COMP4801 Final Year Project

2018-19

Department of Computer Science,

The University of Hong Kong

Project Plan

Project Title: A Motion Tracking Game Based On VR

Student:

Ng Cheuk Hung (3035281093)

Supervisor:

Dr. T.W. Chim

Contents

1 Introduction

Virtual reality games have recently become more popular in the gaming industry. An article pointed out that virtual reality is a technology to provide user an environment for telepresence experience [1]. Different game development companies and studios have introduced motion tracking technology into their virtual reality games and this has been a hot topic in the gaming industry. A journal article described motion tracking device as a type of computer input device for converting human motion into data which can be interpreted by computers [2]. With the use of motion tracking devices. virtual reality game can bring evolution to the video games.

Currently, most of the virtual reality games make use of the motion tracking technology to solely capture the human motion and reproduce the body movements on an in-game character. Therefore, this project aims to expand the usage of motion tracking technology on virtual reality games besides the reconstruction of player's body movements inside the game. There are a lot of information the game can retrieved from the body movements. Body motion can be interpreted as a sequence of human body movements to complete a set of particular tasks [2]. The motion sequences and patterns of the players can be used as a type of data input to control different elements and accomplish different tasks inside the game. As a result, the interaction between the players and the games is enhanced by the enlarged and improved implementation of motion tracking technology on the virtual reality games. Players can then have a better experience in the virtual reality world with the enhanced player-game interactions.

A motion tracking game based on virtual reality will be delivered in the final stage of this project in order to demonstrate how to utilize motion tracking devices in virtual reality game by interpreting the motion sequences and patterns to greatly improve the player-game interactions. This concept of player-game interaction based on motion tracking will be named as motion-driven player-game interaction in this

project. An efficient algorithm for transforming body motion into in-game commands will be introduced as well.

In the remainder of this paper proceeds as follow. First, the detailed background information of this project is offered. Then, the object and scope are presented as well. After that, the methodology of the project is well explained. Finally, this paper closes with the project schedule and a list of potential risks and challenges.

2 Background

Virtual reality technology in gaming industry brings a new level of experiences to gamers. One of the main goals of video games is to provide new experience to the players. Virtual reality can change users' perception to their surrounding environment [1]. While the players enjoy their new experiences inside the virtual world simulated by the virtual reality games, there is a need of interaction between the players and the game objects. Motion tracking devices is then introduced as a method for players to interact with the game.

As stated in an article, a modern virtual reality system contains a game station composed by input and output devices, including a motion tracking device for sending output signals by detecting the movements of the user [3]. Some of these motion tracking devices can precisely capture the motion of the users and send the corresponding signal to the computer. Players can interact with the game with their body movements now while players in the past can only interact with the game with traditional computer input devices, like keyboard, mouse and console controller.

Motion tracking games based on virtual reality have become the spotlight among the gaming industry in the past few years. All the top-tier virtual reality games in the Best of 2017 Virtual Reality Rewards from Steam make use of the motion tracking controller [4]. Steam is one of the biggest digital distribution platform for video games in the world. Its statistical data and attention on virtual reality games shows that the

market of virtual reality games has grown quickly in recent years and game development professionals start using motion tracking technology in their virtual reality games. Most of these virtual reality games solely utilize the motion tracking controller to capture the hand movements and reconstruct the motions inside the game. However, more advanced utilization of motion tracking devices can be used in the game implementation for better player-game interaction improvement. For instance, player should be able to interact with the user interface or control different types of game objects through body motions. Therefore, this project aims to solve this problem by demonstrating advanced implementations of motion tracking devices on a game based on virtual reality.

3 Objective

This project ultimately aims to enhance the implementation of motion tracking devices on virtual reality games to provide a better player-game interaction. It is because most of the current implementation of motion tracking technology on games based on virtual reality is straightforward and monotonous. For instance, hand movements captured by the hand motion tracking devices are usually merely used to reproduce the tracked motions on an in-game character. However, more advanced utilization of the body motion data can be implemented to the game, such as triggering different in-game commands and effects through different body motion sequences and patterns.

Therefore, there are several sub-tasks to be completed in this project. Firstly, an efficient algorithm will be introduced for transforming motion sequences and patterns into data information which can be interpreted and utilized by the game, like mapping to lines in a coordinate system. Then, a motion tracking game based on virtual reality will be made to demonstrate how virtual reality games can make use of those useful data information generated by motion tracking devices on different game elements to provide a better player-game interaction. For example, drawing a circle with the motion tracking device can open a setting menu while most of the current virtual

reality games require players to watch at the setting menu icon for a few seconds to open the menu.

