Virtual Experience System for a Digital Museum

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Abstract. This paper describes a virtual experience system that provides to the participant a new experience of a space and travel for a digital museum. The system creates multisensory stimuli to evoke a sensation of a walk in a tourist site. The virtual walk is introduced as a pseudo voluntary reliving of the experience of the precedent walker at the site.

Keywords: Multisensory Display, Walking Experience, Reliving, Ultra Reality.

1 Introduction

Recently, a museum has had a new possibility of exhibit style by incorporating digital technologies. Digital information provides flexible forms of presentation of the exhibit item and gives new experience relating to the item. We consider that there are two styles of an exhibit that will explore innovative user experience in a digitally enhanced museum.

A virtual representation style of an exhibit item can produce appropriate projection of nature of the item with multimodal information. It also allows a physical interaction of the user to the exhibit item.

A museum is originally directed for the experience of an object. The experience should be a natural and voluntary interactive experience for the participant. However, the reality is usually different. The exhibits in a museum are only seen by the participant prohibiting a touch to them for preservation of objects. In a digital style, the interactivity may be introduced by virtual presentation of exhibits.

Another style of virtual experience is the extension of museum in terms of space presentation. The conventional exhibits are presented in a static display case where the visitor finds the exhibited object in a fixed environment without a context in which the object really existed and used at the time. The object would properly be experienced if the context is presented in a replicated space where it was used. The virtual space experience of a visitor regarding the context of the exhibited object is an

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extension of current museum focusing the real object itself. The experience may be applied to a particular space exploration where the space and the visitor interaction are the content of exhibit. In addition, there are too many large things on the earth that cannot be confined in a museum.

In the present paper, we describe a virtual space experience system that might be used in a future digital museum. The ultimate objective of a museum would be a real user experience regarding an object existed in a particular space and time. Here, a space experience system called Five Senses Theatre is discussed for presenting a walking experience at the tourist spot.

2 Virtual Experience System

2.1 System Hardware

A new display system was built incorporating multiple displays that covered five senses with vestibular sensation. Figure 1 shows the devices that are involved in the system, the FiveStar. It is an interactive display system for a single user of home theater size. A three-dimensional visual display, a spatial sound, a haptic/tactile display for a hand and foot, a wind and scent display, and a vestibular display are involved in the FiveStar that is targeted to produce an integrated ultra-reality [1] experience. The scene of a place captured during walking is displayed on the 3D LCD monitor with a 5.1 ch sound. The wind and scent are generated in response to the scene and the virtual motion of the user. In addition to the visual/audio stimuli, the body of a participant is moved by the 3 DOF seat and the foot motion (horizontal/vertical) generator. Vibratory stimuli are produced at the foot sole, the back, the buttocks, and the sigh.

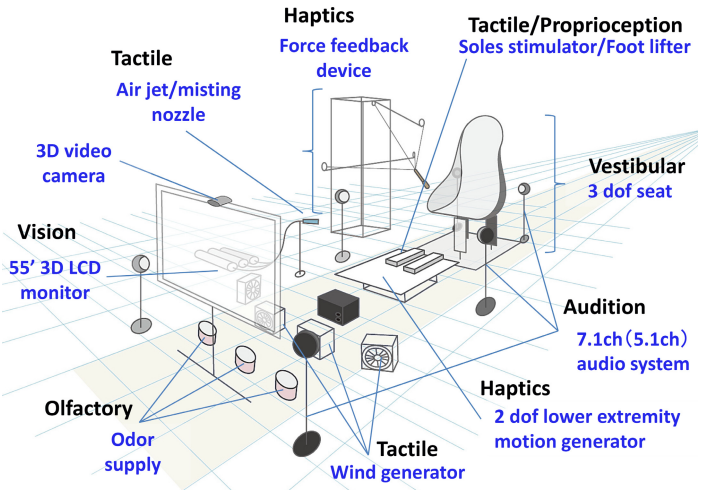


Fig. 1. Overview of the Five Senses Theatre (FiveStar). Multisensory devices are integrated to produce experience of a space of alternative reality.

2.2 System Concept

An experience of a space where the object of interest to exhibit is involved might be a futuristic method to show valuable things and their contexts to the visitors. A digital technology has enabled a three dimensional space experience that is virtually presented to the user by using a stereoscopic monitor with 3D glasses and multi-channel spatial sound displays. Although it presents a remote space in front of the user, the 'walk through' motion of the viewer that is controlled often by a portable controller (sometimes a game controller) does not produce a real walking sensation for the user at all.

