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WALKING IN A VIRTUAL TOWN USING NINTENDO WIIMOTE AND BALANCE BOARD

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Abstract

The main goal of the Human-Computer Interaction technology is to improve the interactions between users and computers by making computers more usable and receptive to the user's needs. The end point in the interface design would then lead to a paradigm in which the interaction with computers becomes similar to the one between human beings. This paper focuses on an application of navigation and interaction in a virtual environment using the Nintendo Wiimote and the Balance Board. The idea is to have a system of navigation control in a virtual environment based on a locomotion interface in order to make the interaction easier for users without any experience of navigation in a virtual world and more efficient for trained users. The application has been developed for the navigation and interaction in the virtual town. We chose Otranto as an example town; Otranto is located in the easternmost tip of the Italian peninsula and, due to its geographical position, the town was like a bridge between East and West. The virtual environment is a loyal representation of the town of Otranto in the Middle Ages.

Keywords

user interface, cultural virtual heritage, Nintendo Wiimote, Nintendo Balance Board

Introduction

The Human-Computer Interaction (HCI) technology is concerned with methodologies and methods for designing new interfaces and interaction techniques, for evaluating and comparing interfaces and developing descriptive and predictive models and theories of interaction.

The HCIs improve interactions between users and computers by making computers more usable and receptive to the user's needs.

Researches in HCI field focus on the developing of new design methodologies and new hardware devices and on exploring new paradigms and theories for the interaction. The end point in the interface design then would lead to a paradigm in which the interaction with computers becomes similar to the one between human beings.

The techniques for navigation within virtual environments have covered a broad kind of approaches ranging from a direct manipulation of the environment with gestures of the hands, to an indirect navigation using hand-held widgets, to identifying some body gestures and to recognize speech commands. Perhaps the most prevalent style of navigation control for virtual environments is directly manipulating the environment with gestures or movements of part of the user's body.

Some developed systems are based on a head-directed navigation technique in which the orientation of the users head determines the direction and speed of navigation [1]. This technique has the advantage of requiring no additional hardware besides a head tracker, but has the disadvantage that casual head motions when viewing a scene can be misinterpreted as navigation commands. In addition, a severe drawback of this and other head-based techniques is the difficulty to perform the common and desirable real-world operation of moving in one direction while looking in another.

Another direct body-based navigation technique is found in some systems that use sensors to measure the tilt of the user's spine or the orientation of the user's torso in order to determine the direction of the motion and to enable the decoupling of the user's head orientation from their direction of movement [2].

Another category of techniques for motion control is based on speech recognition. Speech allows a user to indicate parameters of navigation and can often be used in conjunction with gestures to provide rich, natural immersive navigation controls [3]. Speech controls should play a role in virtual environment navigation, but it is also critical to support an effective navigation based on speech-free techniques.

In the last few years, have also been developed some applications for the navigation in a virtual environment that are based on specific locomotion interfaces and system to control the navigation by walking in place.

String Walker [4] is a locomotion interface that uses eight strings actuated by motor-pulley mechanisms mounted on a turntable in order to cancel the displacement of the walker. String Walker enables users to maintain their positions while walking in various directions in virtual environments because, when the shoes move, the strings pull them in the opposite direction and cancel the step. The position of the walker is fixed in the real world by this computer-controlled tension of the strings that can pull the shoes in any direction, so the walker can perform a variety of gaits, including side-walking or backward walking.

The CirculaFloor [5] locomotion interface uses a group of movable floors that employ a holonomic mechanism in order to achieve omni-directional motion. The circulation of the floors enables users to walk in arbitrary directions in a virtual environment while their positions are maintained. The CirculaFloor creates an infinite omni-directional surface using a set of movable tiles that provide a sufficient area for walking and a precision tracing of the foot position is not required. This method has the potential to create an uneven surface by mounting an up-and-down mechanism on each tile.

Powered Shoes [6] employ roller skates actuated by motors and flexible shafts and supports omni-directional walking, but the walker cannot perform a variety of gaits. Powered Shoes is a revolutionary advance for entertainment and simulation applications, because it provides the proprioceptive feedback of walking.

To make the interaction with the virtual environments easier for users, intuitive input devices as Nintendo Wiimote and Balance Board have been used.

De Haan et al. [7] present the ~~Wii~~ Nintendo Balance Board as a low-cost interaction device that requires leaning instead of stepping and has good potentials for practical use of the navigation task in a virtual environment. By processing the sensor values it is used for both discrete and continuous input in order to drive a variety of VR interaction metaphors.

