

Research in Wellbore Display Platform based on Virtual Reality

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Abstract—Virtual reality technology is applied to production engineering, it provides a revolutionary change to the oil industry. This paper we first analyze the function of simulation platform, then set up basic framework of the system, use 3dsmax and simulation software to simulate wellbore, oil-gas-water mining equipment. Virtual environment in well site is constructed, it simulates the underground work process, and it can dynamically assemble the wellbore by the 2d drawing tools. This platform lets users realize functions that is from design to production engineering simulation process, users can fully master the oil production equipment and control the latest information of the oil wells.

Keywords- wellbore display; VR; geometric modeling; simulation

I. INTRODUCTION

In recent years, oil field exploitation becomes harder and harder, production process in oil extraction engineering is more complex, the wellbore tools also becomes more and more, so a platform which can integrate all the oil extraction equipment is needed for managing oil extraction engineering. Virtual reality technology is a new technology emerging at the end of the twentieth century [1], people can interact with virtual environment that produced by computer using natural skill, in order to achieve visual, auditory and tactile perception which closer to the nature. In this article, we introduce virtual reality technology into oil extraction engineering management, it breaks through the present management mode, and uses virtual equipment produced by computer to integrate environment, so the user and equipment can make close contact. It not only imitates external characteristics of oil extraction equipment to understand each part's composition and structure, but also lets staff simulate operation, assemble shaft manually. This paper also shows technological process in wellbore operation, provides aid for engineering design.

II. APPLICATION AND PROSPECT OF VIRTUAL REALITY IN THE OIL INDUSTRY

Virtual reality system is very popular used in the oil industry. 3d virtual visualization software can do stratigraphic interpretation according to detected data, really simulate underground geologic condition, and provide a 3d visualization oil exploitation decision-making system for engineer, so the engineers can make the best exploration decision opinion. The emulational picture of oil exploitation

show the standard mining operation and mining process, so it is convenient for show and propaganda. Simulation of oil field equipment operation procedure and usage which as oil mechanical operation training courseware, can save the training costs give for new workers units and oil enterprise, improve the degree of visualization of teaching training, in order to train technology workers better more skilled. And it is also useful for security simulation training. Training on the 3d virtual interactive improve training efficiency, save the training costs, and it can simulate the process of the accident, facilitate accident investigators from all angles to observation, analysis accident process, so as to find out the cause of the accident and take preventive measures to prevent similar accidents from happening again.

In 1997, Houston in the United States has built the first oil and gas industry special virtual reality test system in the world, this system can real-time geological explore, analysis, design and drill hole trajectory tracking, it has greatly improved the accuracy of oil exploration and drilling speed, produced the huge economic efficiency[2]. In our country, China petrochemical exploration and development research institute has developed the first set of virtual reality system-multidisciplinary collaborative research decision-making system in 2004. In September 2006 , after research and extensive investigation in application system of domestic and foreign, China national dffshore dil corporation in Bohai sea oil field has built a three dimension visual research center , this system is the domestic first set of multi-channel cylinder seamless system, specs of image in the same kind is the first in the world.

In the future, through the application of virtual reality in urban planning, the well site will be more accurate positioning, underground pipelines, ground communication, electric power and other auxiliary facilities planning will be more reasonable.

III. BASIC FUNCTION AND FRAME STRUCTURE OF THE PRODUCTION ENGINEERING SIMULATION PLATFORM

This platform which applied virtual reality technology can realize the following functions:

(1) It should provide a virtual oil production environment, so the user is able to browse using computer peripherals application in any virtual scene.

(2) It should show and control wellbore 3d model, and show the wellbore data in sheet structure. Through these three aspects cooperate with each other, it is not only be able to see the 3d image of the wellbore overall information, but

also can see the corresponding related data of wellbore tools. (3) Engineering design: It should dynamically assemble the wellbore by the 2d drawing tools operation, and provide print function.

(4) It should provide users with a man-machine interface interaction and help the user to realize the interaction between the equipment and the oil. For example: distinguish the interactive parts (tools name), clear operation information (the basic information of the tools), etc.

According to these functional requirements above, we divide the construction process of the simulation platform into four stages, namely: geometric model construction stage, scene integration stage, drive engine implementation stage and function implementation stage, as shown in figure 1 below.

