Development of an interactive game using a webcam

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Abstract

The electronic games are becoming each time more popular and using resources each time more common in the personal computers like the webcam. Actually some games allow to be played using just the webcam and the body motion. This game category is known as webcam games. This project has as objective research the motion capture technology used by the webcam games. The motivation for this project was the possibility of use this resource to create educational games and games focused in physical rehabilitation on a dynamic and funny way. Thus it was necessary to develop research on existing motion capture technologies used in the current games. Adobe Flash was chosen as development platform, using the AS3 (Action Script 3) programming language. As result, was created a game named "Coleta Seletiva" that allows to identify in a clear way, its behavior and future uses of the researched technology.

Keywords: webcam, motion capture, Adobe Flash

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1. Introduction

The world of electronic games grows continuously. The games alternatives and realism are impressive, even for who doesn't follow the genre. Until a little time ago the unique dispositive used in games was the joystick, which allows the control of the whole game. Following the personal computer's popularization, besides the joystick, the games started to use the mouse and the keyboard allowing the gamers to control the game with the computer's basic resources.

However, these resources are little ergonomics and uncomfortable when used for long periods of time. They can even cause Repetitive Strain Injury Syndrome (RSI).

Recently, Nintendo launched its new console, the Nintendo Wii, assuming the leadership of the new generation games, bringing to Nintendo its "original" position after 17 years [UOL JOGOS, 2007]. Nintendo Wii has a joystick called Wii remote (simply Wiimote), this device is an motion capture controller, that capture the movements made by the player while he's manipulating the controller, like an "air-mouse". [WIKIPEDIA, 2008]

Following this evolutional tendency one of the alternatives found by the game developers to make them more interactive, is the motion capture using a webcam.

Games using this technology are emerging today in the market allowing the player to control the game moving their own body according to the needs of the game. Two significant examples are the games Eyekanoid [POINT OF THE GAME, 2008] and Playdojam [PORTALCAB.COM, 2008]. In the first, the player controls the bar to hit the ball using hands movement, and it follows the movement done by the player's hand. In the second game, the player's image is displayed in the center of the screen, inside a basketball game, and the player becomes part of the game, rebutting or throwing the ball towards the basket.

A research on the motion capture technology using webcam was started, technology that had not yet been investigated in the UNIVALI's computing courses. The objective was to develop a platform to develop games based on this technology, generating as example, games using this behavior.

Initially the main focus was to acquire knowledgement on the area and to produce material for future projects. This way, the game "Coleta Seletiva" was developed, which demonstrates the operation of the technique and the interaction of the player with the game through a library that was named Barbara who uses the webcam.

The game "Coleta Seletiva", developed using the Barbara library, is an educational game aimed to children aged 4 to 6 years.

2. Related Work

A pioneering work on interaction in real time with images from the cameras is Artificial Reality of Myron W. Krueger, 1969. In this work [KRUEGER, 1991] are described and presented studies and developments on innovative ways to interact with computers through the use of human movement without the need for any hardware attached to the person. Such movements were captured by a video camera and used as input for the system.

In Videoplace [KRUEGER, 2006], Krueger has a system to allow a person to interact with virtual objects presented through graphs generated by a computer.

Krueger was able to demonstrate the potential of more than 50 different modes of interaction through his tests, through the construction of prototypes in which the person interacted with virtual objects in some way, for example, drawing pictures with your fingertips, playing in a virtual environment with a bubble, trying to follow dance moves shown on a monitor or interact with virtual balloons that float freely.

In the famous Kids Room [BOBICK, 2000], held at MIT (Massachusetts Institute of Technology), a room was developed in order to attract the attention of children and make them interact in a closed environment.

This is a children's room that tells stories through images projected on walls, lights and sound environment to increase the immersion of children in history. This study used computational vision to promote interaction with virtual objects and to control the intensity of physical effort required by children who are in the room, depending on how active they are.

This new interaction form enabled the development of a new category of computer games named "webcam games" in addition to the conventional model of interaction formed by joystick, keyboard and mouse. According to Paula, Miranda Neto and Bonini (2008), the conventional mode of interaction promotes poor posture and inactivity, in which little physical activity is carried out during the game than to cause repetitive strain injuries, or simply, as quoted by [Abraham and Nath, 2004], making uncomfortable to use for a long period of time.

So, the use of natural movements of the hand or body to control actions in a game provides a more comfortable and easy way to play (Abraham and Nath, 2004).

These and other scientific and technological evolutions enabled the concept of Augmented Reality (AR) that brings the games to the computer's virtual space of the player.

