Virtual Environments for Studies of Nuclear and Radiological Emergencies

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ABSTRACT

For resilience engineering and ergonomics, complex systems must be studied from the understanding of the variability occurring within and around the system. It is necessary to consider since the microscopic interactions located inside of organizations to the macroscopic context of the organization and where it fits. Therefore this article aims to create a tool to reproduce virtual environments for studies of nuclear and radiological emergency response from the perspective of resilience engineering and ergonomics.

Keywords: Virtual Environments, Nuclear Engineering, Resilience, Ergonomics, Emergency Management.

INTRODUCTION

The management of emergency situations is a complex problem, it involves in addition to technology, social and organizational aspects. This problem is compounded by the risk of loss of human lives. Industrial accidents such as the Chernobyl accident radioactive (1986) and Goiânia (1986) in addition to terrorist attacks such as the attack on the World Trade Center (2001) show how important it is to have a modern emergency management. Although generated by completely different factors, the emergency management mentioned had similar problems, which serve as reference for a more accurate study of coordination, control and decision-making in this type of context. Future events of great concentrations of people, such as the World Cup in 2014 and the Olympics in 2016 (to be held in Brazil), reinforcing the importance of this issue, and motivate this project. On the other hand, the Resiliency Engineering aims to study the development of devices for improving resilience in organizations. It provides a conceptual framework to study, develop and provide appropriate solutions for emergency management in complex systems (Marconi et al. 2008, Woods 2006]. Resiliency is a concept from physics, which defines the property of materials to absorb tension and turn them into harmful deformations or not to the material (Blackman 2013). However, in recent years, several other areas of knowledge such as economics, engineering, psychology, physiotherapy and ecology incorporated the resilience concept to their studies. In the organizational context, resilience seeks to relate that forms the productive tensions within organizations promote deformations in operational processes. Thus, it can be considered to study, develop and provide solutions to complex problems such as emergency management is an issue of current and relevant research to science (Blackman 2013, Woods 2006).

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For resilience engineering, complex systems should be studied from the understanding of the variability occurring within and around the system, always considering the existing dialectic between micro - people's work and the use of technologies, and the macro - the context organizational.

Therefore, this article aims to incorporate aspects of ergonomics and human factors on verification and validation of command and control systems design, with the development of technologies the decision in nuclear and radiological emergency response, through the creation of virtual environments.

RELATED WORKS

Some works have used recently, Virtual reality (RV) to perform simulations and trainings. We can mention, among them, the work done in LabRV of the IEN (Laboratório de Realidade Virtual – Instituto de Engenharia Nuclear, collaborator of this project).

- *Sistema de Realidade Virtual para Treinamento de Evacuação*. With this system it is possible to perform training and simulation of evacuation sites with large concentrations of people. Using the core game of Unreal Engine 2 Runtime where the system was adapted to comply with the speed of locomotion of the avatars according to patterns close to human standards. This system can be controlled in network, where multiple users can interact at the same scenario, providing evacuation trainings veracity (Augusto et al. 2007).

- *Sistema de Estimativa de Dose em Ambientes Virtuais.* This system aimed to develop a tool for creating virtual environments for reproduction of nuclear facilities, giving the user the ability to virtually walk through the installation and accounting their receipt of radioactive doses (Carvalho et al. 2009).

VIRTUAL REALITY

Recently, Virtual Reality, also known as VR, can be considered a huge potential technology and applicability in diverse areas of human knowledge, being able to use it since training, simulations and virtual experimentation. Every day we can find many uses for this tool immersive.

The VR enables the integration of three basic ideas: involvement, immersion and interactivity. The involvement may be seen as the degree of motivation of the user with the activity performed, the immersion is associated with perception, feeling of being present in the environment and the interaction of the user with the ability to manipulate virtual objects (Ródenas et al. 2005).

The set of technologies, techniques and interface modes that enable the sensitive integration of a computer system, user, and immersion in a virtual environment can be called Virtual Reality (Ródenas et al. 2005).

Virtual Environments

In this environment occurs the simulation of reality and it is where the representative scenarios are constructed. Virtual environments can be considered scenarios where it is possible, through an avatar (representation of a person in a virtual environment), move in the virtual world, interacting with elements, objects and even other avatars (Goldstone 2001).

PHYSICAL SECURITY

Physical security is essential in protecting against a number of risks and vulnerability reduction. The risk analysis will dictate the level of physical security measures necessary. These range from cleaning, site maintenance and the physical barriers closed-circuit cameras, it may be necessary to use more sophisticated technologies such as presence detectors, substances or radiation (Harper 2012, Mól et al. 2009).

