Development of the Three-dimensional Interactive Simulation System of Oil depot based on VR and XML

Li Heng  
Dept. of Oil Application & Management Engineering  
Logistical Engineering University of PLA  
Chongqing, China, 401311  
e-mail: ylgllh@126.com

Zhao Xiao-gang  
Dept. of Petroleum Supply Engineering  
Logistical Engineering University of PLA  
Chongqing, China, 401311  
e-mail zxghz19918163.com

Abstract—To solve the various problems of traditional sand tables of oil depot, the development procedures of the three-dimensional interactive simulation system are introduced in this paper, according to the similar theories, XML database and virtual reality technology. Based on the introduction of the system’s functions, the development environment and structure of the system are described, and then the implement steps are detailedly represented as follows: modeling the three-dimensional mountain cavern, optimizing the three-dimensional models, integrated display of the three-dimensional models and collision detection and XML data programming and parsing. Finally, the development suggests are proposed.

Keywords-Virtual Reality (VR); XML; Oil depot; Three-dimensional interactive simulation; Collision detection

I. INTRODUCTION

At present, the sand tables of oil depot widely used in our army have three forms mainly: one of them is made by traditional arts and crafts and the oil depots are introduced by manual work; the second form are also traditional but it is integrated by vocal, photic, electric technology. The third one combined with computer control technology is called multimedia procedure control sand tables. When the sand table is made, it will be inconvenient to amend(such as the newly building of oil depot, the rebuilding of oilcans and storerooms), moreover some problems such as the longer making period, the higher making costs, moving hard, occupying bigger space [1]. With the fast development of the virtual reality technology, geographical information system, and remote sensing system, the traditional sand tables has been developed toward to the electric, virtual, lifelike direction [2]. Based on the server database and virtual reality technology, the three-dimensional interactive simulation system of oil depot based on VR and XML have been developed in this paper.

II. SYSTEM FUNCTIONS

A. Ramble of the three-dimensional scene of oil depot

Users can freely move in the three-dimensional panorama of oil depot through mouse, keyboard, mouse plus keyboard and operating handle, and so on. The panorama of oil depot is shown by the above man-machine method. A series of shortcut keys of operation for users are programmed in Visual C++, shown as follows:

2) PgUp, PgDn keys: up, down.
3) mouse rightkey: changing direction through keeping it down.
4) blank: jump if being blocked.
5) mouse leftkey: attributes data can be edited and queried through clicking some object.

When rambling, the ramble speed can be regulated through the “speed regulation” which located in the main menu of “exposure mode”. When rambling in big scenes, the speed should be regulated highly. Contrarily, in the smaller scenes, such as on-duty rooms of office building, ships of receiving oil, operation rooms of oilcans, the speed should be slow, so as to operate conveniently.

B. Automatic show the three-dimensional panoramas of oil depot

The three-dimensional panoramas of oil depot can be displayed through specified flight path, and the general situation of oil depot can be automatically described combined with voice and background music.

C. Rapid positioning of the three-dimensional scenes

System in the lower left corner has a navigation map, user can simply double-click the navigation map to a target location, and the current point of view will quickly navigate to the target location. Sometimes, after the rapid positioning, the point of view may be below the three-dimensional objects, then the users are advised to press PgUp key repeatedly to rise the point of view to the above of the three-dimensional objects.

D. Querying and editing the datum of depot’s equipments and facilities

Points to a three-dimensional object such as tanks etc. and the three-dimensional objects turn into red, which indicates that the equipments and facilities are currently selected. When querying or editing the datum of the
equipments and facilities, there are the following two conditions:

1) If the equipments and facilities have previously been entered the corresponding attributes datum, then the right side of the screen will show the corresponding attribute datum, the user can continue to edit the attributes datum of the equipments and facilities.

2) If the equipments and facilities have not previously been entered the corresponding attributes data, then the user needs to find the corresponding type of equipments and facilities from the first layer (type of equipments and facilities), on the right of the screen attributes data column, and then adding a second layer (device Facilities list), until to the third layer(equipments and facilities information).

The user can edit the attributes datum of the equipments and facilities according to the actual needs of the equipments and facilities.

E. Measuring and calculating the topography

1) Query the geographical coordinates: the longitude, latitude of the current location can be queried.

2) Measuring the distance: left click the first place, and then re-left click the second position, the distance between these two points will be automatically calculated and displayed in the screen.

3) Calculating the area: left click the first place, and then re-left click the second, third and fourth position, the polygon area will be automatically calculated and displayed on the screen.

F. Producing the plans of the combat readiness

System provides 16 examples of combat readiness plans, the user can choose according to the actual situation of the oil depot and then use the Microsoft WORD to generate the combat readiness plans in oil depot and then use the Microsoft WORD to generate the combat readiness plans in oil depot and then use the Microsoft WORD to generate the combat readiness plans in oil depot and then use the Microsoft WORD to generate the combat readiness plans in oil depot.

The user can choose according to the actual situation of the oil depot and then use the Microsoft WORD to generate the combat readiness plans in oil depot and then use the Microsoft WORD to generate the combat readiness plans in oil depot and then use the Microsoft WORD to generate the combat readiness plans in oil depot and then use the Microsoft WORD to generate the combat readiness plans in oil depot.

The user can continue to edit the attributes datum of the equipments and facilities.

