2015 International Nuclear Atlantic Conference - INAC 2015
São Paulo, SP, Brazil, October 4-9, 2015
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
***ISBN:* 978-85-99141-06-9**

TANGIBLE INTERFACES IN VIRTUAL ENVIRONMENTS, CASE STUDY "INSTITUTO DE ENGENHARIA NUCLEAR VIRTUAL"

André Cotelli do E. Santo[1,3], Antônio Carlos A. Mól[1,3], Daniel Mol Machado[2], Emanuele Oliveira Pinto[1,4], João Victor da C. Melo[1,4], Vanessa Márcia de Paula[1,3], Victor Gonçalves Glória Freitas[1]

[1] Instituto de Engenharia Nuclear (IEN / CNEN - RJ)
Rua Hélio de Almeida, 75
21941-906 – Rio de Janeiro, RJ

[2] Instituto Alberto Luiz Coimbra de
Pós-Graduação e Pesquisa em Engenharia - COPPE
Universidade Federal do Rio de Janeiro
Avenida Horácio Macedo, 2030
21941-914 Rio de janeiro, RJ

[3] Centro Universitário Carioca (UniCarioca)
Avenida Paulo de Frontin, 568
20261-243 – Rio de Janeiro, RJ

[4] Colégio Pedro II
Campo de São Cristóvão, 177
20921-903 – Rio de Janeiro, RJ

1. ABSTRACT

Virtual Reality (VR) techniques allow the creation of realistic representations of an individual. These technologies are being applied in several fields such as training, simulations, virtual experiments and new applications are constantly being found. This work aims to present an interactive system in virtual environments without the use of peripherals typically found in computers such as mouse and keyboard. Through the movement of head and hands it is possible to control and navigate the virtual character (avatar) in a virtual environment, an improvement in the man-machine integration. The head movements are recognized using a virtual helmet with a tracking system. An infrared camera detects the position of infrared LEDs located in the operator's head and places the vision of the virtual character in accordance with the operator's vision. The avatar control is performed by a system that detects the movement of the hands, using infrared sensors, allowing the user to move it in the virtual environment. This interaction system was implemented in the virtual model of the Instituto de Engenharia Nuclear (IEN), which is located on the Ilha do Fundão - Rio de Janeiro - Brazil. This three-dimensional environment, in which avatars can move and interact according to the user movements, gives a feeling of realism to the operator. The results show an interface that allows a higher degree of immersion of the operator in the virtual environment, promoting a more engaging and dynamic way of working.

1. INTRODUCTION

With the evolution of technology, computers are increasingly present in our lives and playing a key role in many of our everyday tasks, being incorporated into an increasing number of devices and providing new forms of man-machine interaction [2]. Created by researchers in the field of human-computer interaction (HCI), the concept of tangible interfaces can be considered relatively new in computing. This type of interface can be seen by our society with increasing frequency. With the development of new technologies, these interfaces are undergoing a growing emphasis on their usability to better serve the needs of users [13]. Tangible interfaces introduce new forms of interaction that can be more natural to humans and can be applied in various fields, including nuclear facilities.

The most widespread application of tangible interfaces is the use of physical objects to model various kinds of physical systems [3]. For example: to describe the layout of assembly lines [4], optical systems [11], buildings [12], furniture [4]. Tangible user interfaces are broadly concerned with giving physical form to digital information. At the highest level, there are two basic facets of this approach. First, physical objects are used as representations of digital information and computational operations. Secondly, physical manipulations of these objects are used to interactively engage with computational systems [8].

This work presents the development of a specific tool to the nuclear field, employing VR techniques and tangible Interfaces. This tool allows the improvement of virtual nuclear facilities in order to provide a more realistic and immersive environment for training and simulation purposes. Specifically, the work aims to present a system of interaction in virtual environments without the need of traditional peripherals such as mouse and keyboard.

2. METHODOLOGY

The virtual model of Instituto de Engenharia Nuclear (IEN), located in Rio de Janeiro, was developed using the programs: Autodesk 3Ds Max and Unity 3D. The Unity 3D software was responsible for the modeling of virtual environment, where simulations will occur, and the 3Ds Max for the three-dimensional modeling of existing buildings in IEN. It is important to note the presence of the Oculus Rift, that gave more realism to the created virtual environment bringing more immersion to the user. Finally, the use of Leap Motion device provided a new form of interaction in the virtual environment.

The follow will describe all these tools used during the development of this work.