In order to demonstrate how the motion tracking technology can be used on different types of game, the game product is composed of multiple mini-games from different game genres, like racing game, sports game and action game. Different sets of implementations on the motion information of the players will be used on those mini-games. For instance, player motions are used to control the racing car and interact with the various mechanical components of the car in the racing game while these data are used to trigger different action combos and special abilities in the sports game and the action game.

4 Scope

The focus of this project is to study how to use advanced implementation of motion tracking devices in a virtual reality game to improve player-game interaction. Therefore, the algorithm study is focused on how to transform motion information to simple movement sequences and patterns, like a movement sequence as LEFT → RIGHT → LEFT → LEFT. Then these sequences and patterns are classified and used to trigger corresponding predefined in-game commands. Apart from the algorithm study, A game will be made as a practical application to illustrate the whole process of motion-driven player-game interaction. The generalized process is proposed to start from motion capturing with motion tracking devices to interpretation and simplification of the input motion data, and finally to trigger customized and predefined in-game events. Several mini-games from various game genres will be included as a whole game product to demonstrate how the motion-driven player-game interaction can be implemented on different types of game.

Therefore, the algorithm study does not aim to improve motion tracking devices or motion tracking technology but to propose a model to utilize the captured data efficiently on a virtual reality game in a larger extent. The project will not solve the

problem of precision and accuracy of the motion tracking devices and presume that the used motion tracking device is capable of tracking the body movement of the players precisely and accurately.
Although a game will be delivered in the final stage of the project to demonstrate the proposed motion-driven player-game interaction implementation, it will not be comprehensive enough to be comparable with the commercial games. The delivered game is supposed to showcase the advanced implementation of motion tracking technology on virtual reality games and its effects on raising the game enjoyability, therefore the other elements of the delivered game, such as storyline and aesthetics, are not weighed as much as the aspects of technology and mechanism.

5 Methodology

In this section, the methodology in this project is discussed. Different tools used to implement the project are introduced in the following part, including the virtual reality gear and game engine for implementing the virtual reality game.

5.1 Virtual Reality Gear and Motion Tracking Devices

The virtual reality gear chosen for this project is HTC VIVE. HTC VIVE is a virtual reality gear developed by HTC and Valve Corporation. It consists of a headset and a controller. The controller can be served as a simple hand motion tracking device. The reason why it is chosen for this project is that HTC VIVE has a high accuracy on position and orientation calculation and its end-to-end latency is only 22ms [5]. It is also well supported by the game engine and software development kit to be discussed below. Therefore, the development of the delivered game with HTC VIVE is more convenient and has less risks.

5.2 Game Engine

The game engine used to implement the delivered game is Unity Engine. Unity Engine is a one of the most popular game engine for creating three-dimensional games. It provides a set of scripting application programming interfaces in C# for

developers to implement custom game logic. Unity Engine has a great support on virtual reality game development and development with HTC VIVE. It provides an input system for mapping the input from motion tracking devices. Moreover, C# is an object-oriented programming language, so it is easier to implement game logic since it treats the elements inside the game as an object. The interaction between the objects can be modified to illustrate the motion-driven player-game interaction. Therefore, Unity Engine is chosen for this project.

5.3 Software Development Kit

OpenVR is chosen as the software development kit when implementing the delivered game. OpenVR is a set of application programming interfaces for the virtual reality game development with the feature of independent update for supporting hardware updates according to its documentation [6]. OpenVR is required as a way for mapping device input to game-usable data in Unity Engine when the game is developed with HTC VIVE. Therefore, this software development kit is included in the development tools in this project.

5.4 Agile Methodology

This project follows the agile methodology. In order to perform the iterative development, a preliminary game will be development after the algorithm study to test the feasibility of motion-driven player-game interaction. After the successful build of the test game, a game product will be built on top of the preliminary game by adding more gameplay elements and more advanced game logic implementation. For each game builds above, the game will be tested by a set of gamers for the feedback on the enjoyability of motion-driven player-game interaction and the stability of the delivered game. The game is then further improved and enhanced according to the feedback. Therefore, the project quality is ensured by following the agile methodology.