It is known that the user of a virtual space can perceive the presented space more accurately and memorably when an actual walking motion is performed with the real body in order to go through the virtual space [2]. It shows that the experience of self-body motion in a space contributes to the perception of the synthesized space as it is analogous to the experience of the real world. On the other hand, a real body motion such as walking in the broad area of interest takes a considerable time for experience that causes a significant fatigue that could normally be eliminated in a virtual world.

We introduce a virtual experience system of a space with a virtual walking of the user. A tourist spot such as a World Heritage site is a good example of the space. Walking in the tourist site would be an attractive content of a future museum. A virtual walking experience is not the real walking nor the walking in place that are used in the conventional virtual locomotion interface [3, 4, 5, 6]. Our system does not force the visitor to walk by him/herself, but moves the visitor's body by the motion chair and the drive mechanisms for the lower extremity to evoke the sensation of walking as if he/she walks in a voluntary control of him/herself.

2.3 Virtual Walk

The space experience by a virtual walk is not discussed so far to our knowledge, and therefore it is the salient feature of our system. A space or location of interest is experienced during a walk of the user, not as physical (standing) walking or cognitive walking, but passive walking. The body of a participant is moved by the display system when the participant sits on the seat and places feet on the foot motion generators. Visual and auditory rendering of the space are concurrently presented along with the wind and scent of the location.

These stimuli provided to the participant are essentially based on the data recorded while the other person (a tourist) walked at the location. Thus, the participant receives the stimuli that were accepted by the tourist. The participant relives the experience of the other tourist's walk by means of the multisensory integrated stimulation. We call it a 'virtual walk' in this sense.

This is a new type of experience in which the participant 'receives' an experience despite the essential voluntariness of a proper experience. It may look inconsistent since the experience is what the participant selects voluntarily by oneself. We consider that it might be resolved by using multisensory displays involving the participant's body as a part of the system displays. Originally, the proprioception of a body may be

considered as a display to the brain. The body is usually under control of the central nervous system, and not merely an information source. We assume that pseudo voluntariness might be established where the participant is immersed to the presentation of the location and the walking motion of the original tourist. Normal walking is mostly controlled by the brain stem and the spinal cord which dominate walking autonomously without subjective attention. This is our hypothesis of the design of the virtual walking on the Five Senses Theatre.

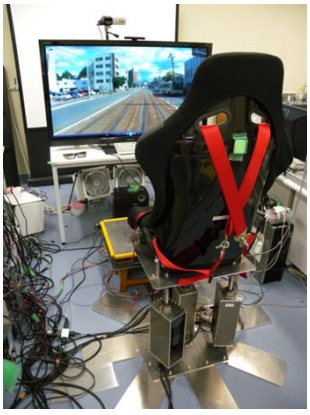
3 Virtual Travel System Prototypes

Virtual travel implementation prototypes were built from 2011, and three destinations were installed and demonstrated at the public exhibitions (Digital Content Expo 2011 and 2012 in Japan).

3.1 Overview

Figure 2 shows the virtual travel systems at the exhibits and the laboratory. The FiveStar system represented the recorded travel to Hakodate (3a, 3b) and Milan (3c) to the user. The user experienced the 3D visual image and sound along with winds and scents of the location. The scene of the experience was recorded with a 3D video

a) Climbing stairs, 2011



b) Virtual travel in Hakodate (Japan), 2011. (3D seat and linear actuators)

c) Virtual walk in Milan (Italy), 2012

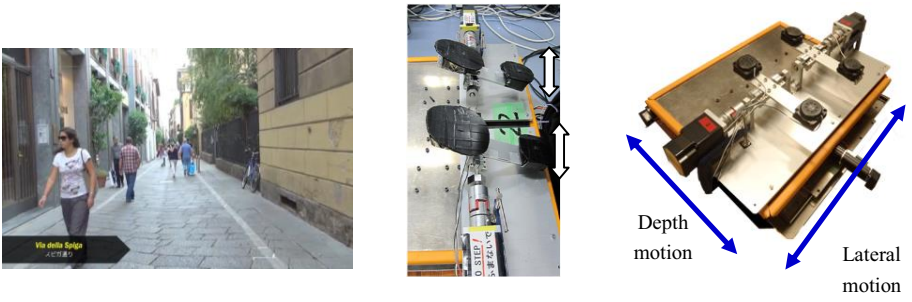
Fig. 2. Travel Simulator Systems on the FiveStar

camera (SONY, TD20) during the walk in the location. The sensation of walking was enhanced specifically by the motion of the body and the lower extremities in addition to the tactile sensation on the sole of the user's feet produce by the system. The adequate amount of stimulation was rather small as compared to the real walking motion. The user received multiple modality sensory information in an integrated single experience of walking the tourist spot.

