2009 International Nuclear Atlantic Conference - INAC 2009
Rio de Janeiro,RJ, Brazil, September27 to October 2, 2009
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
ISBN: 978-85-99141-03-8

USING VIRTUAL REALITY IN THE TRAINING OF SECURITY STAFF AND EVALUATION OF PHYSICAL PROTECTION BARRIERS IN NUCLEAR FACILITIES

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ABSTRACT

The physical security of facilities containing radioactive objects, an already important matter, now has a new aggravating factor: the existence of groups intending to obtain radioactive materials for the purpose of intentionally induce radioactive contamination incidents, as for example the explosion of dirty bombs in populated regions, damaging both people and environment. In this context, the physical security of such facilities must be reinforced so to reduce the possibilities of such incidents. This paper presents a adapted game engine used as a virtual reality system, enabling the modeling and simulation of scenarios of nuclear facilities containing radioactive objects. In these scenarios, the physical protection barriers, as fences and walls, are simulated along with vigilance screens. Using a computer network, several users can participate simultaneously in the simulation, being represented by avatars. Users can play the roles of both invaders and security staff. The invaders have as objective to surpass the facility's physical protection barriers to steal radioactive objects and flee. The security staff have as objective to prevent and stop the theft of radioactive objects from the facility. The system can be used to analysis simulated scenarios and train vigilance/security staff. A test scenario was already developed and used, and the preliminary tests had satisfactory results, as they enabled the evaluation of the physical protection barriers of the virtual facility, and the training of those who participated in the simulations in the functions of a security staff.

1. INTRODUCTION

After the 9/11 terrorist attacks, the world realized the need to improve the security level in several areas so to reduce the possibilities of other attacks. One of the possible types of attack is the explosion of a radiological dispersal device (RDD), often called "dirty bomb", in heavily populated areas, as streets and public squares. This kind of "bomb" is composed of a combination of traditional explosives and radioactive materials. The terrorists could obtain radioactive materials by infiltrating and stealing them from facilities publicly known to hold radioactive materials. However, nuclear research institutes, as the Instituto de Engenharia Nuclear in Rio de Janeiro/Brazil, may be a more interesting target, as they hold a greater variety and quantity of radioactive materials, at higher levels of radiation. Therefore its needed to improve the physical security of such facilities so to reduce the chances of terrorists being able to develop dirty bombs. A mean to improve the physical security is to use a virtual reality system that enables the modeling of such kind of facilities and the simulation of steal attempts scenarios of nuclear materials from nuclear facilities, therefore enabling the analyse and evaluation of physical protection barriers and the training of vigilance/security staff.

2. DIRTY BOMB: CONSEQUENCES

As dirty bombs would utilize conventional explosives, they would have a far, far smaller destructive power than any nuclear bomb, since nuclear bombs utilize nuclear fission to generate its destructive power. However, during the detonation of a dirty bomb, the radioactive material contained inside would be dispersed on a wide area that would become contaminated by radiation. This would lead to the necessity of containment and decontamination of victims and isolation and decontamination of the affected area. According to research made by the United States Department of Energy, considering the radiation levels created from most probable sources, “assuming nothing is done to clean up the affected area and everyone stays in the affected area for one year, the radiation exposure would be ‘fairly high’, but not fatal.” [1] However, a dirty bomb could induce psychological fear and mass panic in the population, as the majority have little to no knowledge about radiation. Furthering the problems, the containment/isolation and decontamination of both the victims and the affected area would require considerable time and expense, and may render areas partly unusable. So, the main objective of a dirty bomb is not to cause deaths and destruction, but to cause psychological harm and economical damage. [2] No dirty bomb has been used, though unexploded devices have been developed.

3. USING VIRTUAL REALITY IN EVALUATION AND TRAINING IN NUCLEAR FACILITIES

Considering how much damage a stolen radioactive material could cause in the wrong hands, the physical security in nuclear facilities must be improved and reinforced to reduce the chance of steal of radioactive materials. As Virtual Reality can be applied in several different areas of knowledge, helping in pre-visualization, simulation and training, it is proposed the use of a virtual reality system to help improve the physical security in two ways.

First, it can help to analyse and evaluate a facility that was virtually reproduced. The presence/absence of physical barriers in certain locations, the positioning of vigilance and security staff, the visibility each staff member have to watch over walls, fences and buildings, the distance walked and time spent by them to go from their vigilance positions to specific places, these and other aspects can be analysed and evaluated so that they can be corrected and/or optimized to enhance the physical security.

Second, it can help to train vigilance/security staff members by simulating an infiltration attempt. All vigilance/security staff members can participate together in the simulation. Each one can play his/her planned role and duties in the vigilance plan, communicate with others to alert them about intruders, and receive new orders and assistance in order to arrest intruders.

