Visual Representation of Gesture Interaction Feedback in Virtual Reality Games

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***Abstract*—As the number of commercial products of virtual reality (VR) has steeply increased and the development of VR technology has quickly advanced, more and more digital contents have been developed using the VR technology. This trend appears in the game industry too. The gesture-based interface becomes one of well-adopted interfaces for VR games, which has been used several years in other domains such as natural user interaction. This paper reports work-in progress for the user study of visual representations of gesture interactions in the context of VR games. We specifically developed four different visual representations of gestures for a VR adventure game and gathered initial user feedbacks for those four visual representation models.**

***Keywords*—VR; Game; Hand gesture; On-air inputs; Controller; Skills; GUI;**

I. INTRODUCTION

Recently, a lot of commercial contents have been provided to users by utilizing virtual reality (VR) technology and the VR games become one of them [1]. As a result, users are experiencing new enjoyment, and various studies related to new user interfaces are under way. Gesture interface is one of interfaces that exists around us before the emergence of VR technology. Gesture interface could provide an intimate interaction with the user in terms of utilizing the user's body directly, and so could provide more immersive feeling based on this intimate interaction. The feeling of immersion is one of critical factors in realistic VR. For example, one of the biggest advantages of a head-mounted display (HMD) is that the user can have complete physical visual immersion because the user always watches the virtual world regardless of head position and direction. Likewise, the use of gestures might enhance immersiveness and therefore it needs to study thoroughly the way of inclusion of gesture interactions into VR.

We have developed user gesture inputs for attacking enemies in virtual reality game contents. Since the visual interaction is directly related to user immersion, it is important for providing users with appropriate visual feedbacks when users are inputting the gesture. This study was conducted to investigate how providing different styles of visual feedback on gesture input can provide user immersion and convenience. In this paper, we specifically propose a couple of visual representation models of gesture input as a way of intuitively providing users with feedbacks for their gestures in the context of VR games.

II. RELATE VR GAMES

The examples of various attempts of introducing gesture interfaces to a VR game were investigated as follows.

A. *Raw Data™*

'Raw Data' is a VR FPS (First-Person Shooter) game developed by Survios (see figure 1). The game is the first commercial VR game to earn more than $ 1 million a month after its release. The interface of this game utilizes the body gestures to allow a variety of behavior patterns, such as holding pistols in both hands, pulling a bow, and flourishing a sword. The success of this game suggests that VR games with gestures may be promising enough and the gesture interface research should be actively pursued.

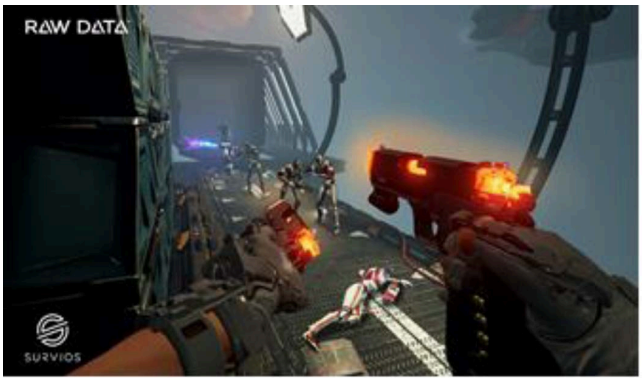

Fig. 1. Raw Data™ [3]

B. *The Unspoken™*

'The Unspoken' is a VR action game that supports Oculus Touch (see figure 2). This game is an adventure game using the concept of magic. It has a combat method such as manipulating the environment around the magician or recalling monsters. The interface of the game features a variety of spells depending on the position of the hand when using magic.

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Fig. 2. The Unspoken™ [4]

C. *Waltz of the Wizard™*

This is the VR magic experience developed by Aldin Dynamics (see figure 3). All functions in the interface are non-targeted by interacting with game objects and by providing manipulation in a manner that experiences the effects of each object. For example, in the case of a chalk, it provides an operation that can be grabbed and written by a hand, and the other throwing and interactable objects can be controlled with both hands. There are also interactions between objects using alchemy.

Fig. 3. Waltz of the Wizard™ [5]

III. TEST-BED FOR THE USER STUDY

A. *Hardware*

We used HTC VIVE, which is one of the models that comes with HMD and hand controller, because we need an instruments to test hand gesture recognition.

Fig. 4. HTC Vive [6]

B. *Software*

Unity 3D is adopted as SW development environment. Unity 3D is one of the most popular and the easiest-to-learn game engines to develop 3D-based entertainment contents. In addition, Unity 3D has an advantage that graphic resources can be easily obtained through an open market. This project uses Unity 3D version 5.6.0f3.

C. *Gesture Recognition Engine*

We used the VR Infinite Gesture asset which is available in the open market described above (see figure 5). VR Infinite Gestures is a plug-in for the Unity game engine that uses neural networks to track gestures in a VR environment and Available in Unity3d without programming or knowledge of neural networks. This plug-in is compatible with Unity 3D environment and runs on HTC VIVE or Oculus Rift.

Fig. 5. VR Infinite Gesture™ [7]

D. *Four Gestures Used in the Study*

The gestures used in the study consists of the following four types (see figure 6). By having each gesture activate different skill type, the user are facilitated to intuitively use the gesture inputs during the game.

