Three Dimensional, Virtual, Game-Like Environments for Education and Training

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INTRODUCTION

Training emergency response personnel to handle a hazardous radiation spill is a challenging task. Conducting repeated training sessions in dangerous or restricted areas in and around research reactors or NPP sites is not a realistic option. Computer games provide an alternative training mode [1]. Recent developments in 3D, virtual environments can be inexpensively and effectively utilized to train in a virtual environment, to communicate the dangers, and train on procedures to be used when dealing with a radiation emergency. While currently adequate, education and training to enhance safety and security at NPP sites can also be much more effectively and efficiently carried out using 3D, virtual animation technology [1-6]. Such models have also been used to train the decommissioning personnel. Different options are available to quickly and efficiently develop the desired 3D models. One of them is the Unreal Engine—a platform in which 3D, game-like environments can be developed quickly and easily with sophisticated details and interactivity. We here report the development of a fairly realistic model of the University of Illinois TRIGA reactor, which is now destined for decommissioning, using the Unreal Engine. The model can be used to train first responders, decommissioning personnel, and even to effectively communicate reactor safety and security issues to students and nuclear personnel.

MODELING THE ENVIRONMENT IN UNREAL

The editor for the Unreal Engine, *UnrealEd* (UED), is designed to be simple and easy to use so that even beginners with no programming or modeling experience can use to create their own *levels* in the game with very little training. (See glossary at the end of this paper for definitions of terms like *level*, etc.)

When developing a *level* in UED, the computer screen is divided into four windows as shown in Fig. 1a. The upper-left, upper-right, and lower-right windows respectively show the standard top, front and side views of the model, respectively. These are flat 2-D views of the model. The lower-left window is the view port, which shows the view from a camera that can be moved around the level while editing. There are thousands of pre-built items that can be selected from a list and simply inserted in the map. For example, to make a room with a table, one needs to select a pre-built table and copy-paste it onto the floor. The object can then be moved, rotated, or scaled. The editing of the map can be broken down and distributed among workers to work on different sections that can be combined later into a single final map.

There is a large community of fans and programmers that maintain several internet sites dedicated to helping people with UED problems [7, 8]. Questions posted at these sites are quickly answered by experts. Codes and modifications made by experts are also available.

In addition to having a simple interface, UED also has the programming complexity to support many advanced features for the simulation. Some of these which are directly relevant to the nuclear education and training related applications are described below.

Using Pictures for Realistic Effects

UED allows pasting of pictures captured by ordinary digital cameras onto surfaces in the model. This feature is very useful in giving a realistic impression of the models. Figure 1b shows screen shot of the reactor control room with pictures of the actual control panels pasted on the model control panel surfaces. The reactor bay is visible through the glass window.

Lava Zones

Lava zones are regions set in the map that are hazardous. If a player (worker) stays in the *lava zone*, his health index drops by a set amount each second. This property, called DamagePerSec, can be used to mimic the radiation level [1]. An increasing value of DamagePerSec indicates a higher radiation level in the *lava zone*.

Health Index

Usually used in computer games to show the number of punches or bullets a player has received, this feature, when combined with *lava zones*, can be used as a dosimeter showing dose received while working in a radiation field. The player's health at the beginning of a simulation is at "full," say around 100. As the worker walks into the calibrated radiation field (*lava zones)*, his health index will drop in proportion to the level of radiation in the area. At the end of the simulation the total loss in health index can be related to a dose received.

Visual Representation of Radiation Effects

To help first responders, maintenance, and decommissioning personnel visualize radiation in the facility, the map floor can be color-coded to show the level of radiation. Several such fields can be turned on or off during the training exercise to show the radiation level, temperature, etc.

RESULTS

A rather detailed model of the UIUC TRIGA has been developed. Additional details are still being added. Inside the reactor building, different floor levels, staircases, control room, octagon shaped structure with the pool and the core, and the bay area have been modeled. The model is roughly to scale. See Fig. 1c. The model includes the surrounding buildings, streets and parking lots. Figure 1d shows the reactor building environment. Only the reactor building has the inside details. A player can start from outside and walk into the reactor building. Digital pictures of the actual facility are being used to make the facility as realistic as possible. *Lava zones* and the health index have been tested. Different segments of the floor can be colored to "show" the level of radiation in that area. Horizontal surfaces in Fig. 1c are color coded showing a fake radiation field emanating from the reactor core. Radiation decreases as with increasing distance from the core. Several details have been added to the model of the water pool including the realistic looking water surface effects. Currently a single player (worker, avatar) can walk through the model.

Training Model

One of the first training modules developed, is to train a group of firefighters in a simulation of a radiation spill at their local research reactor. They (or rather, their avatars) first get the briefing from their leader as they arrive in their vehicles. As they arrive on the scene, they pick up a Geiger counter and begin measuring the radiation level. Upon entering the plant they "see" a spill and visualize the levels of radiation around it. They reach the controls needed to secure the area using a safe path that is free from radiation. After securing the site, they leave the building and go through decontamination.

