

Fallbox: a computer game with natural interaction through head tracking

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ABSTRACT

Natural interaction on computer games is a common problem faced by game designers. For that reason, it is necessary to explore new interaction paradigms like tracking technologies in order to provide novel techniques for interacting with video games. For instance a head tracking system can be used to make the body movement tangible on the virtual world of the game.

The objective of this paper is to provide a technological solution to the creation of a low-cost head-tracking's solution, using the infrared light detection through the Nintendo Wii Remote.

Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation]: User Interfaces, input devices and strategies, user-centered design.

General Terms

Human Factors.

Keywords

Computer games, head tracking, game control, wearable device, augmented reality.

1. INTRODUCTION

Gaming has been a common entertainment activity in many cultures through time; games like Chess have several years of successful history. In recent decades, with the advent of personal computer technology, many exciting new possibilities have emerged to create fascinating games with computers. Computer games can apply complex simulations to create a believable, immersive game world. [1].

Although computer technology opens up many exciting forms of entertainment, playing computer games is still perceived as a complex activity. A recent trend in the video game industry is toward a more complex controller.

Devices such as the Dual Shock 2 controller made popular with the Playstation 2 are designed to satisfy the needs of the avid gamer but can be intimidating for non-gamers to adopt [2]. To answer this problem, the industry has introduced alternative

control mechanisms that allow players to interact with video games in simpler, more natural ways.

For that reason natural interaction on computer games is a common problem faced by game designers. One interesting direction involves the creation of more immersive ways of providing input to games, where players' natural movements translate into in-game actions. Perhaps the most well-known of these are gesture-based interactions using a Wii Remote [3], and movement-based interaction using a dance pad or Wii Balance Board [4].

Because of this, it is necessary to explore new interaction paradigms like tracking technologies in order to provide novel techniques for interacting with video games. For instance a head tracking system can be used to make the body movement tangible on the virtual world of the game.

In this paper we present a technological solution to the creation of a low-cost head-tracking's solution, using the infrared light detection through the Nintendo Wii Remote.

2. BACKGROUND

At the moment to play exciting computer games, the players often make involuntary movements because they are so involved in the game and unconsciously move their body in response to game events. Although the players make these movements, these motions have not influence on the game. Then we can use devices that have the ability to transform these body movements into useful input for the game.

Next we describe the head's tracking technology to be used to transform the body movements on useful information for computer gaming.

2.1 Gaze and computer games

Many recent commercial games already include a concept of gaze-based interaction. Most popular is the first-person shooter genre, where the field of view of the player's avatar is explicitly presented to the user.

Additionally, some games require the player to explicitly control the direction of the avatar's gaze. The character's gaze (therefore the player's head) must be directed toward a target in order to allow a user to successfully accomplish the game goal. This kind of interaction can be afforded by a head tracker device.

2.2 Infrared head-tracking system

Head tracking concept is based in the use of especial hardware for control the videogames, these equipment regularly is expensive and a lot of times is inaccessible for many users.

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Figure 1. Schematic diagram of a head-tracking system.

Infrared camera can detect infrared light, that spectrum of human vision cannot see, the light is detected in some point of vision of camera angle and for calculate the movement of the transmitter comparing two signal in a space of time.

TrackIR [5] is a commercial head-tracking game peripheral based on this technique. IR light captured by the camera comes from reflecting tape placed on the user's head, rather than IR light emitting diodes (LEDs). TrackIR can track six degrees of freedom in 3D space. TrackIR costs approximately \$200. Using TrackIR, head motions can be used to simulate eye-gaze in video games.

An issue with the above tracking system is the prohibitive cost; the \$200 price is high for a gaming peripheral.

2.3 WiiDesktopVR

This technology was created by Johnny Chung Lee and is considered a low-cost (less than \$100); uses a Wii remote, Bluetooth receiver and IR LEDs. The Wii Remote is a motion sensitive controller equipped with an IR filtered camera. Using it as a camera, it is possible to track IR LEDs placed on a user's head. The Wii Remote transmits information via Bluetooth, which is interpreted using the Bluetooth receiver [6].

The technology allows users to view targets floating in a virtual 3D space. The goal of the game is to show the differences between viewing a 3D world with and without head-tracking enabled. With head-tracking enabled, the view dynamically reacts to users head positions and without head-tracking, the world remains stationary regardless of users head position.

2.4 Wii remote

The Wii Remote (also known as Wiimote) has the ability to detect acceleration along three axes using an accelerometer ADXL330. The Wiimote also has an optical sensor Pixart, allowing you to determine where the Wiimote is pointing (see Figure 2).

Can be used as a pointing device up to 5 meters (approx. 16 feet) away. The Wiimote can detect movement up-down, left-right, and can also control slowly forward-backward motion toward an object in a game in three dimensions.

If you use a LED array and some reflective tape, you can use the infrared camera in the Wiimote to track objects.



Figure 2. Nintendo Wii Remote.

If you use the Wiimote in combination with a Wii sensor bar mounted on the player's head, you can accurately track the location of their head and render the game's views on reaction to the player's head movements (see Figure 1).

This transforms your screen into a portal to an enhanced computer game through tangible interaction; the game properly reacts to head and body movement as if it were a real world game.

