

# Simulation Research of Crime Scene Based on UDK

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**Abstract**—The scene simulation is an important part of virtual reality system, it provides powerful methods support to the research of forensic science. First, we research the mainstream virtual engine and choose the UDK (Unreal Development Kit) for simulation, which is fully functional and easy to be used. Then, the prototype system of three-dimensional reconstruction for crime scene was established. The flow of virtual reality simulation, scene management, model and texture were discussed. Finally, this paper takes murder case as an example and finds a solution for the problem of scene investigation and reconstruction, which can promote the development of criminal technology, observe the crime scene from Multi-angle and improve the efficiency and the accuracy of judgment.

**Keywords**- scene simulation; UDK (Unreal Development Kit); three-dimensional reconstruction, forensic science

## I. INTRODUCTION

With the implementation of strengthening police by technology, the forensic science technology has been placed in an important position. The scene investigation is an important component of forensic science and indispensable technology for fighting against all types crime. But the investigation, analysis and research of some special scene is limited by the subjective factors of examiner, such as explosion, landslide, traffic accidents, radioactive contamination and so on. It significantly affects the accuracy of scene investigation and is one of the forensic science's issues which needs to be urgently solved.

The scene simulation is an important branch of virtual reality and is an indispensable high-tech means for the development of various areas in society[1-6]. UDK is a software development kit and developed by Epic which can create simultaneous 3D model and be extendible. It provides a software access to simultaneous application of graph and high fidelity and multi-channel. In this paper, the prominent merits is used to solve above problem, such as real-time visual simulation, easy programming, short period of development, flexible application, powerful function and so on.. The visual simulation of crime scene was designed and developed based on UDK, the flow of virtual reality simulation, scene management, model and texture were studied. The visual simulation and forensic science was closely integrated, a new solution has been proposed for scene investigation and reconstruction.

## II. VIRTUAL ENGINE

We can assimilate virtual engine to car's engine[7]. As we know, engine is car's heart, deciding the car's velocity, capability, stability and so on, so does the virtual reality. In the virtual reality, scenario, art design, music, animation felt by players are all controlled by virtual engine. So virtual engine is the core software component or the main program of a computer video game and can control all the virtual functions. It provides the underlying technologies, simplifies development and often enables the simulation to run on multiple platforms and desktop operating systems.

So far, there have been many game engines all over the world, but only a few of them become well-known. Over the years, we can see that most of the good engines are driven by 3D games. Also, we need one of the 3D virtual engines to build our simulation for high quality. Therefore, we just introduce four classic 3D virtual engines here.

### A. Unreal Engine

The Unreal Engine is a widely-used 3D commercial engine developed by Epic Games. It has been three releases since its first First-Person Shooter(FPS) game Unreal in 1998, and the latest release is the Unreal Engine 3. Its core is written in C++ and it features a high degree of portability, supporting a multitude of platforms. In addition, the Unreal Engine is an excellent platform for rapid prototyping because it provides a sophisticated graphical development environment and a variety of specialized tools including the physics engine and a skeletal animation system which simplify the detailed tasks of modeling physical processes. A great deal of its gameplay code can also be modified without delving deep into the engine internals.

### B. Quake Engine

Quake II, released on December 9,1997, is an American FPS computer game developed by id Software. Unlike Quake engine, where hardware accelerated graphics controllers were supported only by later patches, Quake II engine came with OpenGL support out of the box. Now, Quake II has been an open source engine and the latest version is 3.21.

### C. LithTech Engine

The LithTech Engine is widely regarded as one of the best licensable engines in nowadays. It is a 3D commercial engine which was initially developed by Monolith Productions in

collaboration with Microsoft. Monolith later formed a separate company, LithTech Inc., to deal with further advancements of the engine technology. A number of different video game developers, including Monolith itself, have been using LithTech to power their first-person shooter games, thus contributing to the success of the engine and establishing it as an alternative to other products, such as the Quake and Unreal engines. Because of its powerful function, it can also be utilized for simulation. The LithTech engine is continually being developed and its latest version is LithTech 3.

#### D. Delta3D Engine

The Delta3D engine is developed by Naval Postgraduate School under the sponsorship of the U.S.Army. Delta3D is actually a thin, unifying layer that sits atop many open source products you might already use, such as Open Scene Graph, Open Dynamics Engine, Cal3D and OpenAL, integrating them in an easy-to-use API. Rather than bury the underlying modules, Delta3D integrates them together, allowing access to the important underlying components. It provides a high-level API while still allowing the end user the optional, low-level functionality. Because of its open source, Delta3D has been successfully utilized in a variety of domain, especially the domain of military.