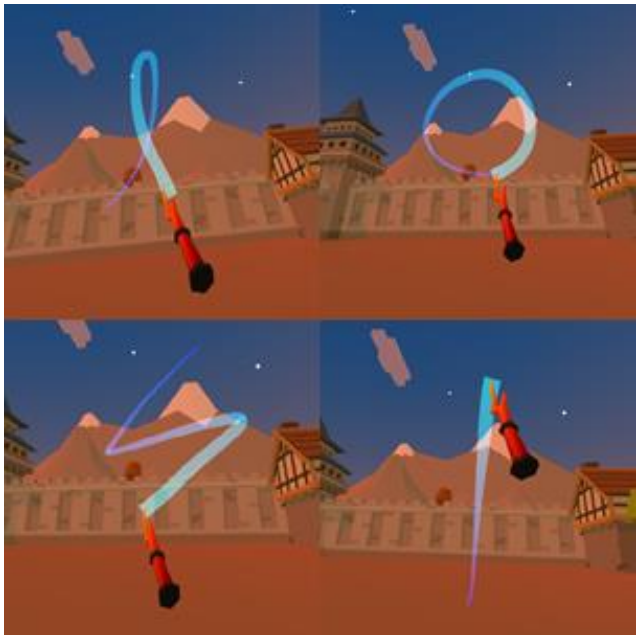

Fig. 6. Four different gestures developed for the game

IV. User Study

When you draw a gesture during the game, they may need visual feedback of their gesture to help them see how they are gesturing. So, We conducted a user study based on the gesture defined in D. The user interview was conducted to investigate the effectiveness of the gesture visual feedback models. In two different ways, visual feedback for user gestures are rendered. One is the line renderer method and the other is the particle renderer method. Both methods are rendered by the way Unity 3d provided in order to visually represent the lines.

Fig. 7. Two different ways of visual feedback models for user gestures

A. Line Rendering Model

The line rendering model is a method of expressing information about the gesture as a trajectory line in which a hand moves. This model draws continuous lines using the array of points in 3D space. Thus, this model can be used to draw from one straight line to a complex spiral. It can also render a wide, textured billboard line [8].

B. Particle Rendering Model

The particle renderer basically uses the same rendering algorithms as the line rendering model. Unlike the line rendering model, however, the previously drawn lines disappear one by one in the order they were drawn. It is mainly used to express the afterimages of a moving object. Our particle rendering model, these afterimages were rendered by particles rendering provided by Unity 3d.

C. Participants and Survey

We conducted a pilot study with twenty participants. The subjects for the study were structured as shown in the table 1. VR experience items in the table, it was defined that not experienced, less than 3 and more than 4 times to 0, 1, and 2, respectively.

TABLE I. Participants

Participants	Gender	VR Experience
A	M	2
B	W	1
C	W	0
D	M	2
E	M	1
F	W	2
G	W	1
H	W	1
I	M	1
J	M	1
K	M	1
L	M	2
M	M	2
N	M	2
O	M	1
P	M	2
Q	M	2
R	M	2
S	M	1
T	M	1

TABLE II. Survey

	Study
Q1	Is it harmonious with the game background?
Q2	Is skills work correctly you want?
Q3	Is it help in game play?
Q4	Isn't it interfere with your sight during gameplay?
Q5	Is it increase game immersion?
Q6	Is it help to know gesture you are drawing?

V. Result

We analyzed user's opinions for visual feedback models for gestures (i. line rendering model, ii. particle rendering model). The detail opinions for each model from the subjects is summarized as follows. The following graph shows the Represents the average of user studies for.

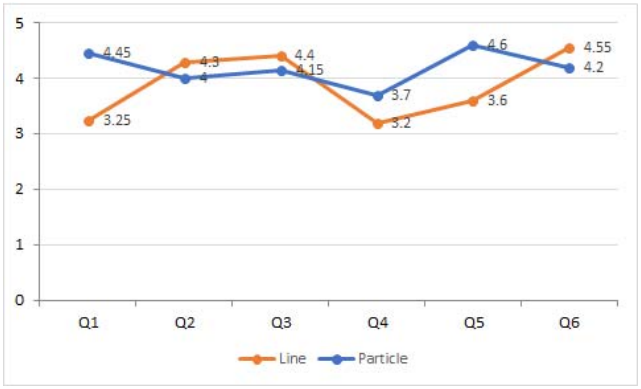

Fig. 8. Result of user study

Regarding the line rendering model, participants mentioned that it was easy for them to grasp the progress of their gesture and for them to adjust if needed, because this model expresses the trajectory of the gesture visually and accurately. However, participants mentioned as a drawback of this model that the line representation of trajectory, compared to particle rendering model, creates visual sense of heterogeneity against a background image on the game.

Regarding the particle rendering model, participants said that the particle rendering model could be evaluated as aesthetically superior to the line rendering model. However, the disadvantage is that the particle trajectory of the gesture disappears soon in this model, and so it is difficult for them to grasp the gesture input made by herself/himself. Therefore, there was a need for them to master gestures before playing the game.

VI. CONCLUSION

This study proposes utilizing gestures as user interface in virtual reality games. Based on each feature of graphical representation of gestures, we also proposed two different visual rendering models for users to conduct gesture effectively and to receive feedbacks on their inputs. Through a pilot study, the proposed models are discussed to find out improvements. We hope that this study can be used to design and develop a gesture interface that allows users to be more comfortable in manipulating 3D VR game contents. It is also expected that further improvement measures will be continuously studied by extending this study.

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