FUTURE WORK

Several features of the Unreal engine have not been tapped yet. For example, it allows multiple players (workers) to "play" the game simultaneously. It allows access and simultaneous gaming capability via the net with voice communication. Work is currently underway to allow simultaneous and interactive training of multiple people with access to the internet from anywhere around the world. In addition, we will also explore the possibility to integrate this model into a stereographic system to provide true 3D immersive experience.

GLOSSARY OF TERMS

Level:	The model of the reactor building and surroundings
Map:	Used interchangeably with level.
Health Index:	A number that represents the health level of a player. It decreases as health is damaged. The default (a healthy person) has a health index of 100 in Unreal.
Camping:	An inactive player

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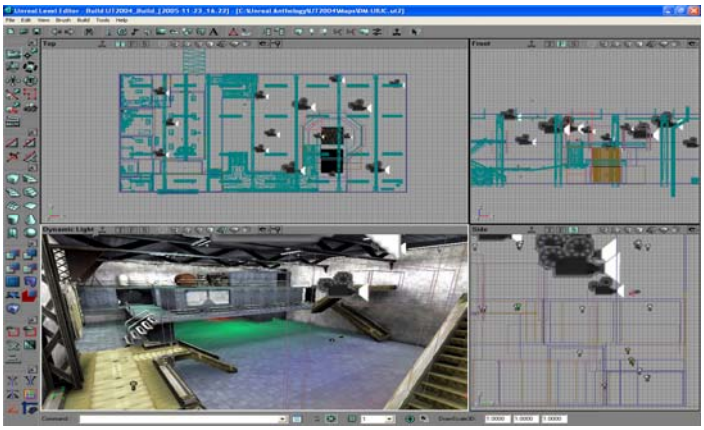

Fig. 1a. A view of the Unreal editor's windows showing the model.

Fig. 1b. A view of the control panel.

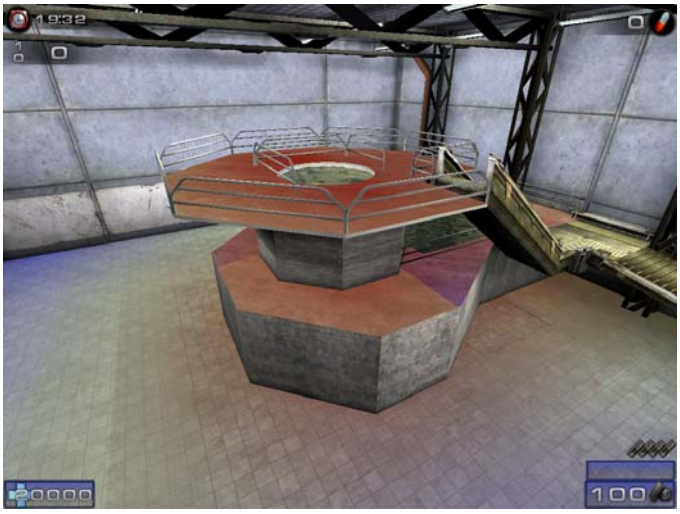

Fig. 1c. Model of the reactor bay. Flat surfaces are color-coded with a fake radiation field with highest levels at the core.

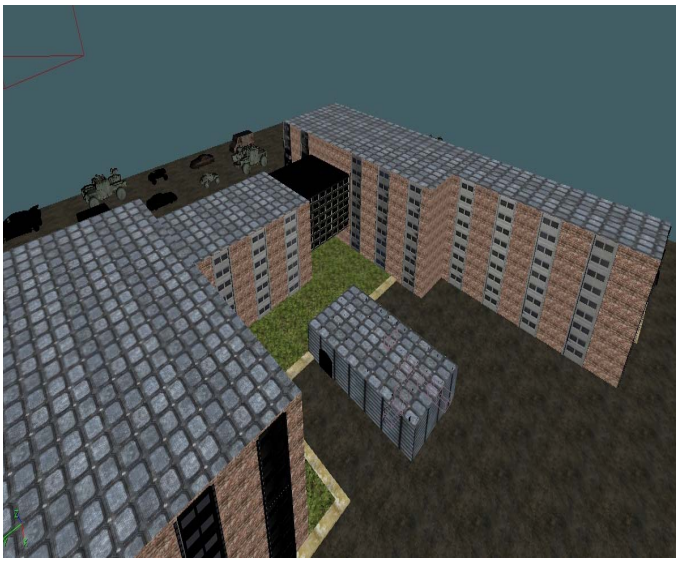

Fig. 1d. An overview of the entire reactor structure and surrounding buildings and streets. The reactor facility is the small building in the center.