Those four engines are fully-featured, and there exist one or more complete games and simulations based on each of these engines. So, it is hard to say which is the best. Finally, we choose Unreal engine 3 for simulation. The following five reasons should be taken into account:

1) *Flexible and low-cost development*: You can download the UDK free from Epic's official website, which provides a powerful internal scripting language(UnrealScript). It is a simple, high-level programming language that gives complete scripting control. Scripts can be connected via Unreal Kismet, an intuitive visual editor that requires no programming knowledge. UnrealScript lets you build prototypes and add new gameplay elements quickly and easily.

2) *Powerful Unreal Editor*: A powerful internal Unreal Editor can meet our needs completely. It can build realistic 3D virtual environment, including textures, characters, vehicles, trees, clouds and so forth. Also you can import the external models to be used in Unreal Editor directly. Moreover, there are many free level editors available for creating your own virtual environment.

3) *High-quality physics engine*: UDK's physics engine is powered by NVIDIA's PhysX, giving you unparalleled control over character movement, dynamic fluid simulation and even soft body physics. Tweak and modify your physics using the Unreal PhAT visual modeling tool. Impose your will on your world via detailed physics modeling. It can also simulate the effect of bump and skid automatically. We can build our simulations more realistically with it.

4) *Particle effects system*: Whether you want fire, smoke, rain or dust, UDK can make it happen with the help of Unreal Cascade. Preview any visual effect in real time exactly as it is seen in the game itself. Make dynamic tweaks to an effect such as an explosion or a burning fire without any turnaround time.

5) *Many mature applications*: The Unreal engine applied not only in game design but also in the domain of education, architecture and military. Thus we can implement our simulation for crime scene reconstruction based on the Unreal engine.

### III. KEY TECHNOLOGY

#### A. Flow of Virtual Reality Simulation

The simulation flow and information which uses UDK is composed of initialization, data loading and scene building, model and texture loading, graphics system initialization and software configuration, main simulation and views rendering, display, as shown in Fig. 1.

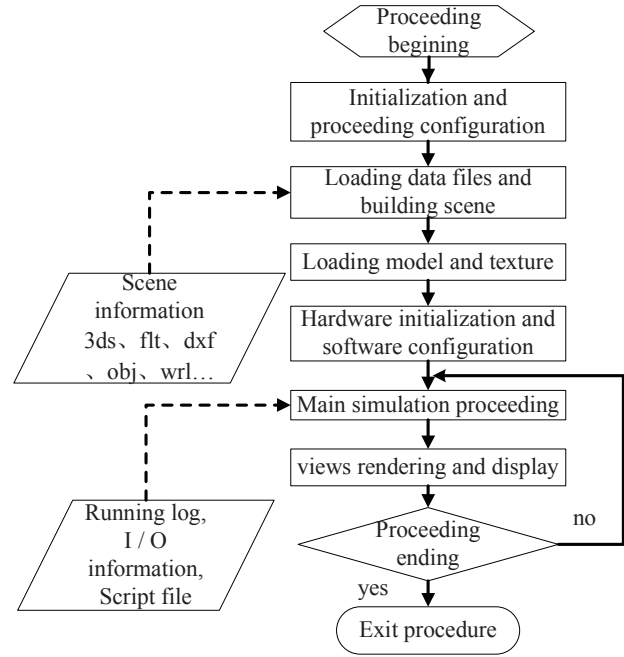


Figure 1. Flowchart of simulation and information

Throughout the flow, only the process of data loading and main simulation has information communication, the various processes are shown as follows:

1) *Initialization and proceeding configuration*: Firstly, the virtual engine loads header files. Then the necessary variables are declared, the shared memory of multiprocess is set with associated function, procedures clock and engine state is initialized. Finally, the number of pipeline is set with internal function and starts work accordance with selected mode.

2) *Loading data files and building scene*: According to the need of user, virtual engine loads simulation data and creates simulation scene.

3) *Loading Static model and the texture*: According to the crime scene, the virtual engine selects the static model from model library and corresponding texture, loads these objects in the simulation scene.