2.1. Autodesk 3Ds Max

3Ds Max is a software to three-dimensional modeling that allows the user to perform rendering of images and animations [6]. It is widely used in production of electronic models, the creation of characters and objects in 3D, creating animated films among other virtual models. When using and applying virtual textures on objects you can assign different surface properties such as gloss, clarity, irregularities. shadow. It is also possible to simulate the lighting of the Sun and moon, for example.

3Ds Max was used to model in three dimensions the external structure of the buildings at Instituto de Engenharia Nuclear (IEN), following their respective real measurements (height, width and length). The figure below shows one building of the IEN being built using this tool.

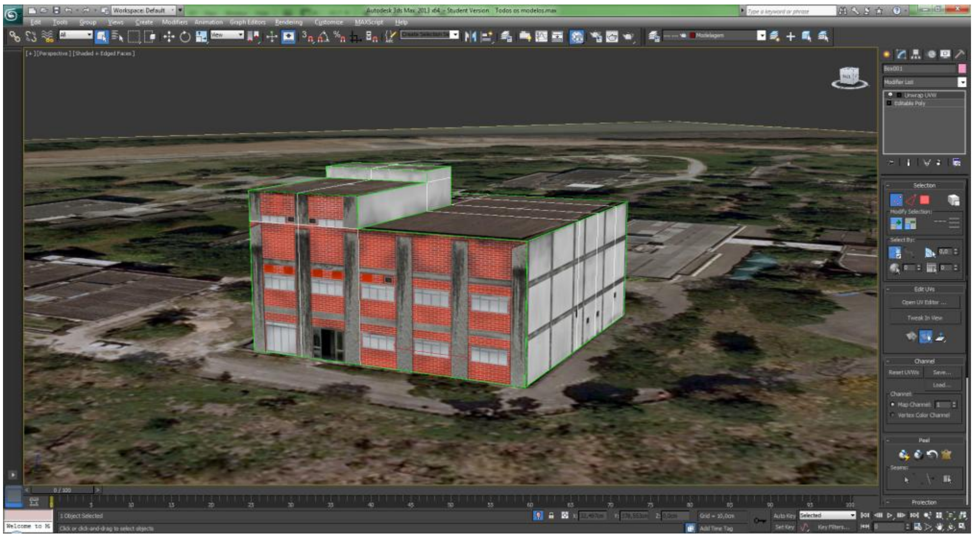

Figure 1: Modeling a building using 3Ds Max. environment

2.2. Unity 3D

Unity is a game development ecosystem: a powerful rendering engine fully integrated with a complete set of intuitive tools and rapid workflows to create interactive 3D content; easy multiplatform publishing [1]. The software is considered to be multiplatform, because it is able to produce applications in numerous devices, such as: computers (PC, Mac or Linux), mobile phones, tablets, virtual reality helmets, televisions, etc. In addition to all this, Unity offers two options for language work, C# or JavaScript.

By default, this tool incorporates multiple software that assist in the development of 3D content, like libraries intended for physical insertion to environments, lighting and interactive audio. Thus, the tool allows the centralization of functions required in creating games, making the programmer to develop applications without concern for compatibility between different systems, in a simple, integrated and transparent manner [5].

With the Unity 3D, the external environment in IEN was modeled, also inserting vegetation, ambient light, natural light (day and night) and avatar (character). Allowing so that the virtual environment resemble the real world, Fig. 2.

