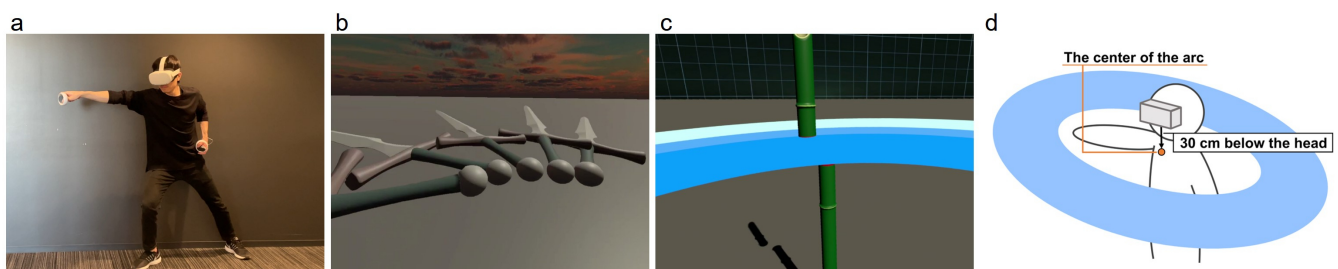*Demo*

Experiencing High-Speed Slash Action in Virtual Reality Environment

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Figure 1: *a. Player in a slashing motion, b. afterimages of the sword moving as the player input, c. hiding the graphics of the sword and displaying the motion blur, d. position of the arc-shaped motion blur.*

Abstract

When a user uses a hand controller to swing a virtual sword in a virtual space, the sword movement seems slow if the its trajectory reflects the input directly. We hypothesize that this is because we are accustomed to seeing fast and instantaneous motion through movies or animations, and thus we perceive their motion as relatively slow. To address this issue, we propose a novel method of displaying exaggerated sword motions to allow a virtual reality user to enjoy a fast slash action. This method displays an arc-shaped motion blur effect along the predicted motion when the system detects the start of the slashing motion until the hand controller motion stops. Graphics of the sword are not displayed during this time. Therefore, the user is unaware of the actual trajectory of their input and how far it differs from the exaggerated motion blur effect.

CCS Concepts

• *Computing methodologies → Virtual reality;*

1. Introduction

In several virtual reality (VR) applications, players can swing a virtual sword in a virtual space by using a hand controller (Figure 1a). If the sword's trajectory reflects the input motion as it is and is visualized in discrete afterimages (as displayed in Figure 1b), the players will feel that the sword is moving slowly. This may be because in movies or video games, the protagonists, such as a sword master (e.g., Sanjuro, Yoda, and Jin Sakai), swing their swords in just a few frames, and the swinging of the sword cannot be seen (note that in films, the framerate is lower (24fps) than the typical VR system (90fps)). By contrast, the players' virtual sword motions would seem slow.

To solve this problem, several exaggeration methods have been proposed to create the illusion that players can move faster than they actually can. Hirano et al. proposed a method for making a sword translucent, i.e., similar to a motion blur, to eliminate the afterimage of the sword. Their method also proposed slowing down the time in the application by using time-scale transformation based on the speed of the sword, to make the player perceive fast movement relatively [HH20]. Granqvist et al. proposed a method to exaggerate the height of an avatar's feet in the kicking motion in a virtual space to create an illusion that the player can raise their feet higher than the actual input [GTTH18].

We hypothesized that players would expect fast slashing motion as seen in films or video games and developed a system that enables players to experience high-speed slashing motion as expected in the virtual space. When the initial movement of a slash is detected, the system displays an arc-shaped motion blur along the predicted trajectory of the motion and makes the sword invisible (Figure 1c).

Hence, the player is unaware of the difference between the exaggerated motion blur effect and the actual trajectory of the sword.

2. Proposed System

2.1. Overview

The system consists of a head-mounted display (HMD) and a pair of Meta Quest 2 controllers. The software was developed using Unity with the Oculus Integration Asset. Currently, the presentation of the virtual environment surrounding the user is simple, with only a single bamboo tree set in front of the user. The player was asked to cut the bamboo with a sword using a controller.

Initially, we developed a method to predict the terminal position of a user's sword motion when the initial action is detected. However, its prediction accuracy was insufficient, as it resulted in a difference between the positions of the actual and predicted inputs. However, we found that the difference was not clear when the terminal position was outside the user's sight.

Therefore, to conduct a preliminary user study, we introduced the following restrictions: all slashing motions were nearly horizontal from left to right, and sufficiently large to keep the terminal position out of the user's sight. Fortunately, the horizontal field-of-view of Meta Quest 2 is not very wide ($97°$). Therefore, the motions required of the user are not great.

2.2. Motion exaggeration

In this section, we describe the proposed method in detail. While the player moves the controller normally, the virtual sword simply follows the input motion as if the player is holding the sword. When the player starts to swing the sword, and the velocity of the controller exceeds the threshold, the system considers it as the start of the slashing action and calculates the direction of the motion as a rough estimation of the slashing direction.

The system then displays a motion blur effect by showing an arc-shaped figure along the estimated direction of the motion, and makes the sword invisible. It appears as if the player had moved the sword and slashed it in a moment. The center of the arc was placed 30 cm below the player's head (Figure 1d). While the system displays the motion blur effect, the graphics of the sword are hidden, and the player is unaware of the difference between the actual and estimated positions of the sword. When the controller appears still, the system determines that the slashing motion is over and re-displays the graphics of the sword. This implies that the duration of the slashing motion varies with the player's input. In the current implementation, the virtual bamboo was cut off with the appearance of the motion blur effect, and the sound effect was played simultaneously.

3. Preliminary Study and Discussion

We conducted a pilot study with several participants to evaluate the effectiveness of the proposed method. The subjects were asked to try out the system and report their impressions through free discussions. The participants experienced and enjoyed the exaggerated

motion of the sword with the lightning speed. By contrast, the motion felt too slow when the exaggeration was canceled. Some subjects, including one of the co-authors, commented that the motions seemed to be slower than their actual input. This may mean that the exaggerated motion felt closer to what the subjects imagined their own motion to be.

Some subjects commented that the motion blur effect, which immediately appeared straight, gave the feeling as if they could swing the sword skillfully. The difference between the trajectory displayed as motion blur and the actual input was not recognized if the terminal position of the sword motion was out of the subjects' sight as instructed. We also tested another motion blur effect, similar to the proposed method but did not speed up the sword motion and displayed the actual trajectory of the sword at each frame. We found that our sword motion was not only slow but curved or winding. When such motions were displayed as they were, we did not feel that we were skillful.

The restrictions that we set were noticed and reported several times. Some subjects terminated their motion inside their sight and found that the actual terminal position differed from motion blur. This restriction on the operating range must be resolved.

To overcome this restriction, the system must predict the terminal position of the motion based on the limited information gathered from the initial motion. We plan to conduct a user study to obtain a large amount of motion data from wide-ranging participants and then test some recurrent neural network-based machine learning technologies [MBR17].

4. Conclusion

We proposed a method to exaggerate sword motions in a virtual space by displaying an arc-shaped motion blur and hiding the sword, which makes the users perceive the sword's slashing motion to be smooth and at a lightning speed. A preliminary study indicated that the proposed method successfully produced the illusion of skillful and exhilarating slashing. The current implementation restricts the operating range of slashing. In future, we plan to conduct a wide-ranging user study to obtain a large amount of motion data to develop a prediction method for user motion in a virtual space.

References

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