III. SYSTEM IMPLEMENTATION

A. Software and hardware environment to implement the system

1) Software environment

The system is developed by the software and technology integration of DirectX, Visual C++, 3D Max, Maya, XML, Quest3D.DirectX technology, which is a new three-dimensional graphics rendering techniques provided by Microsoft, has direct access to fast, low-level, concise function library and hardware drivers to drive the hardware, and is very suitable for producing three-dimensional realistic model of the desktop; Visual C++ as a powerful visual programming language, which encapsulates the DirectX graphics library, the combination of the two is the ideal platform for developing the three-dimensional interactive simulation system. XML(Extensible Markup Language) is a standard general-purpose data interface language, which offer the possibility to exchange information between systems [3] , and through which users can add, query, modify and delete data in the interactive 3D scene. Quest3D which produced by the Holland Act-3D company is an excellent VR tool, is mainly used to integrate three-dimensional picture of the scene.

2) Hardware environment

The system as it relates to the real-time rendering technology of the large-scale three-dimensional scene, so the hardware requirements are relatively high. The normal configuration of the system hardware is: Pentium IV or above, 512M or more memory, high-capacity and high-speed hard drives, high-performance graphics card (64M or more memory). The level of the system performance is greatly related to the hardware configuration.

B. Structure of the system

The overall structure of the system as shown in Figure 1.

C. Key technologies to implement the system

1) Modeling the three-dimensional mountain cavern

The three-dimensional topography scenes of the mountain cavern are too big and contain many details, so the direct use of Maya, 3DMAX may bring some problems, such as heavy workload, much difficulty, and the poor reality. To solve these problems, some modeling processes would be taken, shown as following: First, acquiring the mountain cavern contour; Second, after scanning the contour maps, using some software such as R2V to vectorize them; Third, after the vacuolization of contour maps, transferring the files to special software such as ARCGIS to generate the mountain cavern three-dimensional models automatically; Finally, storing the generated three-dimensional models as the format that can be transferred by 3DS.

2) Optimizing the three-dimensional models

There are mainly three ways to optimize the three-dimensional models:

a) A very small number of irregular objects, such as guards of the door posts, machine tools located in repair workshop, autos and police dogs, should be modeled by the mode of in-kind photographs and transparent mapping, so as to reduce the difficulty of modeling and model number of multi-deformation and improve the real-time rendering speed of the entire three-dimensional scenes.

b) Technology of common models. Some objects, such as the same trees, lawn, street lamps, and wall, etc, share its
same model, which is being located at run time only once, in order to save operating resources.

c) Technology of file compression. models can be compressed and stored through use of Maya, 3DMAX’s optimization techniques, so as to minish the file size and improve the loading speed.

3) Integrated display of the three-dimensional models and collision detection

The steps of integrated display of three-dimensional models are shown as follows: Firstly, according to the physical layout of the depot map, to establish a land of three-dimensional scene; Secondly, lead the established three-dimensional models in the scene; Thirdly, necessarily detecting the collision between the three-dimensional models; Finally, package the entire system by using Quest3D.

The following three aspects of collision are detected when rambling. Firstly, when colliding with the ground, the roamer cannot penetrate the ground, but always changes the height of viewpoint along with the variation of ground. Secondly, when colliding with buildings and facilities, the roamer also cannot penetrate. Thirdly, when roaming to a small part of local scene, the problem that one cannot go forward can be resolved by pressing blank key.

In three-dimensional ramble system, how to detect objects colliding with viewpoint is a key problem. Generally the three-dimensional scene can be divided into many rectangular elements, in that case, the only thing is to judge whether there are other things in the unit of viewpoints. Following is a typical collision detection function.

```c
int CheckHit(struct object obj1, struct object obj2)
{
    float deltaX, deltaY, angle, distance, bumpdis;
    deltaX = abs(obj1.xo - obj2.xo);
    deltaY = obj1.yo - obj2.yo;
    distance = sqrt(deltaX * deltaX + deltaY * deltaY);
    if (distance <= obj.radio)
    {
        angle = atan2(deltaY, deltaX);
        bumpdis1 = AngToDis(obj1, angle);
        return (distance <= 2 * bumpdis1);
    }
    return 0;
}
```

4) XML data programming and parsing

a) xml data programming

Following is the XML documental program of a certain oilcan.

```xml
<SbNode name="4\oilcan" modelID="194">
  <oilcan_use>oilcan_stroringOli</oilcan_use>
  <building_class>vertical</building_class>
  <install_class>half_underground</install_class>
</SbNode>
```

b) xml data parsing

The XML document can be parsed through the parser which is provided by Microsoft in this system, namely, MSXML.dll dynamic-link library (all the needed objects for XML parsing are encapsulated).

Following is program for documental parsing.

```c
//loading the XML document
pDoc->load("C:\ DataOfMainStore.xml");
MSXML2::IXMLDOMNodePtr pNode;
//searching for the SBnode node
pNode=pDoc->selectSingleNode("/SBNODE");
MSXML2::DOMNodeType nodeType;
//getting the node name
CString strName;
strName=(char *)pNode->GetnodeName();
//getting the node value
pAttrItem->get_nodeTypedValue(&variantValue);
m_strId=(char *)(_bstr_t)variantValue;
UpdateData(FALSE);
```

IV. CONCLUSIONS AND SUGGESTIONS

Using VR and XML to implement the 3D interactive simulation system of oil depot is a new attempt. The practice proves that the innovation is not only save a larger manpower, financial and material resources, but also the system is easy for modification and maintenance, and convenient for report and demonstration. In a word, it has advantages of less input and high output, and should be used in all kinds of oil depot.

The system also needs further study in the following aspects:

1) How to display the flow of oil in animation instead of presently flashing colors.
2) How to develop web-based 3D interactive simulation system of oil depot.
3) Further perfect of collision detection.

REFERENCES