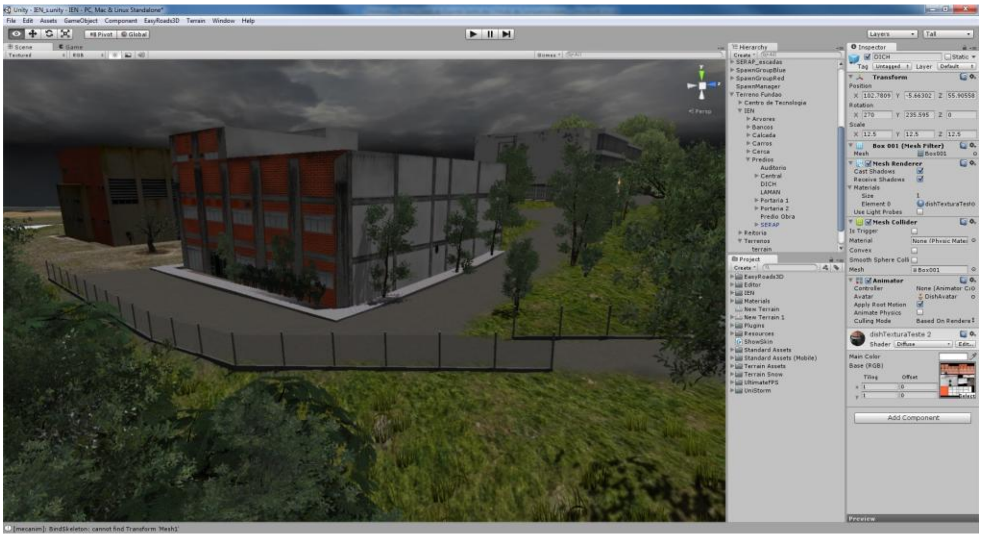

Figure 2: Virtual model of the IEN.

2.3. Oculus Rift

Oculus Rift is a virtual reality equipment for electronic games. Basically, it's a visual system Head-mounted display type. It can also be consider an augmented reality glasses for those who like games, developed by Oculus VR [10]. It is a device that promises to take 3D applications to the next level. It projects three-dimensional images on an LCD screen with the assistance of the accelerometer and gyroscope recognizes the user's head movements. The virtual reality helmet, Fig. 3, is being explored in several other fields, such as: education, health, housing market and others.

Figure 3: Oculus Rift[10].

By using this helmet, it was possible to reproduce a stereoscopic virtual environment with a greater degree of realism. When the user rotate the head, in any direction, makes it possible to observe details of the scenario, giving the feeling of immersion into the virtual world of the Instituto de Engenharia Nuclear.

Another point that drew attention was that when using the helmet, which displays a three-dimensional stereoscopic image (Fig. 4), there was no eyestrain or headaches, something that occurs frequently when watching TV or movies in 3D.

Figure 4: Stereoscopic view of the oculus rift [10].

2.4. Leap Motion

Leap Motion is a small device consisting of a sensor capable of capturing the ten fingers movements of the user, and may also be considered as an optical tracking system based on stereoscopic vision, Fig. 5. These device allows you to control objects in the virtual environment with your own hands, as if you were physically in the environment, giving sense of immersion. The device uses infrared cameras to capture accurate and simultaneous movements of the fingers within hundredths of a millimeter [9]. In addition, the latency is non-existent for human eyes, being lower than the refresh rate of computer monitors.

Figure 5: Leap Motion [9].

The sensor is easy to use, since it stands out for operating instinctivity and simplicity of installation [7]. After the equipment, which is the size of a flash drive, detect the user's hands any movement is automatically recognized by the device, Fig. 6.

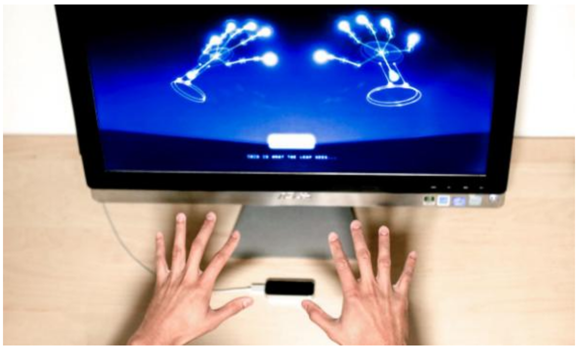

Figure 6: Leap Motion detecting the user's hands [9].

This equipment was used in the virtual environment to give more realism while moving the character. The sensor was added to the virtual environment to move the avatar in the scenario using only the user's hands instead of the traditional forms, such as: the mouse and the keyboard. By placing a hand in front of the sensor, this is detected, making the virtual character able to move. When the user performs a slight rotation in hand, the avatar is also rotated around its axis, in the virtual environment.

3. RESULTS

Figures 7 and 8 presents the virtual environment developed. It is also possible to see how the Oculus Rift was used to give more realism and stereoscopic vision of the modeled environment. Finally, the Leap Motion was responsible for the movement of the avatar with the shifting of the user's hand.