3. Fallbox

Fallbox is a 2D game (see Figure 3) played from the first person perspective. It is based in head tracking using infrared led and the infrared camera of the Nintendo Wii Remote. The aim of this game is that players move his head to control the game avatar (called Chilo) on the X axis. Chilo has to move to dodge the boxes that are falling down.

The game has 5 levels, in which every level the difficulty increases because the boxes are falling faster. Player has a limited life (a 100% bar at start) that is decremented each time Chilo is beaten by a falling box.



Figure 3. Fallbox computer game.

To play it, we created an interaction device (see Figure 4) that is placed on the player's head which consist of an infrared LED that point to the Wii Remote and is the responsible for indicating the position of the player in the game. So the player has to move to control the avatar and dodge the boxes that are falling down game.



Figure 4. Head-tracking interaction device.

3.1 Game design

Traditionally computer games are controlled by the keyboard and mouse but this may be a bit complicated in some games or perhaps it can be boring playing them without much interaction.

The new interaction paradigms (like tangible) have revolutionized the way we play video games, because the player becomes the game controller. In our case, we make use of head tracking which is based on the use of specialized equipment to control the avatar on video games by making them more fun and interesting to play them.

Fallbox allows game interaction by moving our head to control the avatar through the use of head tracking. As the player advances in the game levels the boxes are falling faster, which causes the players have to move faster to avoid them, making the game more fun than if they were playing with a static input device like keyboard or mouse.

Fallbox encourages people to play by moving their bodies, making the game interaction more natural, because the player

will need to interact with their body skill in order to complete the levels.

3.2 Game apparatus

There are needed two devices to control the game, our head tracking device (see Figure 4) and a Wii Remote (see Figure 2), the last one is responsible for detect infrared light emitted by the LED and make possible the player's movement detection.

Through experimentation we found that any light can be detected by an IRC receptor. We make experiments with red and blue light LED and mini light bulbs getting different results regarding the ability of signal perception that IRC receive. After that, we decide to use LED of infrared light because the signal detected by the Wii Remote was more intensive.

This circuit was mounted in a 4 cm for 6 cm printed circuit and reinforced with an small cover of the same material and size; this for ensure the integrity of the components and the battery position; later we lined the device with cardboard to make it look usable.

Other important part is the ergonomic and the usability of this device; was designed to be used for all kind people (no matter genre or age), mounting it on an elastic band adapted to the head shape of the player (see Figure 5).



Figure 5. Playing Fallbox.

4. EVALUATION

We did a trial session to test Fallbox, where several classmates and teachers tested the game; we describe the evaluation process and the results in the next sections.

4.1 Study design

The study was conducted at the School of Telematics in the University of Colima. The subjects of study were 20 people, 11 males and 9 females, with an age range between 14 and 29 years. 70% of the subjects had experience in playing computer games.

We evaluate the acceptance and use of technology through the game experience with two types of interaction: keyboard and head-tracking.

4.2 Procedure

An evaluation session lasting about an hour included the following phases:

Phase 1: A 10 minute introduction.

Phase 2: We performed a live demo showing them the features of the computer game. The aim of this was to put in context the use of the interaction devices to the subjects.

Phase 3: The subjects were given time to freely use the technology.

Phase 4: In this phase the participants were asked to complete a game experience questionnaire (GEQ) with 5 Likert-scale assertions, which included topics such efficiency, effectiveness, immersion, motivation, emotion, fluency and learning curve.

Direct observation was used the entire session. Comments while using the devices were also collected.

4.3 Results and discussion

Here we present some results obtained through the survey (see Figure 6).

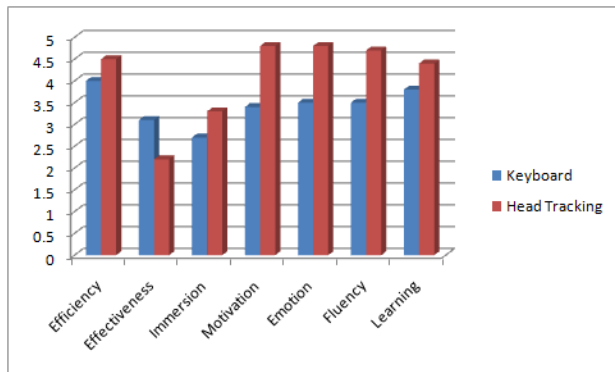


Figure 6. User's perception.

4.3.1 Obstacles for the adoption of the head-tracking device

The subjects identified lack of effectiveness with the head-tracking device as the main (and only) potential obstacle.

4.3.2 Perception of a richer game experience

The participants found the head-tracking technology (in relation to the keyboard) more efficient, immersive, inspiring, exciting, smooth and easy to learn, which indicates that they might indeed use the head-tracking device.

5. CONCLUSIONS

We develop a computer game and an interaction device to control this game with head tracking; using the infrared camera of the Wii Remote. This allows the players to control the video game avatar through detection of real motion of the player, tracking their head movement.

Infrared head tracking provides a natural computer interaction rather than the traditional keyboard and mouse, resulting from the transforming body movements into useful input information for the game.

The evaluation showed that this kind of interaction involves the players in a more realistic gaming experience where the gamer becomes part of the game as if she will be playing in the real world.

Someday, gaze would replace aiming with a controller; meanwhile, with Fallbox we have shown how to develop an enjoyable game with a natural interaction using a low-cost head-tracking device.

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