Santos et al. [8] present a user study performed to compare the usability of the Wiimote as an input device to visualize information and navigate in Google Earth. This study had the collaboration of 15 participants that performed a set of tasks using the Wiimote as an input device while the image was projected on a common projection screen, as well as a mouse on a desktop.

The Wiimote has been hacked by many people contributing to sites that collect a significant body of knowledge concerning the main technical characteristics and constraints of this device in order help the development of new custom applications.

Lee [9] presents the capabilities and limitations of the Wiimote and gives a lot of information obtained by the hacking community that has been reverse engineering the device.

Wingrave et al. [10] define Wiimote as “an imperfect harbinger of a new class of spatially convenient devices”.

The MediaEvo Project

Edutainment, a neologism created from the combination of the words education and entertainment, refers to any form of entertainment aimed at an educational role. The videogame is one of the most exciting and immediate media of the edutainment applications because the game enables a type of multisensory and immersive relationship of the user through its interactive interface; moreover, the cyberspace of the videogame is a privileged point of sharing and socializing among players.

One of the most important applications of edutainment is undoubtedly the reconstruction of 3D environments aimed at the study of cultural heritage; Virtual Reality (VR) technology permits to create applications for edutainment purposes for the general public and to integrate different learning approaches.

The building of three-dimensional renderings is an efficient way of storing information, a means to communicate a large amount of visual information and a tool for constructing collaborative worlds with a combination of different media and methods. By recreating or simulating something concerning an ancient culture, virtual heritage applications are a bridge between people of the ancient culture and modern users.

In addition, the use of the virtual models allows students to interact in a new way, using many possibilities for collaboration. A very effective way to use VR to teach students about ancient cultures is to make them enter the virtual environment as a shared social space and allow them to play as members of that society.

Today the development technologies of video games are driven by strong and ever-increasing request, but there are very few investments related to teaching usage of such technologies, they are still restricted to the entertainment context. Several VR applications in Cultural Heritage have been developed, but only very few of them have an edutainment aim.

The MediaEvo Project aims to develop a multi-channel and multi-sensory platform in Cultural Heritage and to test new data processing technologies for the realization of a digital didactic game oriented to the knowledge of medieval history and society [11], [12].

The game is intended as a means to experience a loyal representation of the possible scenarios (environments, characters and social roles) in the historic-geographical context of the town of Otranto during the Frederick Age (XIII century).

We chose Otranto as an example town; Otranto is located in the easternmost tip of the Italian peninsula, in Apulia, in the so-called Italy’s heel, due to its geographical position, Otranto was like a bridge between East and West.

Otranto was a Byzantine and a Gothic centre, later ruled by the Normans, Swabians, Anjou and Aragonese. After a long siege, on 14 August 1480 the town was caught and the Turkish army massacred the inhabitants.

The cathedral of Otranto is a Romanesque church built during the Norman domination in the 10^{th} century and on the floor there is an enigmatic mosaic done by the monk Pantaleone in the

12th century. The mosaic covers almost the entire floor of the Cathedral for over 16 metres and its size is nothing compared to the complexity of images and references that mixes Biblical narration from the Old and New Testaments with some pagan elements and others of Eastern derivation.

The implementation of an edutainment platform is strongly influenced by the definition of the scenery that is the world in which the framework is placed with the related learning objects and learning path, the characters, the scene's objects, the logic, hence, the rules of the game, the audio content, the texts and anything related to its use.

The framework will have features of strategy games, in which the decision capabilities of a user have a big impact on the result, which in our case is the achievement of a learning target. Nevertheless, the strategy and tactics are in general opposed by unforeseeable factors (provided by the game), connected with the edutainment modules, in order to provide a higher level of participation. The idea is to provide a competition between the players, during their learning process.

The system, on the basis of a well-defined learning target and eventually based on the knowledge of the user, will continuously propose a learning path (learning path composed by a sequence of learning objects), in order to allow the achievement of particular learning results.

Figure 1: Parts of the virtual reconstruction of the town of Otranto.

For the building of the virtual environment has been used the Torque Constructor editor of GarageGames that has been used to create the 3D architectural contents for the Torque 3D engine.

The Torque Constructor has proved to be an efficient tool for the direct implementation of 3D graphics models. In particular, it has many geometrical tools for the graphic processing of the reality context and different controls to select the top of the structure or individual brush model. All units made in the Torque Constructor have been imported into the Torque Game Engine [13].

