Study on the Use of Wearable Devices to Control Objects in Virtual Reality

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Abstract

This study focuses on the design of a wearable inertial navigation device that is based on a MEMS chip and a Bluetooth wireless transmitting module and that uses the object-controlling technology of the Unity game engine to write a game script for a treasure hunt in an ancient Chinese virtual reality world. The wearable device proposed in this paper utilizes an ATmega168 chip as the main controller, which cooperates with a three-axis accelerometer and gyroscopic sensor to detect the forward, backward, and rotating movements of game players. The movement data are transmitted to the Unity 3D game engine using Bluetooth, and the game software can then control the first-person character. The interactive elements between reality and the virtual world combined as described in this paper can deliver a new experience to games, driving simulators, medical surgery, and even a variety of commercial situations. The experimental results show that the performance of the wearable device proposed by the study is stable. This paper was written with the hope that it may attract additional innovative applications that could change human lifestyles in the future.

Key words: Wearable device, virtual reality, Unity 3D, electronic compass

Introduction

Wearable devices [1-4] are electronic devices that can be worn on the body. They utilize various sensors to collect related data, including physiological information (such as heart rate, body temperature, blood pressure, blood oxygen, and steps taken), environmental data (such as temperature, humidity, CO_2, and light), and motion perception (in which inertial sensing elements gauge complex human actions and behaviors). Wearable devices can have a greater range of application when connected to a mobile phone through a communication interface such as Bluetooth or when wirelessly connected to a cloud platform through Wi-Fi for big data processing. Generally, areas of application for wearable devices include leisure and entertainment, health care and health management, information transmission, and environmental monitoring. The most successful wearable products on the market are smart wristbands and smart watches, many of which have built-in accelerometers and gyroscopic sensors that calculate and analyze the collected sensing data and then provide wearers with statistical information on various aspects of life, such as running, walking, lying, and standing. They can even be used to detect the quality of sleep and provide a completely different "quantitative" experience for users: long-term health management based on statistics from more realistic data and long-term records. Examples of wearable devices include iWatch, the first Apple wearable device; the ASUS ZenWatch; the LG G Watch R; and the Sony SmartWatch 3.

System Architecture

The system is composed of three subunits: a personal computer, a Bluetooth wireless receiver, and a wearable device, as shown in Fig. 1. The wearable device is bound to the arm, and the system determines the position and direction of body movement or rotation. This device contains a three-axis accelerometer, an electronic compass, a gyroscope, and a Bluetooth transmitting module. The tilt detection of the three-axis accelerometer can sense motions of the arm, which indicate how the user is moving. The electronic compass can sense the user's position (the angle between the user and North), and the gyroscope can identify the rotation of the player. The Bluetooth transmitting module transmits the position and rotation signal to the signal receiver, and the RS232 serial communicator then sends the signal to the personal computer. The Unity game engine receives the signal in real time and writes a script in the C# programming language to control the first-person character controller in virtual reality.

 ISBN 978-1-5090-3869-5

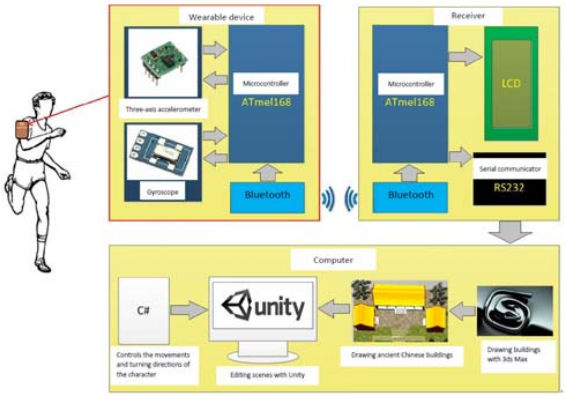

Fig. 1 Block diagram of the system

Scene Creation with Unity 3D

The purpose of this study was to design a wearable device that uses inertial navigation and to develop a treasure hunting game script with an ancient Chinese background using technology to control objects in virtual reality. The overall design of the scene is shown in Fig. 2. For this study, 3ds Max was used to build a variety of 3D models, which were imported into the Unity game engine software. The 3D models include ancient pavilions (marked as (5) in the figure), Guiyuan Temple ((6)), an ancient palace ((7)), a palace gate ((8)), a Wudang stone tablet ((10)), a thatched stone house ((11)), Guhua courtyard ((12)), an attic wing ((13)), and a waterside pavilion ((14)). The game scene also includes features created using built-in functions from Unity such as terrain creation (landscape, marked as (1)), sky rendering (effect, (2)), tree planting (objects, (3)), lawn planting (objects, (4)), a first-person controller ((9)), and a pool ((15)).

