Progress in Nuclear Energy 78 (2015) 19–24

Contents lists available at ScienceDirect

Progress in Nuclear Energy

journal homepage: www.elsevier.com/locate/pnucene

Using virtual reality to support the physical security of nuclear facilities

Márcio Henrique da Silva*, André Cotelli do Espírito Santo, Eugênio Rangel Marins, Ana Paula Legey de Siqueira, Daniel Machado Mol, Antônio Carlos de Abreu Mol

Comissão Nacional de Energia Nuclear, Instituto de Engenharia Nuclear, Rua Hélio de Almeida, 75, Ilha do Fundão, P.O. Box 68550, 21941-906 Rio de Janeiro, RJ, Brazil

A R T I C L E I N F O

Article history:
Received 5 June 2014
Received in revised form
8 July 2014
Accepted 12 July 2014
Available online 15 August 2014

Keywords:
Virtual reality
Physical security
3D modeling

A B S T R A C T

The Brazilian nuclear program has reinforced the importance of improving the physical security of nuclear facilities located in this country. Thus, the present work proposes the development of a new tool that allows the user to make interactions inside a virtual environment, which simulates the nuclear facility's structure, in order to aid on planning action strategies to improve its security. For such, a virtual model of the Brazilian nuclear research center known as Instituto de Engenharia Nuclear (IEN), located on Ilha do Fundão – Rio de Janeiro was developed. It is defined as a 3D model with a high degree of fidelity to the real environment in which it is based. Inside this model, characters known as avatars can move and interact in real time. Situations that could affect invader's visibility and detection such as natural and artificial illumination, climate and shadows can be represented with realism. In addition, the tool has a virtual CCTV surveillance system that allows environment supervising. Thus, the system makes possible strategies simulation, allowing an evaluation of the performed procedures as well as assisting in the training of security personnel in nuclear and radioactive installations.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

Nuclear safety refers to a set of procedures implemented by countries and international organizations in order to assure a security pattern concerning to handle, use and storage of radioactive materials (IAEA, 2006). The security of facilities that are used to store or generate such materials must be performed with great attention. Moreover, it requires strategies that must be created, tested and improved to keep these materials and all information related to the total amount of nuclear material and its location away from terrorists or hostile nations.

The development of strategies like that demands time, financial resources and the engagement of a large group of people. For this reason, they need to be tested in exercises simulating real situations to know if there is compatibility between the theoretical defense plans and the real conditions of the nuclear facility.

Therefore there is a need to evaluate parameters like the nuclear facility's ground topology; the visibility level of the its area and borders; the number of members compounding the defense crew (security agents); equipments for detection of radiation and the time spent to reach a compromised position, just to give some examples (Stackpole and Oksendahl, 2010).

Concerning to this matter, the use of Virtual Reality (VR) techniques on planning the actions related to the safety strategies can contribute to improve the simulated results as shown in (Gatto, 2012), (Mól et al., 2008a), (Freitas et al., 2011), (Gonçalves et al., 2010), (Aghina et al., 2007), (Mól et al., 2008b), (Jorge et al., 2007), (Louka et al., 2005), (Mól et al., 2007), (Mól et al., 2008c), (Jorge et al., 2011) and (Xi et al., 2009).

Thus, this work proposes the development of a computational model using virtual reality techniques which is intended to describe as detailed as possible a real nuclear facility in order to perform simulations of physical security strategies. The objective is to analyze the feasibility on using software for development of games to create such model, described as a virtual environment, which will be used as a study auxiliary tool to define security strategies for nuclear facilities. The paper is organized as follows: Section 2 describes virtual reality basic concepts, virtual environments and avatars.; Section 3 presents the methodology employed in this work;

* Corresponding author. Tel.: +55 21 2173 3700; fax: +55 21 2590 2162.
E-mail addresses: marciohenrique@lmp.ufrj.br (M. Henrique da Silva), cotelli.andre@gmail.com (A. Cotelli do Espírito Santo), eugenio@ien.gov.br (E.R. Marins), analegey@hotmail.com (A.P. Legey de Siqueira), machado.mol@gmail.com (D.M. Mol), mol@ien.gov.br (A. Carlos de Abreu Mol).

http://dx.doi.org/10.1016/j.pnucene.2014.07.004
0149-1970/© 2014 Elsevier Ltd. All rights reserved.