6 Schedule and Milestones

There are three important milestones in this project, namely the algorithm study phase, preliminary game implementation phase and the final game implementation phase. Time is evenly allocated for these three phases in order to complete the project and all sub-tasks in time.

Date	Milestone
30 September 2018	Deliverables of Phase 1 (Inception) - Detailed Project Plan - Project Web Page
October 2018	Research on Virtual Reality and Motion Tracking Devices
November 2018	Algorithm Study
December 2018 - January 2019	Development of Demo Game
7 - 11 January 2019	First Presentation
20 January 2019	Deliverables of Phase 2 (Elaboration) - Preliminary implementation - Detailed interim report
February 2019 - April 2019	Development on Deliverable Game
14 April 2019	Deliverables of Phase 3 (Construction) - Finalized tested implementation - Final report
15 - 19 April 2019	Final Presentation
29 April 2019	Project Exhibition

7 Risk, Challenge and Mitigation

7.1 Inaccuracy of Motion Tracking Devices

The project presumes that the motion tracking devices can precisely and accurately capture the motion and send the correspond the signals to the computer. If the motion tracking devices fails to capture the motion correctly and send the incorrect data input, then the algorithm may output an undesirable in-game command. Since this is a hardware limitation and this project does not aim to solve this kind of problem, the inaccuracy of motion tracking devices may affect the game adversely independent of the algorithm.

7.2 Overhead on Constant Motion Interpretation

The constant interpretation of the raw motion data to the useful motion sequences and patterns may have a high overhead and lower the performance of the game. It is because previous motions need to be stored for calculating the whole motion sequences and calculation of motion sequence and in-game command mapping is performed constantly upon motion detection. The algorithm implementation needs to be optimized to lower the negative impacts of constant motion interpretation on performance issues.

7.3 Precision on motion sequence and pattern interpretation

The precision of interpretation on motion sequences and patterns is also a challenge in this project. Firstly, the game should be able to transform raw motion data into correct motion sequences. For example, the game should be able to recognize the player is drawing a circle but not a square when the player is actually drawing a circle with hand motion tracking device. After that, the game should be capable of mapping the motion sequences to the correct in-game events. For instance, when a player is drawing a long line, the game should be able to open the setting menu correspondingly.

7.4 Mitigation

One of the proposed solutions on the above problems is to simplify and abstract the raw motion data before the interpretation process. The game can transform the raw motion data into simplified motion data, which is easier to be stored and interpreted by the software. This makes use of the concept of abstraction. For instance, instead of using the coordinate system to represent the motion data, the game can simplify them into approximated directional data, like LEFT → RIGHT → RIGHT → LEFT. Since the motion data is abstracted and approximated, minor data error is irrelevant and hence ignored. Therefore, the inaccuracy of motion tracking devices and motion interpretation will have less impacts. The overhead will also be reduced when storing and processing abstracted motion data.

8 Conclusion

To conclude, this project aims to enhance player-game interaction with more advanced implementation of motion tracking devices on virtual reality game. A model of motion-driven player-game interaction is introduced by this project. In order to demonstrate how developers can utilize the motion tracking devices to implement motion-driven player-game interaction, a game will be delivered in the end of the project as a demonstration. The game will consist of multiple mini-games from different game genres, like racing game, role-playing game and action game, to show that the motion-driven player-game interaction can be implemented on different types of game.

References

[1] Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. Journal of communication, 42(4), 73-93. [cited 2018, Sep 28]

[2] Rosenberg, S. N., & Page, D. (2009). Human Motion Tracking Device. S. Patent Application No. 12/076,241. [cited 2018, Sep 28]

[3] Smith, M. D. (2000). Virtual reality game. U.S. Patent No. 6,159,100. Washington, DC: U.S. Patent and Trademark Office. [cited 2018, Sep 28]

[4] Best of 2017 Virtual Reality (2017). Steam. Valve Corporation [Online]. Avaliable from: https://store.steampowered.com/sale/2017_top_vr_titles/ [cited 2018, Sep 28]

[5] Niehorster, D. C., Li, L., Lappe, M. (2017). The accuracy and precision of position and orientation tracking in the HTC vive virtual reality system for scientific research. i-Perception, 8(3), 2041669517708205. [cited 2018, Sep 28]

[6] OpenVR API Documentation (2017). Valve Software [Online]. Avaliable from: https://github.com/ValveSoftware/openvr/wiki/API-Documentation [cited 2018, Sep 28]