Multimodal Mechanism to Promote Interaction Strategies in Games for People with Physical Disabilities

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ABSTRACT

Games share the everyday social and electronic games have conquered the market, attracted the general media attention and also the academy. But the traditional processes of interaction in video games exclude a portion of the population, afflicted by some kind of disability, due to the demands on their interaction mechanisms. Considering this scenario, this paper presents a mechanism to develop strategies for the use of mixed multimodal devices to allow handicapped people with absence of forearm to interact in virtual environments and games. To achieve this purpose the processes of interaction patterns were analyzed and mapped, regarding both, first and third person, three-dimensional games and two-dimensional games, to redirect the commands and actions to alternative devices of pointing and command, such as the Wiimote and the Myo. Such redirections were implemented and analyzed in applications adapted to use both devices as well as their main characteristics and applicability. Thus, the result obtained from this project is a multimodal mechanism for interaction in electronic games or interactive virtual environments in order to allow people with congenital or acquired absence of forearm to use such applications. The paper concludes that mechanisms that allow multimodal devices instigate technological innovations to promote the inclusion of handicapped people in society.

Keywords: virtual environments, multimodal interaction mechanism, games, assistive technology.

1 INTRODUCTION

In the health field there is always the need to seek more innovation in order to facilitate and improve the life of society. Social inclusion is a concern for all, to avoid the exclusion of disability is something that can not be ignored, the need to include disabled people in social acts is increasing. Being necessary the effort of researchers to achieve this goal turning into a reality that everyone can be included in society.

Disability, which is understood as a physical manifestation or the loss of a structure or function of the body, the inability refers to the functional plan, individual performance and the disadvantage say about the social condition of injury, resulting from the condition. The expression "person with disabilities" can be applied referring to anyone with a disability and that are under the protection of law [1].

Natural Interaction (NI) is considered a concept, almost science, which studies ways of man interacting with electronic devices through the five senses of human beings, through gestures, voice commands, body movements and expressions or detection and identification of human body parts like face, hand, thumb, retina, joints, etc [2].

With the emergence of new equipment, natural interaction is gaining prominence in games where the user interacts by means of gestures and talk to the machine.

NI became popular with the advent of games for video game, with technologies like Kinect and Wii. However, his concept is already part of fiction and scientific literature [3].

The games help in the circulation and movement of the muscles, which is something essential to the disabled, because if some muscle set is not trained and some kind of movement needs to use it, the more superficial acts can become painful for those who do not practice any kind of physical activity [4].

This work shows the development of a strategy using mixed devices that allows disabled people with the forearm absence to interact in virtual environments and games. To achieve this effect, were analyzed and mapped the pattern interaction processes, with three-dimensional games in first and third person as games with two-dimensional features, to redirect the commands and actions to alternative devices of pointing and command, such as the Wiimote and the Myo. Such redirects were implemented and analysed in applications adapted to use both devices as well as their main characteristics and applicability.

2 METHODOLOGY

In this section, studies of interaction in virtual environments and games, as well as the form of mapping in these environments are presented.

2.1 Interaction Studies in Virtual Environments and Games

In a virtual environment the interaction is an important feature for a quality experience. It is pertinent that the user is satisfied with respect to the interaction to increase attention to tasks and interest in performing them in the virtual environment.

There are a variety of game styles today that can be explored, however only the most popular ones are discussed in this section. The game style of First Person Shooter (FPS) is a type of game in the first person point of view in which you control a character freely in a scenario carrying melee weapons and firearms [5]. These games require the player to be fast and precise in their actions, where commands for movement and orientation are performed simultaneously by the left and right hands, respectively, this requires the player to make use of both hands; for players who have a physical disability in the upper limbs this prevents it from playing or limits his ability to play.

When played on the computer these games make use of the keyboard and mouse, where the movement of the character is performed through the keyboard, usually using the arrow keys (up, down, left and right) or letters (w, a, s, and d), as illustrated in Figure 1, ensuring that the character go forward, backward, to the

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left or to the right, respectively, and the orientation of the character is performed by the mouse, as shown in Figure 2.

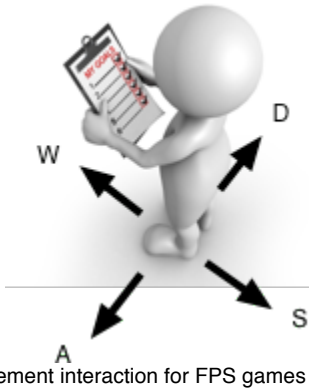

Figure 1: Movement interaction for FPS games or third person action with fixed camera, view from behind.

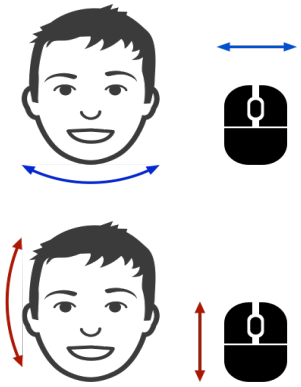

Figure 2: Mouse movement interaction in first person view mode.