Figure 1 shows some areas of the virtual reconstruction of the town of Otranto in the Middle Ages. During the navigation it is possible to find some checkpoints and interest points in order to trigger particular audio or/and video events. It is possible to surf in the virtual reconstruction of the town with a guide or to have a free surfing. Fig. 2 shows the Interest Points of the town.

The Nintendo Wii

Wii is the last console produced by Nintendo; it was released in October 2006 and, according to official data of 2010, has surpassed 70 million units sold. The reasons for this success can be undoubtedly found in the new approach that the gaming console gives the user in terms of interaction that effectively makes it usable and enjoyable by a large part of users.

The secret of this usability is the innovative interaction system; the Wiimote (word obtained as a combination of "Wii" and "Remote") replaces the traditional gamepad controller type (with cross directional stick and several buttons) with a common object: the remote control.

The Wiimote is a handheld device containing several buttons, a 3-axis accelerometer, a highresolution high speed IR camera, wireless Bluetooth connectivity and a vibration motor in a robust and easy to configure pack.

The infrared camera that sense the infrared LED of a special bar (called "Sensor Bar") and it can interpret, by means of a built-in accelerometer, the movements of translation, rotation and tilt.

The Wiimote has been equipped with a series of accessories that increase its potential, such as the Balance Board. This input device, by means of four pressure sensors at each corner, is able to interpret the movements of the body in order to control the actions of the user.

The four pressure sensors give the balance board four degrees of freedom. In practice, however, the balance board is an isometric input device and during the normal use, the balance board supports the user's weight and the user cannot increase the pressure on one sensor without also decreasing the pressure on other sensors.

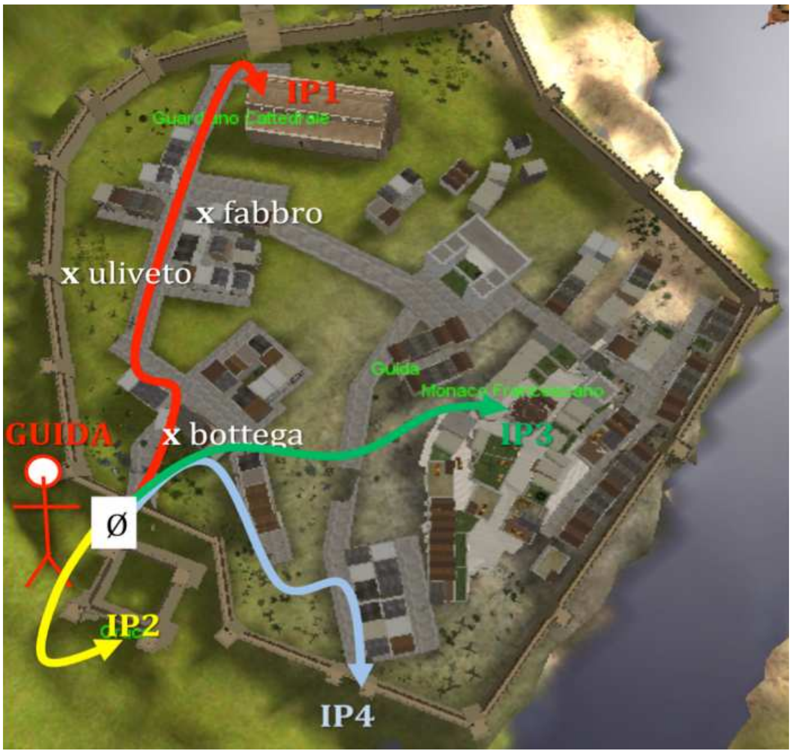

Figure 2: The Interest Points in the virtual town of Otranto

Figure 3 shows the interaction modalities of Wiimote and Balance Board. Since the frequency of communication between the Wii console and the Wiimote/Balance Board are those of the standard Bluetooth, these devices can be used as tools to interact with any computer equipped with the same technology.
Appropriate libraries have been realized in order to allow the interfacing between these devices and a computer.

The Navigation in the Town

This paper presents an application for the navigation and interaction in a virtual environment using the Nintendo Wiimote and the Balance Board. The aim is to make the interaction easier for users without any experience of navigation in a virtual world and more efficient for trained users; for this reason we need to use some intuitive input devices oriented to its purpose and that can increase the sense of immersion.