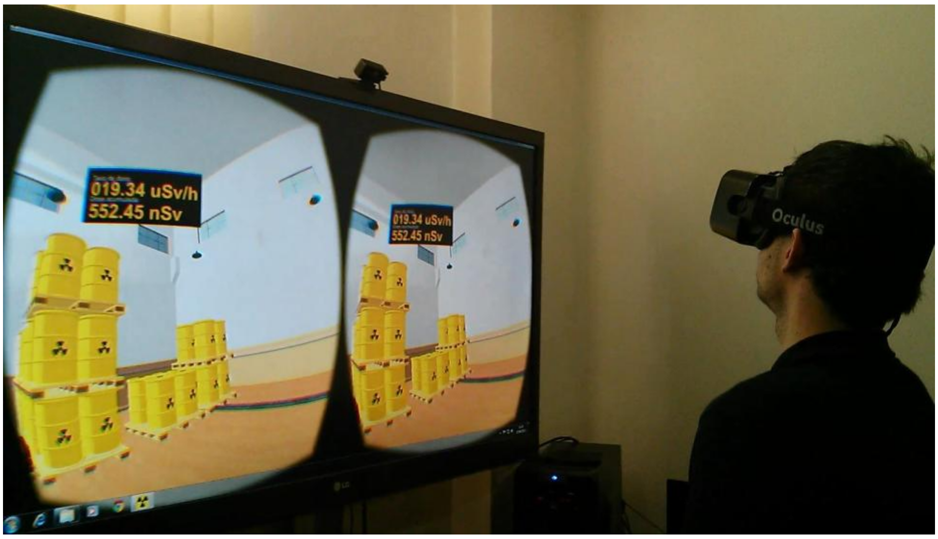

Figure 7: Stereoscopic view of the IEN.

Figure 8: Oculus Rift View and Leap Motion Detecting Hands.

4. CONCLUSIONS

This work showed the feasibility of using virtual reality to create virtual environments. This new technology presents the ability of these new equipment has to reproduce a virtual world of a real environment, which can be used for security training, information about nuclear energy, virtual tour in a nuclear facility, among others. With the Oculus Rift and the Leap Motion, this interaction between the real world and the virtual occurred in a more intense manner. The feeling when the user uses the Rift and Leap Motion is total immersion, getting a degree of realism in 360º. These new forms of interaction allows the user the possibility to interact with the virtual environment without using the mouse or the keyboard, being totally immersed. Future work may address the use of this technology to assist in the training of more specific tasks, placing the user fully immersed in the virtual environment using the Rift and Leap Motion, to perform functions and evaluate their performance without putting anyone at risk, since it will be done in a controlled environment reducing the cost of training.

ACKNOWLEDGMENTS

This research was sponsored by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES and Conselho Nacional de desenvolvimento Científico e Tecnológico - CNPq. Our thanks also to the Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro - FAPERJ and Comissão Nacional de Energia Nuclear - CNEN, that, through the Instituto de Engenharia Nuclear - IEN, has provided all necessary resources to the development of this work.

REFERENCES

1. BLACKMAN, S.; *Beginning 3D Game Development with Unity 4: All-in-one, multi-platform game development*. Apress, New York, United States of America (2013).

2. DOURISH, P.; *Where The Action is: The Foundations of Embodied Interaction*. The MIT

Press, USA. (2001).

3. FITZMAURICE, G.; ISHII, H.; AND BUXTON, W.; *Bricks: Laying the Foundations for Graspable User Interfaces*. In Proceedings of CHI'95, pp. 442-449. (1995).

4. FJELD, M.; BICHSEL, M.; RAUTERBERG, M.; *Build-It: An Intuitive Design Tool Based On Direct Object Manipulation*. In: Gesture and Sign Language in Human-Computer Interaction, Vol. 1371, pp. 297-308. (1998).

5. GOLDSTONE, W.; *Unity 3.x Game Development Essentials*, Packt Publishing, New York, United States of America (2011).

6. HARPER, J.; *Mastering Autodesk 3ds Max 2013*, Sybex, Camp Hill, United States of America (2012).

7. HODSON, H.*; Leap Motion Hacks Show Potential of New Gesture Tech*. New Sci., Vol. 218, 21p (2013).

8. ISHII, H.; *The Tangible User Interface and its Evolution*. Communications of the ACM, Vol. 51 (2008).

9. LEAP MOTION CONTROLLER. In: <https://www.leapmotion.com> (2015).

10. OCULUS VR; In: < https://www.oculus.com/> (2015).

11. UNDERKOFFLER, J., ISHII, H.*; Illuminating Light: An Optical Design Tool with a Luminous-Tangible Interface*. In Proceedings of CHI'98, pp. 542-549 (1998).

12. UNDERKOFFLER, J.; ISHII, H.; *Urp: A Luminous-Tangible Workbench for Urban Planning and Design*. In Proceedings of CHI'99, pp. 386-393 (1999).

13. WEISER, M.; GOLD, R.; BROWN, J.; *The Origins of Ubiquitous Computing Research at PARC In The Late 1980s*. IBM Systems Journal, Vol. 38 (1999).