Section 4 discuss the tests with the results and analysis, considering proportionality, different vision angles and the time displacements spent on both real and virtual environments. Finally, Section 5 is dedicated to final considerations and conclusion.

2. Virtual Reality

Virtual Reality (VR) is defined as a group of technologies and techniques developed to integrate both user and computational systems. Its objective is to give to the user the feeling of be living inside a virtual world in real time by means of advanced interfaces. Thus VR can be seen as an experience between user and computational systems in 3D.

In other words, VR is an interface that allows the user to access computational applications in real time besides giving him the opportunity to visualize, make movements and interactions inside virtual environments built by the computer, employing multi sensorial devices to do so (Kirner and Siscoutto, 2007).

This concept was firstly employed by the United States Air Force just after the end of World War II, with flight simulation purposes. Due to this initial application, the VR was intended to isolate the user of the real world. Nowadays VR can be commonly found in a great variety of applications such as virtual modeling, ergonomic studies and, with higher intensity, VR is used on the entertainment industry to create games, movies and animations (Francis and Tan, 1999). The great range of VR applications make it possible to be classified according to the way in which the user will interact with the virtual environment. There are two classes: Immersive VR (IVR) and Non-Immersive VR (NIVR) (Burdea and Coiffet, 2003).

The objective of IVR is to merge the user inside the software's environment as far as it is possible, giving him the feeling of complete isolation of the real world. To do that, special technologies are used in order to block up the user's perception. IVR intends to create a more intuitive way of dealing with the virtual world allowing the user to look around by moving his head and giving him space perception by emulating the human view, for example.

Moreover, IVR tries to make the user recognize sound orientations by locating its source based on direction and distance like it is done at the real world besides it gives him the opportunity to communicate through gesture and voice commands (Haguenauer et al., 2011).

On the other hand, NIVR does not require the total isolation of the user. So, regular devices like monitors, keyboards, mouse and others are used. However there are interfaces in which the user is partially isolated form the real environment in a hybrid procedure using both, conventional and non-conventional devices. In such cases it is proposed the Half-Immersive classification (HIVR) (Burdea and Coiffet, 2003).

Fig. 2. IEN's aerial image.

3. Methodology

This work proposes a two-phased method. The first is named “environment modeling”, which consists on building the virtual environment itself. It is done by means of two softwares: Unity 3D and AutoDesk 3ds Max. Whereas the plot of the ground is performed by Unity 3D, AutoDesk 3ds Max is used to create edifications like near buildings and the facility itself.

The last phase is called “functionalities implementation”. It consists on the addition of auxiliary devices for the Unity 3D nucleus, like virtual cameras, aiming to allow it to fulfill the purpose intended in this work. Such functionalities are made to be part of Unity's nucleus by means of a parameters configuration using C#.

3.1. Environment modeling

3.1.1. Edifications

The edifications modeling is performed by AutoDesk 3ds Max. A topographic image was added to this software to be used as a model for the studied area. To define how high each building is, it was used a rough's calculation method based on a comparison using photos took at the very place of study. This was how the height values used by AutoDesk 3ds Max were found.

There was also the need to build the interior of each building due to the high number of people who access IEN installations every day. The same technique using photos and comparisons was

Fig. 1. Weather menu.

Fig. 3. IEN's virtual model.

Download English Version:

https://daneshyari.com/en/article/1740608

Download Persian Version:

https://daneshyari.com/article/1740608

Daneshyari.com