AR is the overlay of virtual objects generated by computer in a real environment, using it for some technological device [Kirn and Tori 2004 apud Zorzal ET AL 2006]. This definition of AR is part of a broader context called Mixed Reality (MR).

The concept of MR concerns the actual existence of elements belonging to the world in which users live and synthetic, created by computer, in the same environment. Depending on the way in which this combination occurs, the degree of reality and virtuality, applications are classified into different sub-areas, including Virtual Reality (VR) (also called Increased Virtuality) and AR. While in VR is a dominance by virtual objects, where an entire world is modeled by computer in AR which is the very real world is mixed with some synthetic artifacts, added in real time, in a way that they seems to belong to the environment that they are added [Milgram and Kishin, 1994 apud LIMA, 2007].

In other words, MR is the combination of real environment with the virtual environment generated by computer. It can receive two denominations: Increased Reality when the environment is the real principal, and Increased Virtuality, where the virtual environment is the main environment. Thus, the AR is a particularization of mixed reality [Zorzal et al, 2006].

Actually, AR is used in various fields of application, such as entertainment, medicine, education and maintenance (LIMA, 2007). Further on making virtual objects can be placed in real environments, the AR also allows the user to interact with virtual elements using their hands, thus eliminating complex technological devices and making the mixed interaction with the environment much more enjoyable, attractive and motivating [Santin et. al. 2004 Zorzal et al 2006].

Several programming languages have been used to create prototypes such as Java [Abraham and Nath, 2004] and the C language [Paula, Miranda Neto and Bonini, 2008] and [Zorzal et al 2006]. But in all implementations remain the need for a webcam to capture the movements of the player. These images are analyzed by a computer, processed and displayed on a monitor. There is the possibility of projecting the image generated in a wall, facilitating for the players visualization of the elements which they can interact.

Here are some webcam games examples:

- Eyekanoid (Figure 1);
- Playdojam (Figure 2);
- Flights Over Sahara (Figure 3);

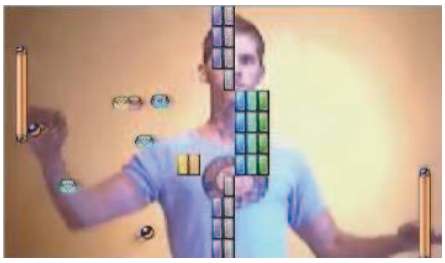

Figure 1: Eyekanoid (http://cam.playdo.com/play_eye.htm)

Figure 2: Playdojam. (http://www.playdojam.com/)

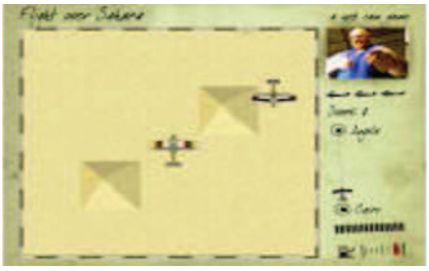

Figure 3: Flights over Sahara (http://www.motiongames.net/)

3. Development

In the game Coleta Seletiva, the child / player aim to not let the trash fall out of the game screen. The aim of the game with the observation of children in this age group, is that they knows how to interact with the tool, gathering all the falling garbage with a trash, in a coordinated manner. The game is ready to react in different ways to the garbage collected or not, but it is not necessary that the child win the game but that is in constant movement to collect the garbage, earning points.

This is a playful game that seeks only to identify the characteristic features of the garbage. The movement required is small and only horizontal, to facilitate the gameplay, since the age in question (from 4 years old) haven't the total development of motor coordination.

The game developed following the idea of games like Playdojam or Eyekanoid, but the "body" of a educational game. So the game was contextualized in the process of collection, causing the child to identify what is garbage and collecting them.

Figure 4 shows a game screenshot, where you can see the elements falling and the trash where they should be collected. The handling of the garbage is made by moving a yellow object, held in the player's hand (or a glove). The trash will follow the yellow object caught by the webcam, even if this object is the player's shirt (in which case the player needs to move from one side to the other to move the garbage).

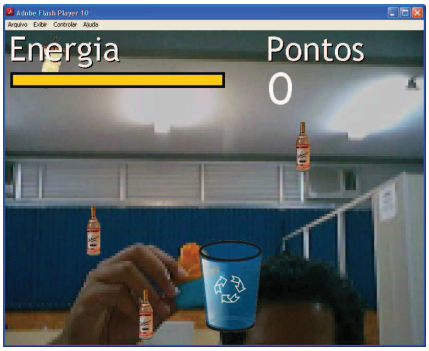

Figure 4: The game Coleta Seletiva

The choice of a yellow object to provide a reference was made to facilitate handling, as the children can more easily relate a real object with the game trash than with the own hand movement. The yellow color was chosen because it is a living color and easy to find on various objects.