3.2 Presentation of a Walk

Three places were presented as if the user walked through the area of interest. The user walked on a flat alley in the city, climbed stairs, stopped to see a historical building, turned to change the direction, started to walk, went down stairs, and walked looking to the side. These motions need to be presented with a different combination of stimuli by the devices.

While you walk on the flat pathway (Fig. 3a) by the FiveStar system, the reciprocal lifting of lower extremities by pedals (Fig. 3b) was provided concurrently with a horizontal front-back direction movement of the 2-dof motion generator (Fig. 3c). These stimuli to the lower extremities were also synchronized with the 3D seat motion.



(a) Flat pathway (b) Pedals with vibrotactors (c) 2-dof motion generator

Fig. 3. Walking experience on the FiveStar

The presentation of the pedals and the 2-dof motion generator were created by adjusting the amount and the form of the motion referring the real motion of a walk. Figure 4 shows the trajectory of a heel in the body coordinates during a walk of a subject, 172 cm tall, on a treadmill at a velocity of 60 m/min. Figure 5 indicates the trajectory of a heel during the presentation of the FiveStar system. The same data is, plotted in Figure 4 in red. Although the height of the real motion was about 200 mm, the presentation of the system was about 8 mm in height. Only 4 percent (one twenty-fifth) amplitude was adequate to render the sensation of walk in the system. The 3D seat presented an oscillatory motion of the body of about 1.5 mm amplitude as shown in Figure 7 that was about one twentieth of the amplitude in the real walk (Figure 6). The presented stimuli were generally very small in amplitude relative to those observed in a real walk.

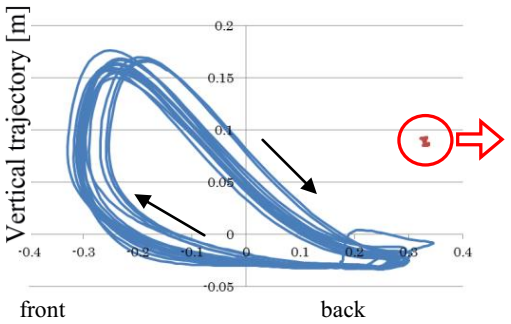


Fig. 4. Real (blue) and presented (red) motions of a heel while walking (in the body coordinates)

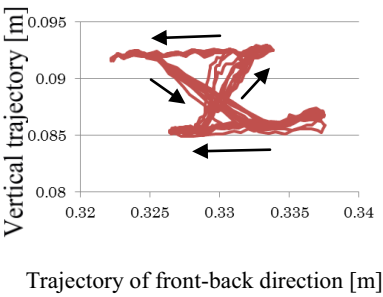


Fig. 5. Presented heel motion by the pedal and 2D motion generator

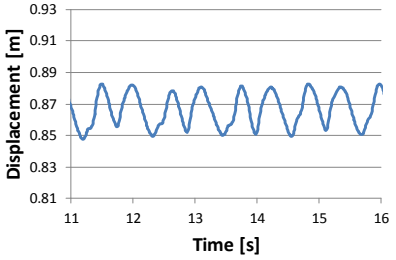


Fig. 6. Motion of the coxal bone during a real walk on the treadmill moving at 60 m/s

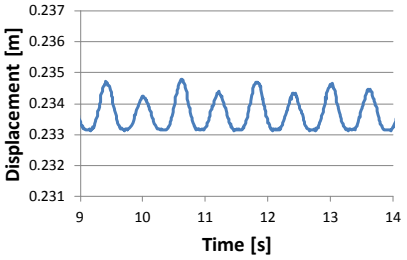


Fig. 7. Motion of the 3D-sheat chair body at the left rim

This means that a voluntary walk of the other person may be re-lived by a participant with a small passive motion of the body. The passive reception of a self-body motion as an artificial substitute of a voluntary walking motion may be very sensitive when the body is driven externally. This feature is advantageous when the display for a multisensory theatre is built since the mechanism could be installed with small parts.

4 Conclusion

A new method of display in a digital museum, a virtual space experience, was introduced in the present paper. A working hypothesis of a virtual walk that relives the walk of the other person was presented. A user experience of a virtual walk in a particular place, especially a tourist spot, was developed in the form of a seated multisensory display system where the participant's lower extremities and the body were driven externally in conjunction with other information to the five senses. The external drive of the body and the lower extremity needed for presenting a virtual walk was

proved to be a reduced amount as small as less than a twentieth of real motion of actual walk. This implementation suggested a new design of virtual reality, that is, the ultra-reality.

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