Tilt Control Technique for Quick Centroid Movement Input

Rei Sakuragi[1], Vibol Yem[1] and Hiroyuki Kajimoto[1]

[1] The University of Electro-Communications,
1-5-1 Chofugaoka Chofu, Tokyo, 182-8585, Japan
{sakuragi, yem, kajimoto}@kaji-lab.jp

Abstract. Centroid movement input is one way for navigating through the virtual environment. However, it has problems that the input speed is slow, and imposes high load for the user. To solve these problems, we propose to keep our body almost straight, by tilting the ground against the users' centroid motion, thus reducing the influence of the gravity. We developed the system and conducted a preliminary evaluation, found a positive reactions from the users.

Keywords: Foot input. Slope compensation. Centroid movement.

1 Introduction

Foot input is important for Virtual Reality (VR) applications, especially when users must hold tools with their hands, and must walk in the virtual environment. As it is difficult to provide a space for free walking many studies have been proposed so far. Locomotion interfaces made of sophisticated treadmills and tracking systems were designed to improve the walking sensations in VR [1][2][3]. They enabled users to freely walk while their global displacement is mechanically compensated. However, such systems are very expensive for construction. On the other hand, centroid movement as an input, such as balance Wii board [4] is a low-cost alternative foot input.

However, navigating by centroid movement has a problem in its operability. Controlling the centroid by tilting the body, the users must support the tilted body with their feet muscles, which leads to fatigue and also longer operation time because they must intentionally restore their posture for each input.

Our idea is to present a slope against the users' centroid movement input. By this technique, the user's body will not lean so much against the direction of gravity, so restoring the initial posture becomes easier, leading to faster input. Muscle fatigue is also expected to be reduced.

Marchal. et al.[5] have proposed floor tilting during centroid input while they tilted floor to the direction of centroid movement, our method tilt floor against the direction of centroid movement.

adfa, p. 1, 2011.

2 Systems

We made a device that tilt against the user's centroid movement. The slope is presented by a stepping motor (AR98SMKD-N25, Oriental Motor) and a crank mechanism. The user's centroid movement is measured by balance Wii board (Nintendo Co., Ltd.). The centroid movement is reflected to the movement in the virtual environment, and to the inclination of the plate.

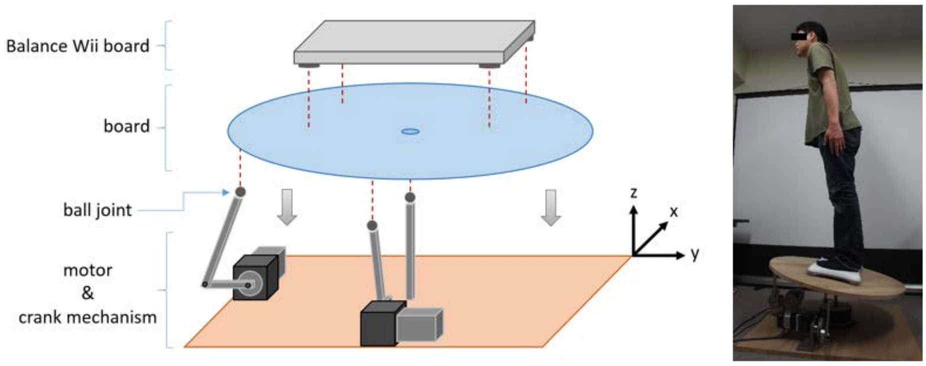

Fig.1. System structure (left) and appearance of user making input by the dynamic device (right).

3 Preliminary Evaluation

As a preliminary evaluation, we measured the time to complete a navigation task in a virtual environment.

The evaluation was performed in a 3D virtual environment without any contextual cues. The only landmarks were the gates that the user had to navigate through. The gates were placed in random points in x-axis. A fog effect was added to mask the distant gates, allowing to perceive only the 2 closest gates. A texture on the ground provided visual flow information during the navigation.

The experiment was carried out with a display (820 × 463 mm) placed in front of the user, 2000 mm away, and on a 900 mm height table. The user stood on the device which height is 400 mm. The board which the subject stands on tilts in promotion to the percentage of load against the whole body weight, and the maximum angle was 4°. It takes for about 0.083 seconds to present the maximum angle from the board's neutral position. Three participants, aged 22-23 years, all male, participated in this experiment. Each of them had a practice trial, and we compared the data between the dynamic condition (proposed method) and static condition (no control) at the followed 5 trials.