The story script takes the first-person perspective of Zhang Wuji, the famous protagonist of "The Heaven Sword and Dragon Saber." At the beginning of the game, Zhang Wuji completes the closed-door practice of martial arts and comes out from Guiyuan Temple ((6)). When the protagonist steps out of the temple, he finds a Wudang stone tablet ((10)) standing beside him. The stone tablet is engraved with a maxim: "Dragon Sword, the master hero. Order the world, no one dares to reject. When the Heavenly Sword comes out, nothing can compete with it." After reading the maxim, Zhang Wuji must begin to look for the Dragon Saber and the Heaven Sword, which have been hidden in the ancient Chinese palace ((7)). To win the game, the protagonist must travel from Guiyuan Temple ((6)) to the ancient Chinese palace ((7)), collect the saber and sword, and strike them together to obtain the power of the Yue Fei martial arts, which is hidden within the Dragon Saber.

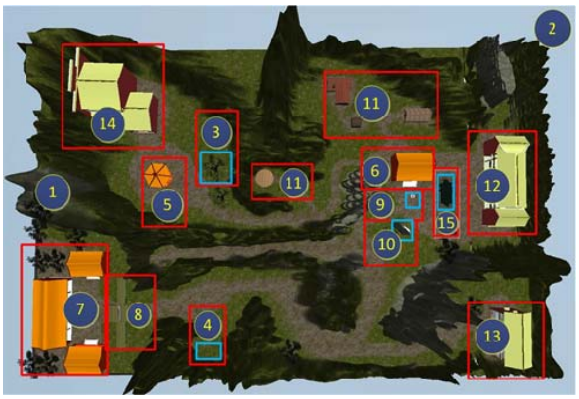

Fig. 2 Game scene of hunting treasure in ancient China

Functional Tests and Experiment Results

In Fig. 3 and Fig. 4, the game player rotates his body to the left and instantly stops. The wearable device senses the position of the game player based on his direction of rotation and transmits the data to the Bluetooth receiver using the Bluetooth transmission module. The RS232 chipset in the Bluetooth receiver then transmits the data to the Unity game engine, which writes a program in C# to allow the first person to take the action of turning left on the Unity screen, as shown in Fig. 5 and Fig. 6. The players finally arrive at the palace gate, enter the ancient Chinese palace, and win the game.