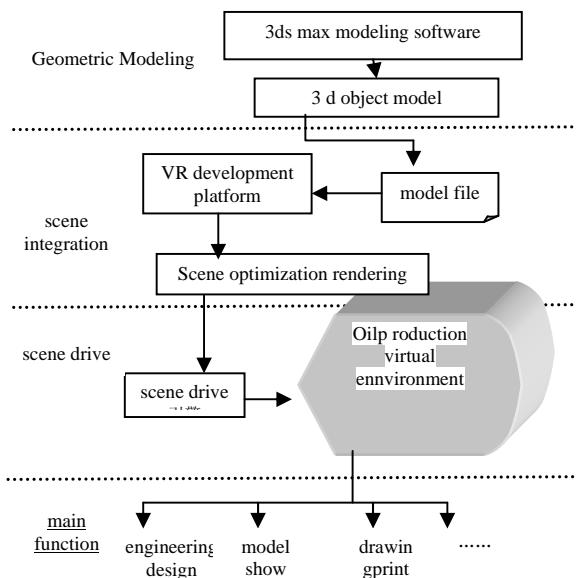


Figure 1 Design framework of this simulation system

A. Geometric modeling

According to the need of the project, geometric modeling can be divided into modeling tools and environment modeling. The modeling of wellbore tool is the use of geometric modeling technique, 3dsmax to simulate tools from shape and appearance, and apply a large number of texture mapping, sample technique to reduce the complexity of the model. According to the drawings of the wellbore tool, we decompose the model, modeling every single part. After the completion of the construction, entity model need to be integrated. Modeling of the well site environment includes sky, ground, trees, distant view, and so on. The principle of constructing sky is to cover a half sphere as "top", map the texture of the sky in the internal surface. When viewpoints move by surface within the space that composed of earths surface, boundary facade and top surface, people feel depth of vision, sky with the proper amount of light effect. And it can increase dynamic effect through the texture transformation means. Vision construction is to

construct a closed "box", to realize simulation of distant view in this direction through texture mapping in different surface of the "box". We often construct the trees by cross proper or use mapping technology to realize billboard face [3].

B. Scene integration

After the completion of the basic model building, all sorts of model should be integrated, scene and some optimization technology should be applied to complete the construction of virtual scene, includes lamplight design, model angle design, model scheduling algorithm and the optimized algorithm. Instantiation technology is used when the database model is repeatedly cited, so the running system can save a lot of memory. LOD techniques is used when we create different model according to the needs., If an object is far away from the viewpoint or the object is too small, LOD model drawing is the best choice. Conversely, if the object is near to the viewpoint, or the object is fairly big, refined LOD model is used. Because it can effectively reduce the number of polygons in windows, efficiency increases significantly. The use of external references can allow the user to direct the required documents or texture in the current scene and exit system in the appropriate time, and it provides great convenience for the global scene create. And it can save memory in a certain range and extent, enhance rendering speed and machine running speed, and manage scene conveniently.

C. Scene driver

The scene drive engine executes interactive activities between object and people, and makes the virtual scene movement. It includes the interaction of user and 3d model, the control of 3d models, etc.

D. System function

This stage is to realize the basic functions according to the customer's need by constructing model and virtual environment. It includes the design of the engineering drawings and print, use drive engine to realize 3d model show, 3d model management, user management, and other functions.

IV. THE REALIZATION OF SYSTEM FUNCTION

A. Geometric modeling

In order to guarantee the authenticity and immersed sense of the system, collision detection that between virtual environments and viewpoint is considered, it can not pass through objects. The involved collision roughly divided into two kinds: collision between viewpoint and virtual environment, collision between wellbore components.

When collision is between viewpoint and virtual environment, we apply the collision detection methods based on forward sight. It consist of four horizontal lines, which located all around the viewpoint, length L is a little shorter than the length of the arm. When distance between viewpoint and objects which is on the direction is greater than L, there is not a collision. When the distance in less than L, there is a collision, and viewpoint will not move in this direction again.

In order to solve the collision problem between wellbore components [4], we place a transparent box at the position of the tool, its scale slightly larger than virtual tool, the transparent box is set as collision point P. Judge of collision point P intersect with six planes of the box whether or not, using point and bounding box intersecting algorithm. Take one of the surface for example, the surface is four vertices A, B, C, D of the bounding box form the quadrilateral face F1, the center of the F1 set to F1 (x, y, z), the coordinates is shown as formula (1).

$$\begin{cases} x = (x_A + x_B + x_C + x_D) / 4 \\ y = (y_A + y_B + y_C + y_D) / 4 \\ z = (z_A + z_B + z_C + z_D) / 4 \end{cases} \quad (1)$$

Surface F1 unit normal vector is set to N, calculating is shown as formula (2).

$$N = \frac{AB \times BC}{|AB \times BC|} \quad (2)$$

Among them ,

$$AB = (x_{AB}, y_{AB}, z_{AB}), BC = (x_{BC}, y_{BC}, z_{BC})$$

The result of the product by vector points is used to judge collision point is located in or outside, within or above the bounding box [5]. If $N \cdot P > 0$, the collision point is located in the bounding box outside, not a collision; If $N \cdot P = 0$, the collision point is just above the bounding box, begin to collide, namely the collision is between operated tools and other parts, then it point out that interaction occurs between tools, so as to avoid the operating tools cross in other objects, and to ensure the authenticity of the operation.