The awareness of those involved is of paramount importance because it is the workers who know their respective workplaces, and can provide important information about potential vulnerabilities. Employees should also be trained to report to security team abnormal events such as suspicious behavior, strange people at the service, dropped packages and foreign objects in trash cans (Harper 2012 , Mól et al. 2009).

NUCLEAR SECURITY

In the broader sense, the term Nuclear safety refers to a series of measures implemented by States and international organizations to ensure safety in the handling, use and storage of radioactive materials (Carvalho et al. 2009, 2001).

In the restricted case of this article, shall mean Nuclear Security as the number of reasonable and necessary measures to prevent individuals from coming into possession, and makes use of radioactive materials in attacks against the state, authorities or the general public. These measures must ensure that radioactive materials do not leave their repositories without authorization, do not get lost when in transit and do not get access to places likely to be targets of attacks.

In view of recent terrorist attacks in several countries, the international community recognizes that new and more powerful measures should be taken to protect and readiness for a range of attack scenarios involving nuclear terrorism.

METHODOLOGY

In this article researchers utilized Virtual Reality Techniques (VR) to the modeling of the Instituto de Engenharia Nuclear (IEN), which is located on Ilha do Fundão – Rio de Janeiro – Brazil. With the use of 3ds Max software was possible to model the three-dimensional buildings present in the institute, and with the Unity 3D create the virtual world where simulations will occur.

The follow will describe the tools used in the construction of the virtual environment.

Autodesk 3ds Max

The first program to be described is 3ds Max, which is developed by Autodesk, and the version used for the realization of this work was the 2013. 3ds Max is a three-dimensional modeling software that offers a complete solution for modeling, animation, simulation and rendering for 3D games and animated graphics that enable artists and designers to quickly increase your productivity (Carvalho et al. 2006).

Making use of 3ds Max, the external structure of the buildings of the Instituto de Engenharia Nuclear (IEN) could be modeled in three dimensions, following their respective actual measurements (height, width and length). The figure 1 shows the building of the Divisão de Confiabilidade Humana (DICH) being built using this tool.

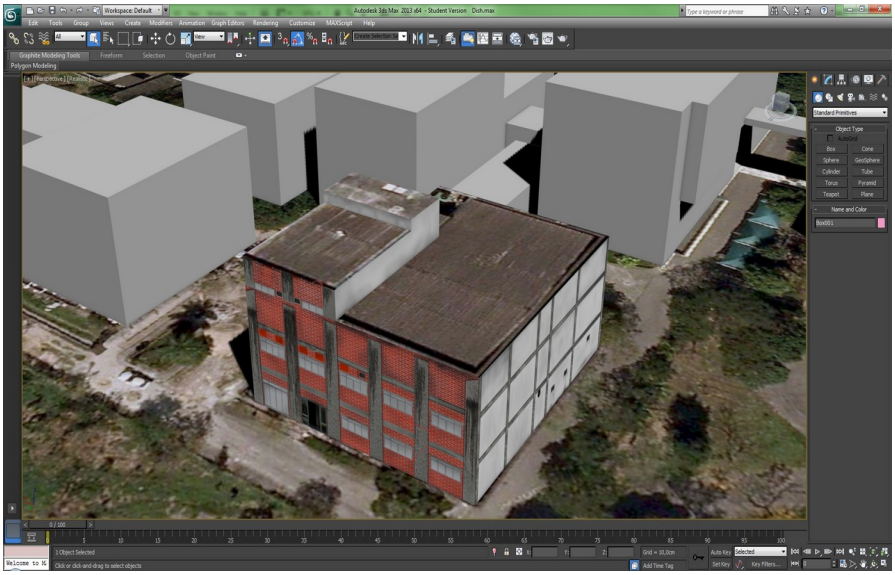

Figure 1 - Modeling a building using the software 3ds Max.

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; thousands of quality, ready-made assets in the Asset Store (Mól et al. 2008). Beyond all this, the Unity provides three options to work with C #, JavaScript or Boo.

Unity Asset Store, also known as resources store, saves time and effort during the development of a game, with free and commercial tools created both by Unity Technologies, as well as community members. The store has a wide variety of resources available, containing from textures, models and animations to sample projects, tutorials and extensions of the Editor. These features are accessed through a simple interface present in the Unity Editor and are downloaded and imported directly into your project (Stanney 2002).

