VR Entertainment System "Ideal Vacation":
A Game Designing Focused on the Sense of Presence

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Abstract

VR systems became generally popular and everyone can easily enjoy VR entertainment contents now. In VR contents, the sense of presence is one of most important elements. The strongest reason for losing the sense of presence is vection. A good way to avoid vection is to use uniform motion.

We developed a VR system based on a boat with constant low speed movement. And we devised a new game design method and implemented VR contents named "Ideal Vacation". It was focused on the sense of presence, and also implemented somatosensory stimulation due to unstable seat by using an airbed. We evaluated our proposal game design by playtesting, and good results were obtained.

Keywords-component; Virtual Reality; Game Design; The Sense of Presence; Somatosensory Stimulation

I. Introduction

In 2016, many VR systems such as "PSVR" and "HTC Vive" were released for home use, and entertainment VR contents became more popular. The sense of presence is an important element of VR entertainment contents[1][2][3][4]. It means that the players feel that they really exist into the content's world. Higher the sense of presence makes higher immersion into content. If sense of presence is too low, the players feel only looking a scene.

We developed a VR entertainment content focused on the sense of presence, and we devised a game design method that assisted us to create the sense of presence.

II. Method

The most important reason to lose the sense of presence is a difference between the visual acceleration and the sensory acceleration. We considered a situation that the visual acceleration is equal to the sensory acceleration. Those states are stop and uniform motion, and we choose a boat based system contained uniform motion.

A. Preliminary Prototype

At first, We developed a prototype to implement some elements to test are shown below[5]:

- Moving view point without any accelerations
- Some objects invade personal space of the player
- Tactile information match to visual information

We tested some boat speeds and determined that the best situation was going down the river slowly.

In PSVR content "Summer lesson", game character face is sometimes close up to player face very nearly. It became an incursion to player's personal space. In this case, it was verified that the player felt a cross-modal effect. We thought it means the sense of presence existed in the player. And we implemented the incursion to the personal space such as cherry blossom petals and autumn leaves were coming. Also we implemented a couple of features on gripping item. one of them is a dragonfly is coming and perch on it. another is when it touches into water then water is splashing.

We set a wood frame in the same position to the visual boat edge, it could be touched by the player. when the player touches the real frame, they feel safe.

This prototype only has a wood frame with spacer. the playtesting scene is shown in Fig. 1.

Fig. 1 Playtesting scene of the prototype

B. Required Factors

Through the playtesting prototype, we considered more effective factors that create the sense of presence, and conducted field research in VR amusement park. As a result, we obtained that somatosensory stimulation effectively improves the sense of presence. Especially the passive stimulation is more effective than active one, because the active stimulation worked without player's will, and the sense of agency is lost.

We determined to implement the somatosensory stimulation without losing the sense of agency. A boat moves and shakes

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according to the movement of the passenger. This movement is accompanied by the sense of agency, so the sense of presence is not lost. This reaction needs to respond quickly, and in active systems the equipment becomes large and difficult to control. So we gave up to control, and attempted to implement using simple physical phenomena by an airbed.

C. Hardware Equipments

Our VR system was based on HTC Vive and Unreal Engine. And we devised a boat unit that was built stronger than the prototype with wood. The created boat unit is shown in Fig. 2.

Fig. 2 Our boat unit

This unit was based on a floorboard, and attached to a surrounding handrail. The railing is strong enough to handle the player's weight. The shape was not a box but a cage because it reduces the weight of the unit and thereby reduces the inertia weight to increase the motion response. The seat also fixed to the floorboard.

The setting structure of the boat unit for experiment is shown in Fig. 3.
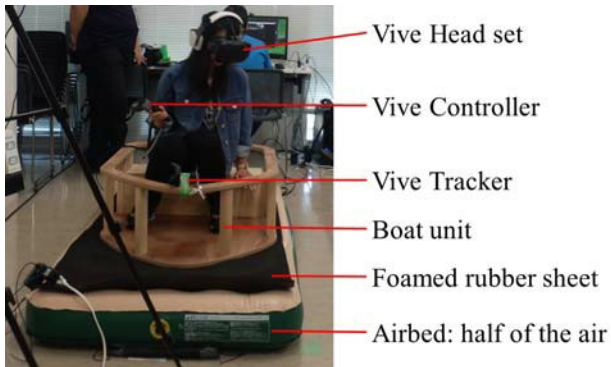

Fig. 3 Structure of the boat unit

The boat unit have a floorboard that set onto a airbed with a foamed rubber sheet. The airbed was filled 50% of its capacity, because we intentionally kept the unit to destabilize. And we inserted the foamed rubber sheet between the airbed and the unit, in order to prevent the unit from sliding.