B. Wellbore model display and control

This part mainly includes wellbore 3d model show, 3d control and wellbore data sheet show. Through these three sides cooperate with each other, we not only to be able to see the 3d wellbore image, but also see the corresponding related data of wellbore tools.

When show the whole 3d model, in order to make the tool and model one-to-one correspondence, model should be consistent with wellbore data sheet. If this process is realized, System must first find the corresponding 3d model name according to tool name and type, and then automatic assemble based on wellbore data sheet. We use collision detection technology to achieve in getting and feedback scene in the model. When the mouse is on the wellbore tool model, the system shows related attributes of the tools, as shown in figure 2.

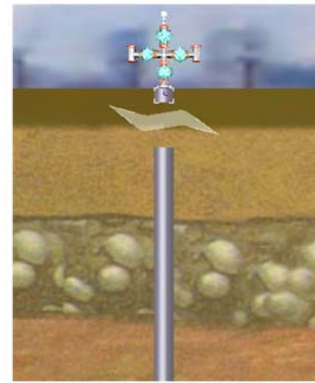


Figure 2 Wellbore 3d display

There are two ways to view the information of wellbore tools 3d model, one is by clicking on the tool's name in wellbore data sheet; the other is by clicking on 3d graphics "show" of tool's name in wellbore data sheet.

The control of three dimensional model is mainly realized through the button and the mouse, mainly including move up and move down, amplification, narrow reset and the left-right rotating. " move up" button is to make 3d models integral move upward; " move down "button is to make 3d models integral move down; " reduce " button is to make 3d models whole reduces; it is convenient to view string structure as a whole; " zoom in " button is to make the whole 3d model larger, it is convenient for users to view the detailed structure of each tool; " reset " button is to make the whole 3d model restore to its original state, including the size, location, etc; The left-right rotating control is realized through the mouse, dragging the left mouse button around can realize model left-right rotating.

C. The realization of engineering design

This function module is mainly designed for engineering personnel. The system provides wellbore two-dimensional sketch of the tools, users can design engineering through selecting tool's sketch, print page settings and printing after design, as shown in figure3. This module mainly includes these functions: operation of toolbox, dynamic assembly of wellbore, page layout, print preview and print.

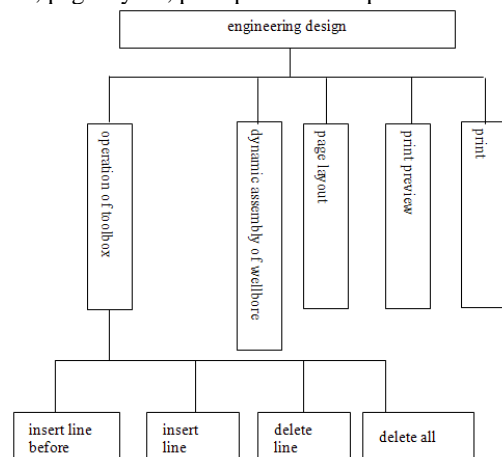


Figure 3 Model input Block

Corresponding tools name, tools specifications and depth must be filled in after dynamic added. According to actual condition, tool specification is with special characters, so a soft keyboard used to add special characters should be designed. Engineering design through the use of toolbox and soft keyboard is based on the Ajax technique, it do not need access to the server, so it can improve the speed of design. The function can realize the engineering design and print design. So the function contains a series of operation when print, such as the page setup, print preview and print.

V. CONCLUSION

Production engineering builds on information database display platform and bases on virtual reality technology, it can blend computer graphics and database as an whole, store and process production engineering information. This system can provide a complete inquiry, analysis tools for production engineering design personnel, it also can directly show the problems of various parts information, the well completion status and production measures etc, and guide the drill site construction, help underground work personnel and other

personnel interact and cooperate. It can be used in accident prevention treatment, real-time data analysis and decision, etc. Good application effect is got when implement in realty.

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