There was been developed a research on the required technology to develop interactive games using a webcam. With the results of the research, the Barbara library was developed to make the object motion and color capture easier. Barbara was written in Action Script 3 programming language, using the tool Adobe Flash.

One way to motion capture by color, implemented in the Barbara library works in as follows:

- The program capture the webcam's current image
- The image is scanned, looking for items that match the color set by user.
- When an object is found, a rectangle is made using the edges of the points where the object was found.

Figure 5 shows an example of how such behavior is detected in tests performed during the project.

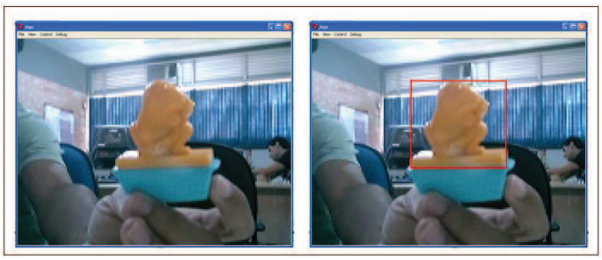

Figure 5: Object detection using colors.

4. Tests and results

Trials were made out with three different objects for the trash movement, one of them, a yellow glove, another is a glass that looks like the game trash itself, and the third is a shirt that a child was wearing. The children's reactions were different in all tests, and the glove's use was the most practical, because allowed movement freedom to children play the game, but the glass has a very interesting effect, because the children would actually pick up trash with the glass, simulating a real collection of garbage.

The use of the shirt was a different experience, because the children needed to move from side to side to collect the garbage that fell, it created an hyper active effect in some children, making them start running from one side to the other in a frenzy. This fact make the meaning of the game get lost, making the children have fun because of the moving part, and not because of the game meaning itself.

Figure 6 illustrates two pictures of the game play, during the tests made in the Colégio de Aplicação Univali, with children aged from 4 to 6 years old. In tests it's always utilized an environment with computer, webcam and multimedia projector, so the children could follow the game of the other colleague in the projection. A child that's playing interacts with the image of the monitor.

Figura 7. Tests with children of the Colégio de Aplicação Univali. - CAU

With the tests we can realize that the children interacted very well with the game, and enjoyed it even more. The fun is a part of the game and also a part of the interaction fun. Another important point is the immersion that the game created to these children and the degree of motivation generated.

Besides these aspects, the fact that there's no need of a joystick or other device, with buttons and options, made the children play more naturally, even a digital game.

5. Conclusions and Future Work

Children aged between 4 and 5 years old, sometimes, are excluded from some games, because they can't read yet, and also don't know how works input devices such as mouse, keyboard and joystick. The lack of motor coordination is a problem for children to reach the end of the game, and get unmotivated to continue playing, besides that, there is always a concern with the tool utilized to play the game, because children could drop it into the floor or break it.

The Computer Vision can help to solve this problem, making these children, to participate of the digital world and to have access to electronic entertainment.

There are several applications of this interface, guided by visual signals, to be applied in games: control of the mouse and recognition of gestures and postures. The interfaces to these features may be more intuitive to the present time and promote access for people with special needs. With this purpose, the library development has shown to be very versatile and of easy application for the development of the applicative described in this project.

Besides the library, the software developed has been tested by children of CAU Airplane Group - College Application UNIVALI, showing that it may be an ally to the development of children's motor coordination in the range of 4 years old. The children's motivation in the game was a strong point in the tests, but it still needs some adjustments in the speed of movement, size and shape of objects, fulfill needs of that children's age.

The explanation of this fact makes reference to the phrase: "general specific motor coordination" that's the kind of coordination that allows a child or adult to control the body in space, controlling the movements more harsh. Ex: Walk, Jump, crawl [GALLAHUE, 2004]. It is well developed through the Coleta Seletiva game, because the distance determined to make sure that children are well positioned with the object in webcam, makes them have to give 4 steps to be able to get of one side to another on the screen.

The tool is working as proposed: it collects the garbage, sum score, control the energy bar, the use of a yellow object in the capture of the webcam image, has reached the goal of moving the trash, and garbage randomly fall as planned.

Due to the test realized with the CAU's children, we could observe that some adjustments are necessary. Examples: The speed that the garbage falls should be reduced; the sounds emitted shall only be positive and motivating; the score, because children can't count yet, should be run with visual images or sounds; the sum and subtraction figures which were to improve energy bar, had no response differentiated from the others, showing that child that age don't have actually a need to win, but when they lose the game, they got unmotivated.

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