A Vive tracker was attached on the unit to capture the movement of the unit due to the player's behavior.

D. Implemented Software Contents

The theme of our content was the four seasons in Japan, and boating on a calm river. The season of spring, summer, autumn, and winter changes according to the progress, and total time is about 5 minutes. The player could interact with the environment by operating the fan with the controller,

In the spring part, cherry blossoms on the riverside correspond to the players' operation and petals fly toward them. The screenshot is shown in Fig. 4.

Fig. 4 Spring scene screenshot

In the summer part, fireworks are launched then the players face upwards and their attitude are changed naturally. Also reproducing the sound of the waterfall with stereophonic sound. The screenshot is shown in Fig. 5.

Fig. 5 Summer scene screenshot

In the autumn part, leaves come flying and also a dragonfly flies nearby the players. this dragonfly perches on the top of closed fan when the players hold it. The screenshot is shown in Fig. 6.
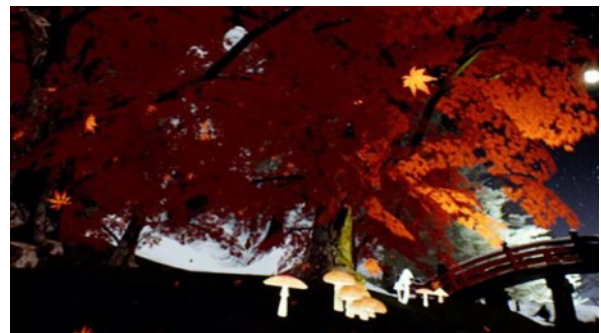

Fig. 6 Autumn scene screenshot

In winter, snow rabbits appear on the riverside and move according to the movement of the boat. The screenshot is shown in Fig. 7.

Fig. 7 Winter scene screenshot

In anytime, when the players touch the water with the fan, water would be splashing. The screenshot is shown in Fig. 8.

Fig. 8 Water splashing scene screenshot

E. Playtesting

The content was evaluated by playtesting. We did not teach anything of contents to participants beforehand, and after playtesting we had a questionnaire and interview their impressions.

The questionnaire was 7 level evaluation on the sense of presence. If the player thinks that it is just a visual experience then it is 1 point, and if they feel that they were actually there then it is 7 points.

III. Result

We conducted an experiment at the 22 Tokyo Polytechnic University students. The scene of the experiment is shown in Fig. 9.

Fig. 9 Scene of the experiment

The result of the questionnaire is shown in Tab. 1.

Tab. 1 Result of the questionnaire for the sense of presence

Numbers of points							Average	Standard Deviation
1 pts.	2 pts.	3 pts.	4 pts.	5 pts.	6 pts.	7 pts.		
1	1	2	4	3	6	5	5.05	1.692

We obtained comments on contents impressions and physical impressions mainly. Comments on contents are shown below:

- It is good that characters move according to the boat's movement.
- I'm relaxed.
- It is good that there was something coming near the face.
- Sound effects are good enough.
- I'm tired.
- Improvement of the feelings of reality by wood frame.
- Good complement of sensory.

Comments on physical impressions are shown below.

- I felt like I was in a real boat when I got into the boat unit.
- The shake of the boat unit felt real and scary.
- I felt like I was in a real boat when I was leaning out my body from the boat unit edge.
- I felt motion sickness when I got out the boat unit.
- I felt the shake caused by the change in posture according to the operation of the controller, as a genuine shake.
- I felt it is a real canoe when I got into the boat unit.
- I felt the boat unit is moving forward.

IV. Discussion

We thought the intended game design has been realized from the comments on the contents impressions. The commenter who got tired was a player not familiar with VR content and HMD.

We thought we presented the feelings like a real boat to players from the comments on the physical impressions. The commenter who got seasickness has not had much experience boarding in boats. However from this fact, we thought we were able to be implement a similar experience of a real boat.

V. Conclution and Future work

We devised a new game design method focused on the sense of presence and implemented. Therefore we verified that the implementation of the sense of presence was possible. Also we verified that the somatosensory stimulation by using an airbed improved the sense of presence.

We would continue researching and developing methods to improve the sense of presence for VR games.

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