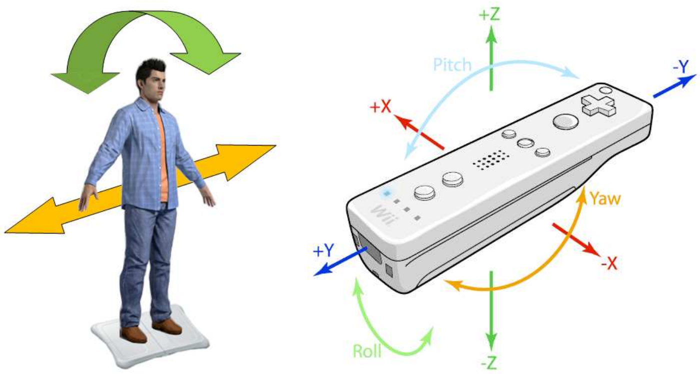

Figure 3: Interaction modalities of Wiimote and Balance Board.

Because we walk on our feet, the control of walking in virtual environment could be felt as more natural when done with the feet rather than with other modes. For this reason we used the Nintendo Balance Board as input device for the navigation. This device offers a new and accessible way to gain input and is a low-cost interface that transmits via Bluetooth the sensor data to the computer and enables the calculation of the direction taking into account the inclination of the user.

In addition, in order to implement the control of different views and to change the point of view of the user, in our application we use the Nintendo Wiimote.

A software layer that allows using the Balance Board and the Wiimote as input devices for any application that runs on a computer has been realized. The aim is to allow to receive signals and commands from the Wiimote and the Balance Board and to translate these into commands for the computer in order to emulate the keyboard and the mouse.

Figure 4 shows the use of Wiimote and Balance Board in the MediaEvo game.

The application, created to provide a new system of interaction in the virtual world of the MediaEvo project, can be coupled to any application of navigation in a virtual world.

To run the application, it is first necessary to configure the keys able to emulate any type of movement, to set the sensitivity of the Balance Board and then to connect the device. For these operations have been used some open-source libraries in C# [14]. The purpose is to simulate the use of a mouse and a keyboard starting from the properly interpreted and translated inputs received from the Wiimote and Balance Board.

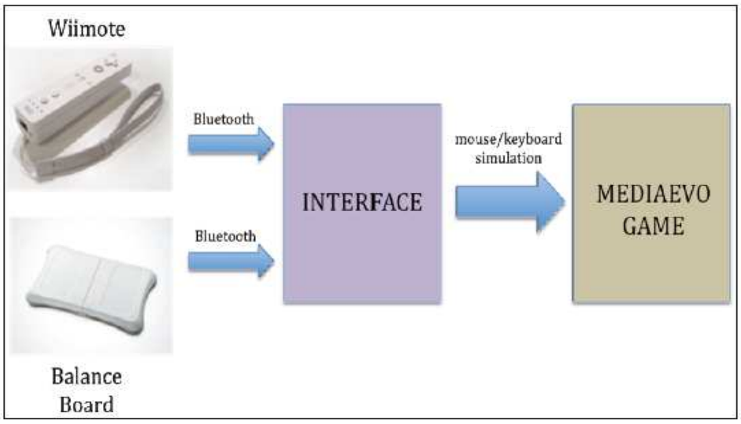

Figure 4: Use of Wiimote and Balance Board in the MediaEvo game.

The aim of the interaction by means of the Wiimote is to simulate the mouse using the two following modalities of interaction:

- "mode 1" uses the movement on the X and Y axes of the accelerometer to move the mouse (and, in the 3D environment, the user's point of view) on the longitudinal and latitudinal axes;
- "mode 2", that is the default mode, allows to move the mouse (and, then, the user's point of view) using the direction arrows of the Wiimote.

The modalities of interaction provided by the application involve the use of the Wiimote and Balance Board simultaneously. In particular, the user is able to move the avatar in the virtual environment by tipping the scales in the direction where he wants to obtain the move; an imbalance in forward or reverse leads a movement forward or backward of the virtual character, while the lateral imbalance corresponds to the so-called "strafe" in video games, where the movement is made on the horizontal axis while maintaining a fixed pointing direction of the gaze. The Wiimote, however, is used to impart the look direction of the character during the navigation in the virtual environment.

Figure 5 shows a user during the navigation in the MediaEvo virtual environment using the Wiimote and the Balance Board.

Conclusions and future work

MediaEvo Project provides a multichannel and multi-sensory platform for the edutainment in Cultural Heritage. In this paper we present an application developed in order to provide a new modality of navigation and interaction in the virtual environment of the MediaEvo Project using the Nintendo Wiimote and the Balance Board.

A future development of this application could be the conversion in an external library by adding specific methods and attributes; in this way it can be directly integrated into other applications.

Porting of the developed application in a multi-platform language in order to be used in different development environments could be another future work.

Figure 5: Navigation in the MediaEvo virtual environment.

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