4. UNREAL

The virtual reality system presented in this paper is a modified and adapted version of the Unreal Engine 2 Runtime [3] game engine (Figure 2).

Figure 2. Unreal Engine simulating a nuclear facility scenario and a male avatar.

A game engine is the core component of a video game software that provides some (or all) of the resources needed to develop a video game. Some of these are real-time video rendering, colision detection, physics simulation, contents editors (usually a scenario editor), and a script language interpreter for modification and adaptation of the engine for other uses. This way, the development of new games and applications can be simplified, as the user focus time and effort in the contents and customization.

The Unreal Engine is a robust game engine that enables the development of any kind of 3D game, but was originally developed for first-person shooter games. The Unreal Engine 2 Runtime is a free version of this engine that comes with a license that restricts its use to non-game applications, and initially comes better suited for first-person or third-person simulations of humanoid characters exploring 3D scenarios. It comes with the UnrealEd (Figure 3), an easy-to-learn scenario editor, and supports the Java-like object-oriented UnrealScript script language. Several aspects of the simulation generated by the game engine were developed as UnrealScript classes. Since the user has access to all those classes, the user can greatly modify and add functionality to the simulation and the engine as needed, making it a good choice as a base for developing virtual reality applications.

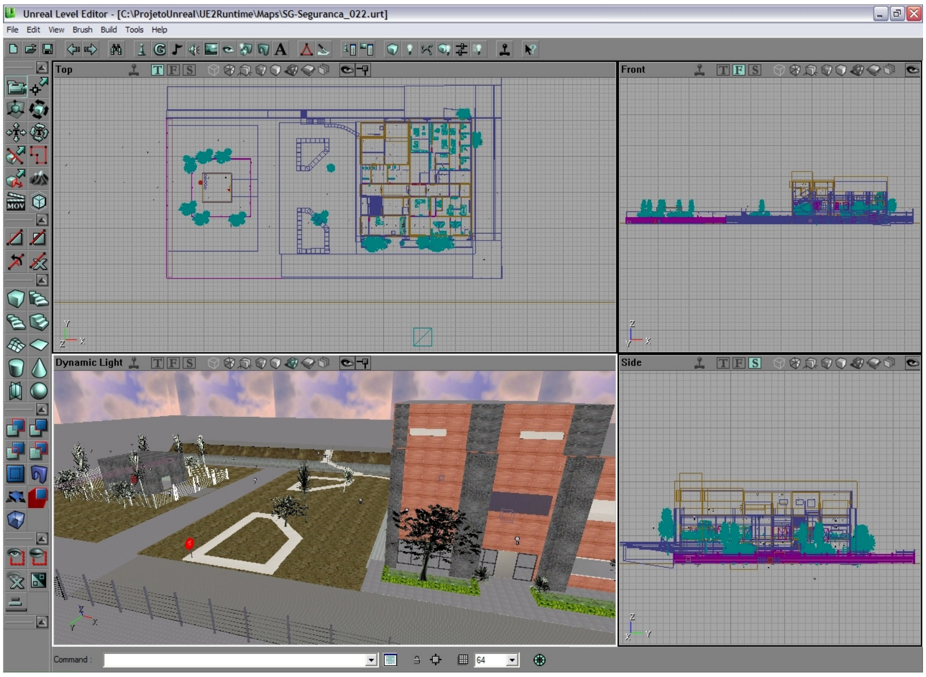

Figure 3. UnrealEd scenario editor.

5. DEVELOPMENT

To change the Unreal Engine 2 Runtime into the proposed virtual reality system, a number of changes and aditions were made, most of them making changes and additions to classes through UnrealScript:

- A male and a female avatars, the virtual characters that represent the users inside the virtual world, were added. [4] By default, this version of the engine comes with no avatar, and the user is presented as a simple cube.
- The avatar’s properties were changed through UnrealScript, so that the simulation better represents the real world. 3D model size, colision cilynder size, jump height, walk speed, run speed, all were changed to make the simulation as close to reality as possible. Comparison tests between virtual scenarios and their real world counterparts were conducted to certify this.
- A test scenario was developed. The facility is surrounded by fences. Inside is the building containing the radioactive material (surrounded by its own fences) and the building with the surveillance room.
- The necessary changes and additions to make this version of the engine working in network, so that all the users could participate in the same scenario at the same time.
- Fences that take a specific time to fall when touched by a avatar were added to the scenario. This represents the time spent by the intruders to trespass the fences.
- A new object that shows the viewpoint of a remote camera was added. This object acts as a surveillance monitor, and several were added to the surveillance room (Figure 4).