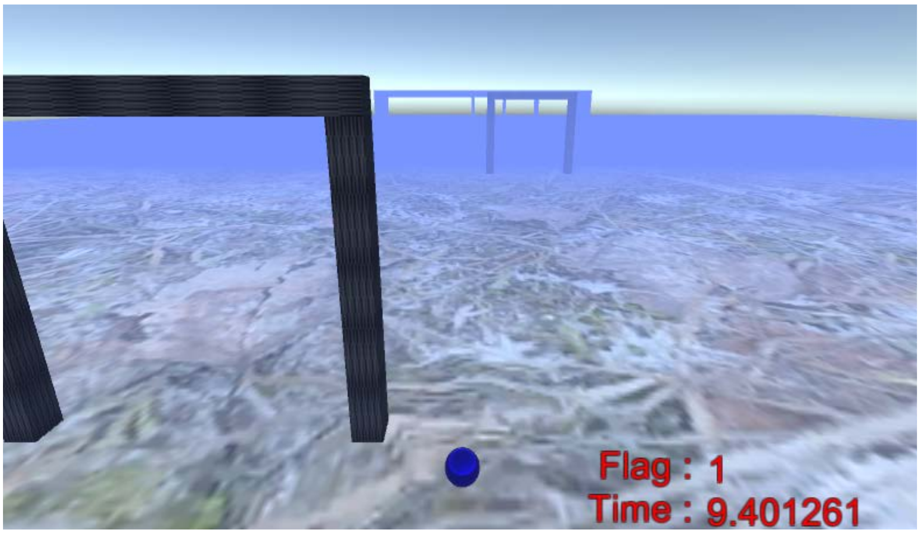

Fig.2. Snapshot of the virtual environment used during the evaluation. The different gates represent the path that the user had to navigate through.

Fig.3. shows the time required for each trial. At the practice trials, some participants took much more time to complete the task when the interface was dynamic, but there was a trend that the time required became shorter every inning. The error bar shows the standard deviation. We did not find any significant difference between the two conditions due to the number of participants.

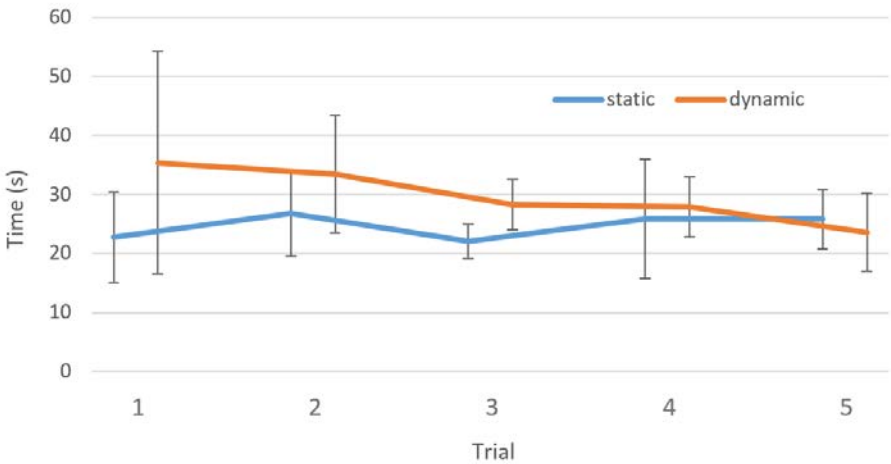

Fig.3. Transition of the required time for 5 trials

According to the introspection report, the dynamic condition was easy to recover an input error than the static condition, and felt less fatigue in some trials.

4 Conclusion

This study aimed to develop a high immersion interface for navigation in virtual environment while remaining globally static in the real world. The interface is composed of a rotating system, to make the user's centroid movement input faster with less fatigue. Currently, due to limited number of participants, we could not conclude effectiveness of our method, but we obtained positive introspection report. We will optimize gain and latency between centroid movement and floor inclination, and conduct and evaluation.

Acknowledgement: This research is supported by the JST-ACCEL Embodied Media Project.

References

1. Iwata, H., Yoshida, Y.: Path reproduction tests using a torus treadmill. Presence: Teleoperators and Virtual Environments, 8(6):587– 597, (1999)
2. Fernandes, J. K., Raja, V., Eyre, J.: Cybersphere: The Fully Immersive Spherical Projection System, Communications of the ACM, Volume: 46, Issue: 9, (2003)
3. Iwata, H., Yano, H., Fukushima, H., and Noma, H.: Circulafloor: A locomotion interface using circulation of movable tiles. In Proceedings of IEEE Virtual Reality Conference, pages 223–230, (2005)
4. Nintendo : http://onlineshop.nintendo.co.jp/shop/item_detail?item_id=1118354, (2007)
5. Marchal, M., Pettré, J., and Lécuyer, A.: Joyman: a Human-Scale Joystick for Navigating in Virtual Worlds. In proceedings of IEEE Symposium on 3D User Interfaces, pages 19-26, (2011)