An interactive music rhythm game in VR using HMD and full-body tracking

Akinari Fujimura¹ and Michael Cohen¹*

¹ Spatial Media Group; University of Aizu; Aizu-Wakamatsu, Fukushima; Japan

Abstract. The evolution of full-tracking devices has advanced to the point where full-tracking, which was previously a hurdle for individuals, is now easily possible. There is a need to explore the usefulness of full tracking devices and their potential to improve the VR gaming experience. The purpose of this study is to explore how full tracking can expand the VR gaming experience by developing a VR music rhythm game using a full-body tracking device, exploring how can this device expand the gaming experience?

1 INTRODUCTION

1.1 Background and Purpose

Full-body tracking [1], which used to require a certain amount of space and high cost, has recently been replaced by technologies such as HaritoraX wireless [2], mocopi [3], and Uni-motion [4]. With the advent and evolution of full-body tracking devices that can operate standalone, space-saving, and at relatively low cost, it can be said that VR has become more familiar to VR experiencers who use HMDs. Therefore, even in the field of VR games that use HMDs, it is expected that full-body tracking will increasingly be incorporated into games as an extension or the core of the game in order to deepen the player's VR experience. Therefore, we develop a VR game (music rhythm game) that incorporates full-body tracking using HMD using HaritoraX wireless, full-body tracking device, and verify and propose how can it expand the gaming experience.

1.2 Motivation

The reason we developed a music game despite the variety of genres is that there are major titles among VR games [5][6], and we thought that movement that uses the whole body would go well with music, such as dance.

* Corresponding author: xilehence@gmail.com

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).
1.3 Possible Full tracking advantage

In addition to the HMD and hand controller, addition of lower body tracking will increase input options, expand the degrees of freedom, and deepen VR experience. It is also expected to create a more immersive experience. Specifically, the idea is to improve the experience by parallelizing game control that is normally done with the hands with lower body, generate events interactively by performing specific movements using the lower body.

1.4 Game features

- Support for concurrent note-falling with hands and feet
- Input through spatially specific movement of the foot tracker
- Enhanced interactive VR music experience

2 IMPLEMENTATION

The specific game expansion plan is to add parallel processing with the feet to a music VR game in which the hand controller handles a stream of notes one after another, or to trigger an event when a specific foot-related action is triggered. The game processing itself will be implemented in a simple manner in order to increase usability.

2.1 What be used in this development

- Development software platform: Unity game engine 2021.3.15f1 (URP)
- Gamer hardware platform: Meta Quest2
- Full-body tracking device: HaritoraX wireless
- Bluetooth USB adapter: TP-Link UB500
- Unity plug-in: SteamVR plug-in
- Notes json file generate: NoteEditor [7]

2.2 Basic Notes Music Game Implementation

We create a json file with information on the note generation timeline for music games in NoteEditor [7]) (as seen in Fig. 1) and import it into Game's Project, and use scripts to create a note generation system for music games.
We use the SteamVR plugin to sync the Unity game screen to the HMD and to get coordinates of the HMD and hand controllers.

Haritora Configurator (as seen in Fig 2) and a Bluetooth USB Hub attached to the PC to get trackers information for the HaritoraX wireless trackers attached to the body (chest, hip, knees, ankles) and with the Haritora Configurator add-on Add a total of six trackers to steamVR.

We add the controller prefabs of the steamVR plugin to the Scene hierarchy and specify the device number in the inspector to get the coordinates of each tracker in Unity at game runtime. If the HMD, hand controller, and each tracker are successfully mirrored in Unity, full-body
tracking itself is complete. Now we have the basis of the VR music game and the tracking information.

2.3 System schematic

![System schematic diagram]

*Fig. 3. Device and application connections*
2.4 Parallel operation of hands and feet

Based on the notes generation explained in the previous section, I implemented a game part that processes notes in parallel with hand controllers and ankle trackers. Treat the ankle tracker as a foot because the position of the ankle tracker and the foot are almost the same.

The player is required to process the notes flowing from the front when they overlap judgment lines (as seen in Fig 5). Notes processed by hand controllers come from the upper lane. Notes processed by the ankle trackers come from the lower lane. The processing method is to hit from above with a hand controller, and overlap with an ankle tracker. The reason for this difference is that the feet cannot move as quickly as the hands. If the distance between the note and the judgment line at the time of judgment is less than a certain value, the player will receive points.
2.5 Input from specific lower body movements

Ankle trackers touch each other and make simple specific foot movements, such as raising one foot, to create inputs that affect the game. This is not just an input for a music game system, but rather an approach that allows players to play sounds at their own timing and to create visual changes in the VR space. This can improve the interactivity of games and provide a concrete example of free expansion in the field of VR games using HMDs.

3 EVALUATION

Subjects were invited to experience this game with and without full-body tracking expansion and complete a survey based on that comparison.

<table>
<thead>
<tr>
<th>Question</th>
<th>Range</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>In this experiment, how much did full-body tracking expansion increase the level of immersion in the game compared to without expansion?</td>
<td>No change at all: 0</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>~ increased: 10</td>
<td></td>
</tr>
<tr>
<td>Did you feel that the full tracking of your whole body position was reflected in the VR space, making it more immersive?</td>
<td>Not at all: 0</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>~ Certainly: 10</td>
<td></td>
</tr>
</tbody>
</table>
How much did you feel the interactivity (the experience of receiving a response from the game when the player takes an action) has improved?  

| No change at all: 0 ~ increased:10 | 8.0 |

Did you feel that the method of expanding game input with specific body movements could be used in other game genres?  

| Not at all: 0 ~ Certainly: 10 | 9.3 |

3.1 Discuss

In this survey, all participants said that the game expanded they implemented with full-body tracking improved their sense of immersion in the game compared to playing the game with an HMD alone. Subjectively, based on these results, it can be said that this implementation was appropriate as an extension. The second question confirmed that the sense of immersion was improved as the whole body was reflected in the VR space. Furthermore, the third question confirmed improvements to the interactivity of the game, and the fourth question showed that the full tracking extension in this game could be useful for things other than music rhythm games. From these results, it can be said that this implementation shows that performing full-body tracking in VR games on HMD is useful for improving immersion and experience.

4 CONCLUSION

We could show that the player's gaming experience can be improved by expanding a VR music rhythm game that uses a HMD with full-body tracking.

5 FUTURE WORK

Verification of VR game experience expansion using HMD with full-body tracking devices other than Haritra Wireless.

Implementation of a universal system for compatibility between different full tracking devices during expansion.

References

7. “NoteEditor” https://github.com/setchi/NoteEditor (20 October 2023)