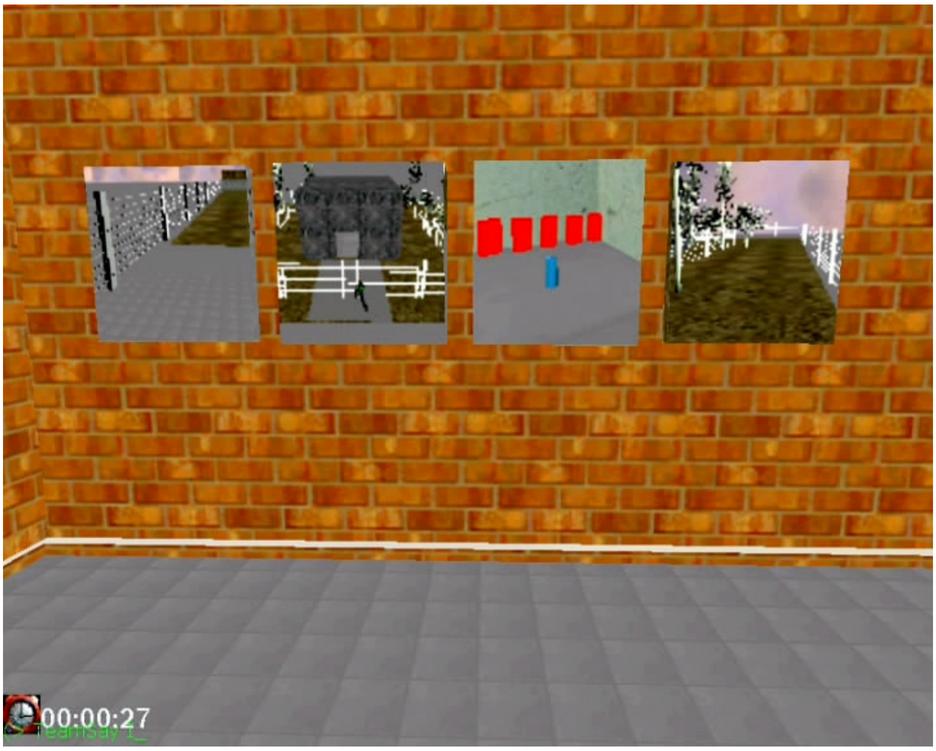

Figure 4. Virtual surveillance monitor.

- A new object that represents a radioactive material, presented as a blue cylinder. When the intruder type of avatar touches the cylinder, it vanish from the ground and reappears behind the avatar, to represent the theft of the material.
- The avatars can function in two categories. The intruder avatar must steal the radioactive material (represented by touching a blue cylinder) and flee while avoiding to be found or caught by the security staff. The security staff avatars must patrol the facility and restrain any intruder (represented by at least two security avatars touching at the same time the intruder avatar, thus freezing it in place).
- A game engine launcher was added, to facilitate the choice of character name, gender and color, scenario and game server.
- Other additions/changes to the engine interface, as menu changes.

6. CONCLUSIONS

As the system became ready, simulations were conducted, and the results were satisfying. As predicted, the system enabled the analysis of placement and distance between the building containing the radioactive material and the security staff posts, and the team work of the security staff. In the test scenario, it was found out that, although the security staff was sucessfull to stop the intruder, they took too much time to go from their vigilance posts to the building containing the nuclear material because of the distance. The communication between the security staff enabled them to react properly to reach and stop the invader in time.

Future changes and additions:

- change of avatar models to better represent the security staff and intruder;

- new avatar animations to better represent its actions, such as trespassing of fences, holding the stolen radioactive material, and the security staff restraining the intruder;
- new types of physical barriers;
- addition of stun guns to the security staff as a mean to stop the intruder;
- modelling of new scenarios, to further test the system.

ACKNOWLEDGMENTS

This paper was made possible thanks to the support of Antonio Carlos de Abreu Mol, Mauro Vitor de Oliveira, Isaac José Antonio Luquetti dos Santos, Cláudio Henrique dos Santos Grecco, Paulo Victor Rodrigues de Carvalho, and all other collaborators in the Instituto de Engenharia Nuclear, Rio de Janeiro, RJ.

REFERENCES

1. Rockwell (2004) "The Power of Nightmares - BBC TV Documentary" Dr. Rockwell introduced 44:30, statement 45:00 (2004).
   "Fact Sheet on Dirty Bombs", http://www.nrc.gov/reading-rm/doc-collections/fact-sheets /dirty-bombs.html (2009)
2. "Dirty Bomb - Chronology of Events by Lexi Krock and Rebecca Deusser", http:// www.pbs.org/wgbh/nova/dirtybomb/chrono.html
3. "Unreal Engine overview", http://wiki.beyondunreal.com/Unreal_Engine (2009).
4. "Example Models for the Unreal Engine", http://udn.epicgames.com/Two /UnrealDemoModels.html (2009).