The mouse can be used as a pointing device, illustrated in Figure 3, which allows the player to point to a coordinate on the screen, and set the target, where the right , left and middle mouse buttons are responsible for performing the actions such as apply zoom, shoot and switch between weapons, or select an item.

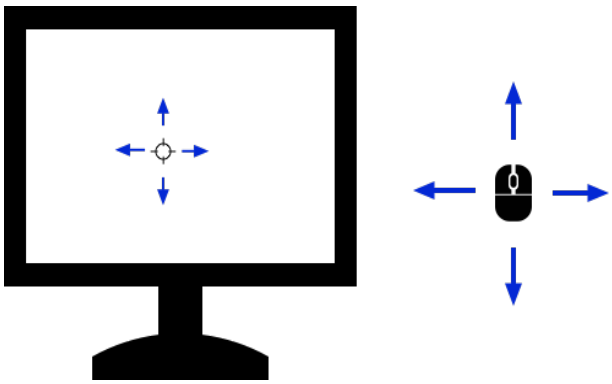

Figure 3: Interaction: Mouse as a pointing device.

Another popular style of games is the Third Person Action (3PA), where the main difference between it and the FPS is the position where the camera is placed, in 3PA the camera is located behind the character and the mouse is responsible for guiding both the camera and the character in the XY plane and only of the camera in the ZY plane, as illustrated in Figure 4. Some games that belong to this style are the Resident Evil and Tomb Raider games franchise.

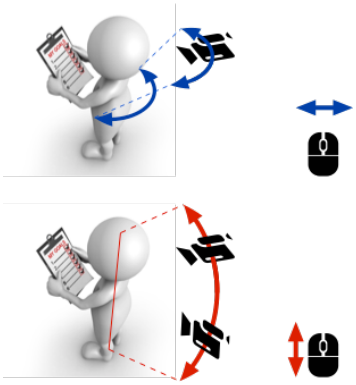

Figure 4: Mouse movement interaction for third person action games, the camera is fixed behind the character.

The developed or adapted games for video game consoles like PS4, Wii and Xbox have, basically, the same characteristics of computer games; the difference is in how the player interacts with the virtual environment. In this case the interaction between the player and the game is by means of a joystick controller, where all the actions taken in the game are executed from the touch of a button or a group of buttons, also requiring the use of both hands. The use of a joystick rather than keyboard and mouse allows that the game provides to the player a feedback on the execution of certain actions in the virtual environment, provided by means of joysticks which have the Dual Shock technology, capable to vibrate using a set of motors. In this case the interaction process is performed using the left hand to control the movementation and the right hand for orientation, and the buttons located on both sides perform actions like shoot, switch between items, use items and interact with an object.

Real Time Strategy (RTS) is another game style with great presence in the gaming world, represented by games like Command & Conquer - Red Alert 3, StarCraft: Brood War and WarCraft III: The Frozen Throne. In games of this style the player can control multiple units simultaneously, for this, the camera provides a superior view of the terrain and not just a character view. The keyboard and mouse are devices used for interaction in this environment and as well as other styles of games, it is necessary the use of both hands to play, one to point and select units, another to send the commands.

2.2 Mapping Study

In this section, are presented the studies about the forms of games mapping that are used in this work, in other words, the instruments adopted: Wiimote + Nunchuck and Myo.

2.2.1 Wiimote

The Wii Remote or Wiimote, Figure 5, is the control of Nintendo used as an input device for the Wii console and acts differently from other devices. The Wiimote is able to capture the player's movements in the real world, using an accelerometer in the X, Y and Z axes and a gyroscope to transfer them to the virtual world, as well as having a set of physical buttons and an infrared sensor.

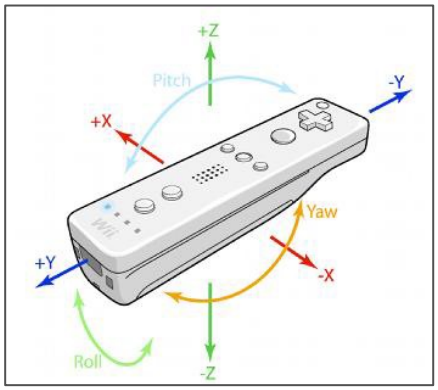

Figure 5: Movements recognized by the Wiimote [6].

The Wiimote communication is via Bluetooth, which allows devices other than the Wii able to use it, for example a computer, providing a range of possibilities for its use. Through the correct mapping of your movements, it is possible to adapt it for various applications, such as those already mentioned. For this, the Wiimote replaces the navigation actions in the virtual environment, assimilating part of the commands executed by the mouse or joystick.

Maps the movements performed in the X, Y and Z axes in Wiimote and through a transfer function they are applied to the virtual world simulating the movementation commands or the infrared sensor functionality for calculating screen coordinates, transforming on a pointing device such as the mouse. The use of the Wiimote control still allows the user to have both hands free and can be positioned on the forearm or the user's arm through a bracket, Figure 6, giving more freedom to the user.


