TSI project.

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