The software made it possible to develop a virtual model of the Instituto de Engenharia Nuclear (IEN), creating the external environment around the buildings as can be seen in figure 2.

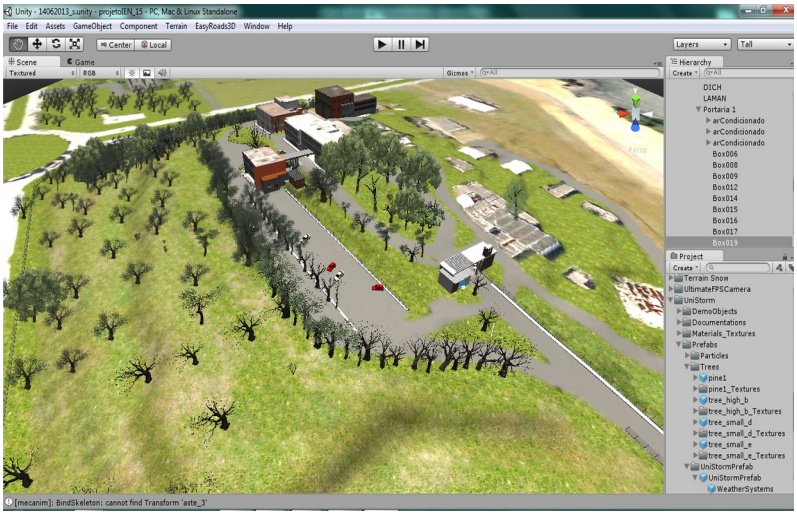

Figure 2 - Virtual model of the IEN.

With Unity, virtual cameras were positioned to be used in monitoring the environment as can be seen in figure 3.

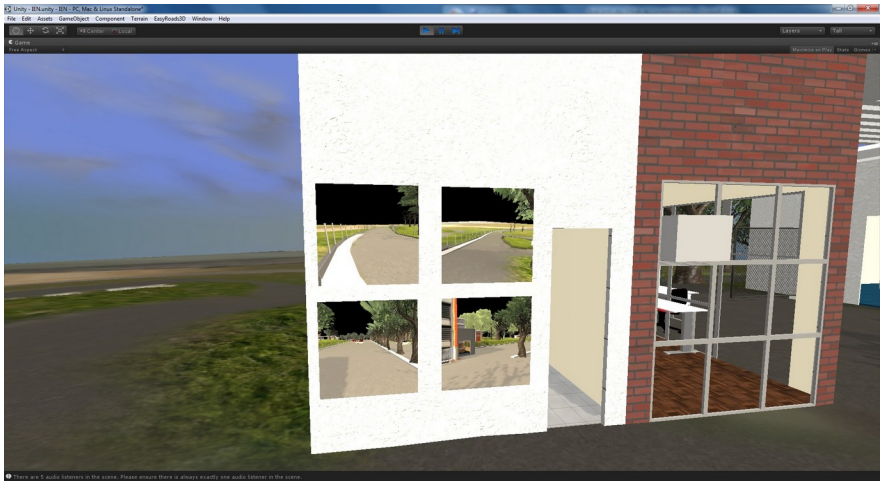

Figure 3 - Virtual cameras image being displayed on the monitors.

RESULTS

Figures 4a and 4b show the comparison between the Instituto de Engenharia Nuclear - IEN and the virtual environment, using the characteristics of the real model.

With the software running is possible to check the realism given to each component used in the construction of virtual IEN, figure 5.

In order to maintain the visual identity of the nuclear site, the proportions of the buildings as well as its position within the site were reproduced with greater degree of realism, figures 6a and 6b.

Figure 4a - IEN picture taken from Google Earth.

Figure 4b - Image of virtual model of the IEN.

Figure 5 - Reproduction of the software running.

Figure 6a - Building on the IEN installation.

Figure 6b - Corresponding virtual model building.

CONCLUSIONS

This work showed the possibility of using virtual reality for the development of a tool to improve the physical security of nuclear facilities. Once the security planning of these facilities is an extremely complex task, but absolutely necessary. With this tool, it is possible to visualize and plan action strategies, without interrupting the operation of the facility. Therefore, can be used for security training and simulations, as well as providing an evaluation and assistance in the removal process of people. Future improvements, such as internal modeling of buildings, the environment around the IEN and development of systems to assess the quality of each character's

actions in with goals and objectives to be achieved during the simulation, which may make this a more efficient tool.

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