Figure 6: Wiimotes attached by armbands in the arm and forearm [6].

2.2.2 Myo

The Myo is a wearable with bracelet format. This device can control applications by gestures and interact with computers and other similar digital media, recognizing electrical impulses in the user's muscles. Also, it does not require cameras to track the movements of the hand or arm and has a low cost [7].

The Myo is used in the user's forearm, as can be seen in Figure 7. It is necessary to perform a calibration for each specific user, because each one has specific activities and muscle contractions. After performed the calibration, the wearable allows the control of softwares and other applications through gestures and movements. Its purpose is to control computers, phones and other devices, sending data captured by it via Bluetooth [7].


Figure 7: Wearable Myo [7].

2.3 Development

Game development is a complex task that demand developer's multidisciplinary, technological and advanced mathematical knowledge, such as physical simulation, computer graphics, collision detection, input and output management, among others.

In order to provide focus on the tasks proposed in this work it was used the game engine Unity 3D as core system, together with input and output plugins to capture the information of Myo and Wiimote + Nunchuck devices and a dynamic script system to perform the mappings of the commands or information captured in devices for the game.

2.3.1 Unity 3D

The Unity3D engine is a multiplatform game engine developed by Unity Technologies. Its distinguishing feature is the cross-platform compatibility, even with mobile devices and web environments . The Unity engine was written in C/C++, with the development of games allowed only in the languages C#, Javascript and boo, but, as provided by the .NET framework, it has the feature to allow the attachment of scripting engines in other languages that share the subsystem CLI from Microsoft[1].

The project uses the Unity 3D as core system, responsible for tasks such as communication with input and output devices, in addition to provide the interface with the script system [8].

In Figure 8, there is a scenario example for games developed in Unity 3D software.


Figure 8: Game scene in Unity 3D.

[1] www.microsoft.com - acesso em 05/06/2016

2.3.2 Unity Plugins

One of the main features in choosing the Unity 3D is the mechanism of plugins that the tool provides. This way you can easily attach a set of features to perform complex tasks.

The project uses three specific plugins, the UniWii and the Myo plugin to communicate with the WiiMote+Nunchuck and Myo input and output devices, respectively, and the plugin to communicate with the Python[2] programming language, which uses the .Net implementation, IronPython.

The UniWii plugin implements all sensor and buttons reading processes. It also provides the routines to calculate the screen mapping from infrared emitters to provide the pointing device feature.

This way it is possible to calculate the device orientation or movement by means of the accelerometers, verify if some button was pressed and calculate where in the screen the device is pointing [9].

The Myo plugin implements the processes for the device sensors reading to allow the developers to verify which pose was triggered, if the accelerometers detected acceleration in some direction, or what is the device orientation indicated by the magnetometer.

A component responsible to retrieve the input devices readings and features to redirect those readings to the script system was developed in order to aggregate all of the features and provide the developers a ready to use solution.

2.3.3 Script System

The script system implements the architecture for quick game production, a software layer that splits the logic and the programming with the feature of feedback commands towards the application Kernel developed by Unity 3D [9].

The script mechanism is instantiated in a component that implements the singleton design pattern [10], which guarantees only one instance of an object of the specified class and implements the object visibility for the system.

This process main goal is to abstract the development of the input-output interaction devices, specially the Myo and Wiimote+Nunchuck, from the game developer in order to make the development and command mapping easier.

This way a configured Myo pose can be mapped to a specific button just by configuring the mapping script.

3 Results

Within the context of the data and analysis presented the project has, as result, the multimodal mechanism that integrates the devices Myo and Wiimote+Nunchuck and provides an easy configuration procedure to allow the development of applications that can use the features this mechanism provides in terms of interactivity to offer accessibility to people with absence of forearm.

The Wiimote can be attached to the prosthesis and function as the pointing device while the nunchuck is used for the movement of the character. Due to the disability the wiimote buttons are inaccessible to the user so, to overcome this obstacle, the Myo armband poses act as the buttons and perform the remaining actions within the virtual environment; all this process can be easily configured due to the script system that guarantee the game to be developed in Unity 3D, with the mapping being done in a per user case.

[2] www.python.org - acesso em 05/06/2016

4 Conclusion

Game engines turn the task of developing games easier, allied to the advances in interaction equipment or mechanisms it allows researches so that several of these devices can be simultaneously used in order to provide disabled people, formerly excluded from the activity of video game play, to participate in this practice.

The mechanism made easier the integration between the two distinct device categories, each substituting functions of a fundamental device to interact in games, the pointing device and the command device, in case of PCs, represented by the *mouse*, freeing the programmer from coding the device data retrieval routines.

5 Future Works

With these results the main goal of the group is to provide a mechanism that promotes the inclusion of disabled people in activities with ludicrous characteristics. A future pertinent activity is to directly map, in the operating systems, the device redirection configuration in order to allow that players that could not do it before can play commercial games that do not use the mechanism proposed here.

Finally, this mechanism provides a pertinent mean to develop researches in areas like physical therapy or rehabilitation for people with disability.

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