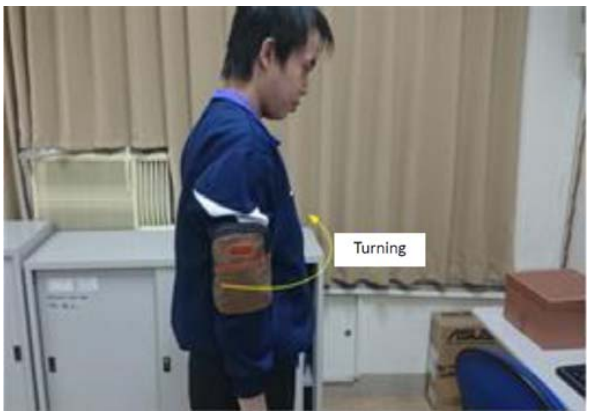

Fig. 3 Player turns his body to the left

Fig. 4 Player turns his body and stops

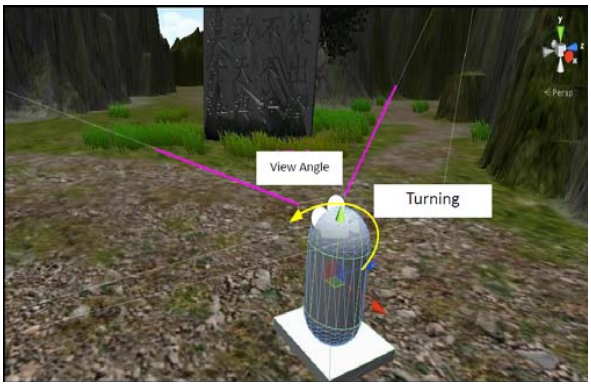

Fig. 5 Character controller turns left

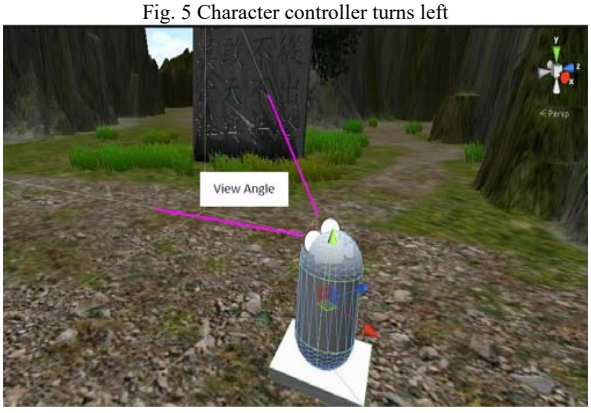

Fig. 6 Character controller turns around and changes the visual angle

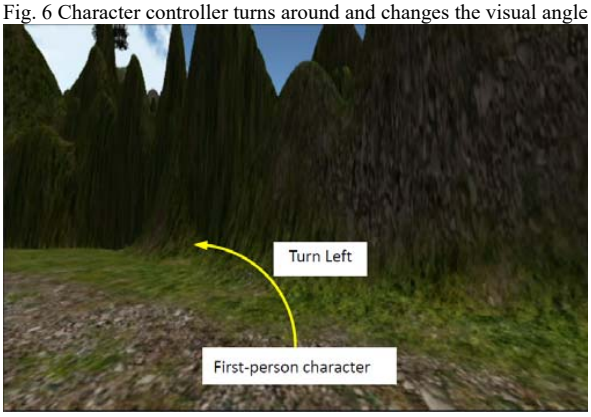

Fig. 7 Player turns left

Fig. 8 Player turns left and moves toward the ancient Chinese palace

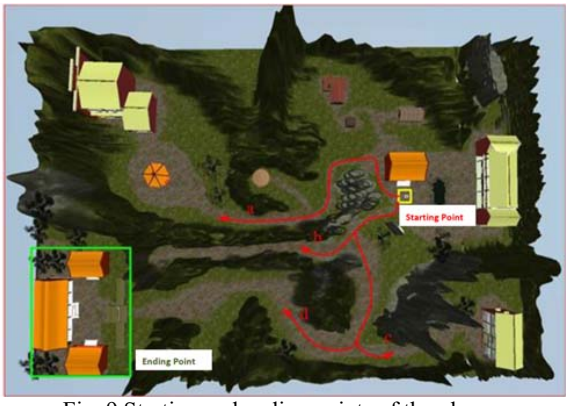

Fig. 9 Starting and ending points of the player

Conclusions

The purpose of this study was to use an eight-bit RISC microcontroller chipset to detect the actions of game players and use motion-sensing interaction technology to control 3D character models in virtual reality. In the study, we used an electronic compass to detect the directions of rotation of the players and utilized a three-axis accelerometer to detect the movements of the players. The Unity 3D game development engine was used to design the game script, and modeling materials from Maya and 3ds Max were imported into Unity 3D to enrich the model materials of game scenes and enhance the appearance and flexibility of the game. For example, ancient Chinese palaces, pavilions, houses, and animals were added to the game scenes. Unity can now release the game on various device platforms, which can then be used to develop cross-platform games for platforms such as PC, PS3, and Android. Unity provides a very user-friendly interface and supports game script development in C# or Java to significantly simplify the development process so that users can easily develop games

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 ISBN 978-1-5090-3869-5