Birdman: a flying simulation system

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Introduction

Birdman is a flying simulation application incorporating an optical motion tracking system, which allows users to imitate bird flying movement to control the virtual camera movement. Big projection canvas in front of users displays a moving forest scene that provides players with the flying illusion. The application enables users to explore the virtual forest by controlling their flying speed, height, and orientation via changing their arms' flapping speeds and height as well as the orientation of the body.

Related Work

Flying is always the dream for human beings over the past thousands of years so we invented toy like the kite, created aircraft to take us into the sky, some people even invested countless time into adventure sport like paragliding. However, all these flying experiences aren't easy to get access in our daily life because all these activities require us to have corresponding instruments, money, big-enough places, and most importantly, the knowledge about how to use them. Fortunately, the emerging technologies like Virtual Reality and Motion Tracking provide us with the opportunity to simulate different motion scenarios including flying without stepping out of the room.

Various virtual flight simulators have been used by the Army to train their pilots and test aircraft so that they can reduce unnecessary lost and wastes if we were testing in real flights[1]. Such simulators provide the closest experience on real airplanes, but, at the same time, allow trainees to make mistakes and gradually train their skills in different flying scenarios like taking off, landing and combats. Moreover, as Virtual Reality becomes more and more accessible by consumers, a lot of people get addicted by VR flight simulation game like VTOL VR, where users can fly as a combat aircraft via VR headset Oculus Rift, as displayed in Figure 1.

Figure 1. Paint Space AR interfaces.

These flying simulators provide the user with the first-person view to give you the illusion that you are flying inside of an airplane, which highly relies on the visual channel. But such applications don't support many direct body movements to control the virtual aircraft, instead, users need to express their moving commands via a button handheld controller.

There are some other motion simulators that indeed support realistic body movements to control a virtual avatar. For example, Lee, Hyuck-Gi, et al. mentioned that Virtual Golf Simulators, as shown in Figure 2, which allow users to swing real golf clubs to play a virtual golf game, have the power to detect the players' behavioral intentions. It provides great potential to achieve better sport training results[3].

Figure 2. Virtual Golf Simulators.

Design Philosophy

The system we designed provides the first person view that would give you the flying illusion. Players can imagine themselves as a bird flying among trees in a big forest. The realistic forest scene will change dynamically as users are flying, which improve the enjoyment of the game playing process.

Besides supporting flying simulation, our system allows users to imitate bird flying movement; birds flap their wings to fly while in this game, the player needs to flap their arms to control the camera moving. Users can freely explore the forest through direct and natural body movements to control the height, speed, and direction of the view during the flying process.

To make the interaction as natural as possible, we fully consider our natural spatial and movement system as well as the bird's flight mechanism. Finally, we designed the following interaction mechanism:
(1) The speed of arm flapping controls the flying speed. More quickly you move your arm up and down, higher speed you will get.
(2) The range of arm waving controls the height of flying. The larger amplitude will lead to fly higher.
(3) The body direction controls the flying direction. Turning your body right (left) causes the flying direction turning right (left) simultaneously.

Such seamless mapping makes the learning curve of our application is not steep at all.

Implementation

Our system implementation can be divided into three parts: one is game scene building via 3D game engine Unity, two is real-time motion tracking via Qualisys System and the last is sending the motion tracking data to Unity to control the virtual camera moving.

For the game interfaces part, we built a virtual forest scene, displaying in Figure 3, where users can fly among or above the trees to enjoy different views. Instead of letting users control a virtual bird, we get rid of the virtual avatar and immerse users with the pure forest view. The first-person view provides a better flying illusion.

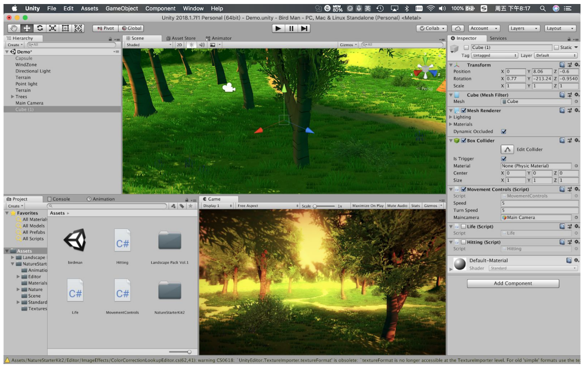

Figure 3. Unity development interfaces

For the interaction development part, we first generated a human model that marks the position of the head, two wrists, right and left shoulders, two elbows as well as the chest in Qualisys software. Then, we used the Qualisys Unity API to send the motion data to Unity. When the game is playing in Unity, it will automatically initiate a human model as same as the one we created in Qualisys. This model enables us to detect every position changes of each marker on this model via C# code.

According to our ideal interaction design, we need to detect the arm flapping speed and the amplitude as well as the orientation of the body. To realize our interaction as natural as we designed, we extracted the most related markers that represent corresponding body positions — two wrists markers and two shoulder markers. We transform the changing speed of the height of two wrists into the moving speed of the camera, in other words, the flying speed. The highest position of wrists markers when flapping the arms determines the flying height. Moreover, we should two shoulder markers to calculate body orientation. Two shoulder markers consist a vector; the changes of the angle of this vector has been mapped to the orientation of the flying view(camera).

Figure 4. The player is playing our game.

Discussion and Reflection

Currently, our system only provides one kind of theme - forest, but it is clear that the system has the potential to support more diverse motion simulation scenarios like flying over ocean or cities or even flying in a Quidditch game.

Additionally, such motion simulator that supports rich and natural body movement input can be used in a virtual gym or rehabilitation system. Immersive and dynamic virtual scenes not only give players the motion illusion but also the motivation and enjoyment during boring fitness or painful rehabilitation process [4].

In this project, we utilized the marker-based motion tracking system, which is not accessible and portable enough. However, with the development of computer vision, in the future, marker-less tracking systems will be capable to track more natural human-computer interaction so that we are able to unleash the power of natural body movement to interact with the digital world.

Reference

[1] Jayashanka, W. A. P., et al. “Phoenix Fighters: Virtual Flight Simulator for Air Force Trainees.”/Compusoft/, vol. 3, no. 10, 2014, pp. 1167-1171/. ProQuest/, http://proxy.lib.umich.edu/login?url=https://search-proquest-com.proxy.lib.umich.edu/docview/1708138627?accountid=14667.
[2] Top 7 Oculus Rift Flight Simulators in 2018 - Rift Info written by Alex, MAY 8, 2018 at https://riftinfo.com/top-4-oculus-rift-flight-simulators-at-this-current-moment
[3] Lee, Hyuck-Gi, et al. “Presence in Virtual Golf Simulators: The Effects of Presence on Perceived Enjoyment, Perceived Value, and Behavioral Intention.” New Media & Society, vol. 15, no. 6, Sept. 2013, pp. 930–946, doi:10.1177/1461444812464033.
[4] Avola, Danilo, et al. “VRheab: a fully immersive motor rehabilitation system based on recurrent neural network.”/Multimedia Tools and Applications/77.19 (2018): 24955-24982.