4) *Hardware initialization and software configuration*: The graphics pipeline and its status is set in this process. The

simulation-channel is established and its pipeline is designated. The simulation cone, windows and corresponding channel is established. The frame rate of simulation is set in this aspect.

5) *Main simulation proceeding*: The program will access the external I / O or read the script file of simulation, the status of cone and model is changed according to this information and the simulation events is processed. Finally, the running log and simulation information is saved in accordance with requirement.

6) *Views rendering and display*: The program will call internal function and deal with the cone image, then the results will be sent to display in this aspect.

In the above-mentioned major process, the program will cycle the two final processes until the end of simulation in accordance with requirement.

### B. Scene Management

In the system of virtual reality, the core is the virtual scene, which would create a cultural environment and reflect the objective world in fact. According to the actual work, the scene is divided into indoor and outdoor, indoor scene is subdivided into two-bedroom, three-bedroom and so on according to room structure of real life. Finally, the virtual scene is generated by UnrealED and the scene library is established to fast rebuild virtual crime scene.

### C. Textures and Models

#### 1) Static Model Management

UnrealED can not only generate static model but also support mainstream 3D modeling software (3DMAX and MAYA). According to the actual situation of the crime scene, we mainly focus indoor scene and do our best to find the objective entities in it. The common models can be obtained from network, the special evidence in crime scene can be generated by three-dimensional modeling software. In order to facilitate management and use, the models can be classified as furniture, daily necessities, transport, human, weapon and special marks, etc..

#### 2) Texture Management

UnrealED provides a powerful texture library and can meet the most requirements of simulation, but we still have to establish own texture library because of crime scene's particularity. UnrealED supports BMP or JPG format images, but the picture must be a power of 2 image. In order to facilitate management and use, the textures can be classified as metals, flooring, fiber, plants, people, signs and so on. The evidence textures include blood, fingerprints and shoe prints and other important on-site evidence.

## IV. SIMULATION EXAMPLE

The department of forensic technology is often faced with the crime scenes of theft and murder. It is very difficult to investigate and rebuild because of fatalness and particularity. The murder case is taken as an example and the process of visual simulation based on UDK is particularly introduced in this paper. There are lots of three-dimensional modeling software, such as 3DMAX, MAYA, Creator, Vega, etc., we

choose 3DMAX to generate 3D model in this paper. The human body, furniture and other related models can be built, imported into UnrealED by ASE format and placed in the scene with the right location and proportion according to need. Finally, we can paste the texture, set color, transparency and other properties, the virtual renderings of murder scene are shown as Fig. 2, Fig. 3 and Fig. 4.

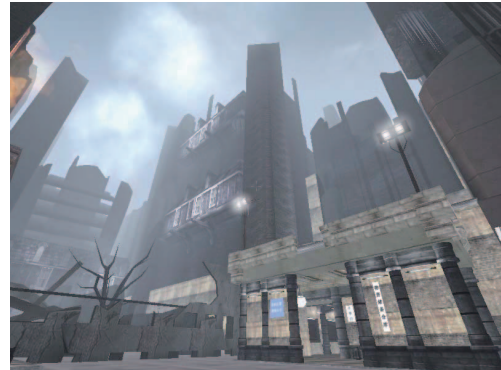


Figure 2. Virtual Scene of Outdoor

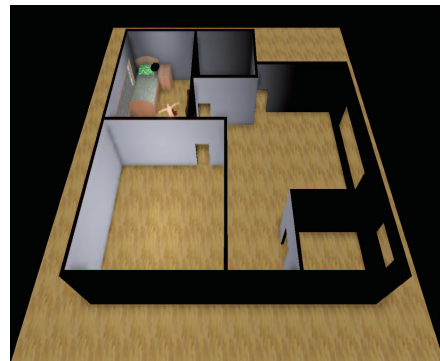


Figure 3. Virtual Scene of Indoor



Figure 4. Virtual Effect of Murder Scene

## V. CONCLUSION

In this paper, the visual simulation of crime scene based on UDK is studied, the mainstream virtual engines are introduced, the flow of virtual simulation is designed, the key technologies are discussed. The visual simulation and forensic science was closely integrated through the invasive interaction between the user and the simulation environment. Finally, this paper takes murder case as an example and finds a new solution for the problem of scene investigation and reconstruction.

#### ACKNOWLEDGMENT (*HEADING 5*)

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