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The Research of Oil Extraction Engineering Based on Virtual Reality

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Abstract

The data of production engineering industry has gradually increased after years of development, but it lacks of a unified, interactive, visual information query and show platform. This paper focuses on production engineering construction equipment and scheme of the system architecture of the simulation system, it analyzes the basic required function of the system—model show, stratigraphic simulation, and production data query, and also introduces the key technology of system, including the equipment model transformation, the stratigraphic of the simulation, the realization of human-computer interaction. The system can provide users with complete database information query, intuitively shows the problems of the component parts information and production measures, etc, so it is helpful for engineering design personnel to design program, reporting and analysis.

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Key words: VR; Oil extraction equipment; Stratigraphic simulation; Particle System; Fuzzy Query

1. Introduction

Wellbore is a very important part of oil well, it loads all types of underground tools, so the information of wellbore become a important data to maintain oil field production and improve oil yield^[1]. How to enhance the

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information of wellbore status, and increase analysis utilization rate is the most important management problem which the managers face.

With the development of information technology, oil industry also introduce virtual reality. We can make use of immersion, interaction, imagination which are characteristics of virtual reality to interpret earthquake data 3D visualization, design and optimize well location and borehole contrail of oil drilling, engineering design oil platform on the sea, construct reservoir model and simulate oil reservoir numerical value, create realistic virtual enviroment to train special operations.

This article is an application of virtual reality used in exhibition wellbore real time and simulating underground operation. With this technology, we can show wellbore tool model vividly, assemble wellbore dynamically, simulate statues of underground reservoir and operation measures, provide visual situation of underground pipe column for researcher and manager to make effective decision.

2. System framework and function analysis

This system works in the browser/server (B/S) mode, the B/S model can increase the data sharing and improve the utilization rate of software, maintenance is reduced greatly. System structure is shown in figure 1.

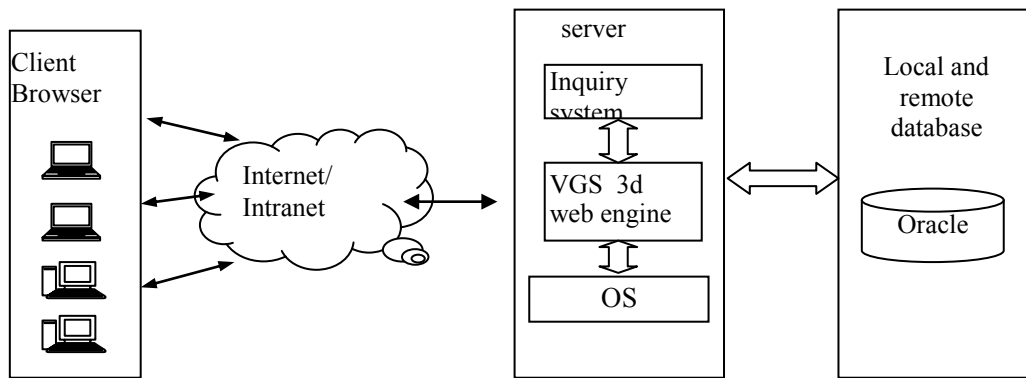


Fig.1. System architecture

The system's main purpose is to design the wellbore information dynamic processing and display software, with the use of virtual reality technology, the composition information and wellbore measures dynamic image will show up intuitively.

System can be divided into three part from the function: model information recorded, engineering design and information query.

(1) information input module. When entry new tools corresponding 3 d model to the database, it contains the name, model path, the tool model, model tool length and note information, all messages upload to the Oracle database.

(2) engineering design module. It is used for construction design and wellbore design, it can also dynamic design and output according to the need.

(3) information query model is the system's main function modules, greatly informations, it can display wellbore structure information three dimensional, small layer of information is shown in the chart and the data table query, etc. This module contains information query landing submodule, overall information 3d display wellbore submodule, small layers information query design submodule, dynamic measures 3d display

submodule, wellbore tool information query submodule and production data query submodule.

3 The key technology of system and implementation

3.1. 3d model built based on VR

3d model created is justified or not is be the key to virtual reality system whether success, the outstanding model can give users into vivid feeling^[2], the user immersed in a virtual environment, and the system response in time, no apparent delay's feeling. Here briefly explain the system of the applications of the modeling process and optimization technique.

The modeling of the main wellhole tool is the use of geometric modeling technique, 3dsmax to simulate the tools from appearance. Specific modeling process as follows ^[3]:

- (1) The data collection, according to the tools to create model, select the texture and drawing pictures.
- (2) Determine the hierarchical structure model, through the analysis of the model, the model tree segmentation and separately modeling and model integration at last. The advantage of this is that improve the utilization rate of the model, reduce duplication of work, but also conducive to management. And 3dsmax also offers a hierarchical structure to organize and manage complex model.
- (3) The construction of the model. According to the model of the structure and drawings, followed by go up to below, by inside to outside principle, use 3dsmax step by step to provide the dots, lines, planes and solids, create and modify tools, to create 3d model.
- (4) Model optimization. After the built model, should remove redundant polygons and will shape the triangle. And deal with model and the texture and enhance the material model fidelity.

Figure 2 shows Y443-108 (II) that is a drill style packer model.

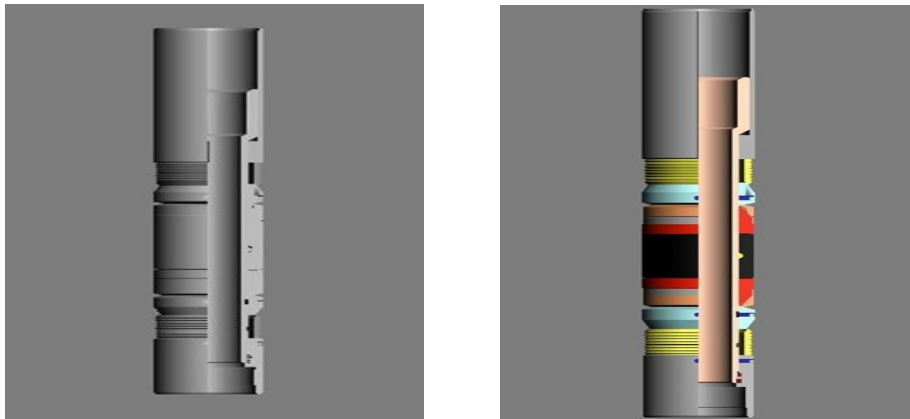


Fig.2. Drill style packer model

We use example technology, and texture mapping technology LOD technology in model optimization. In this project, because many tools is widely used ,so if every tool, component is to recreate, and load into memory to operate, it will cause great waste of resources, so it can use examples technology, the same tools in memory store only one instance, after translation, zoom and turn we can get other tools. The LOD is the technology trading space for time , in this project we constructing some details of the different hierarchy model, when driver the model it can automatically select the relevant details according to judge rules, so as to achieve the real-time model simplified, and do not affect visual result. And texture mapping technology is the

2d image digital mapping to the surface of the model, makes the number of object face reduce for the use of the texture and the simplified model is vivid.

3.2. Measures simulation based on particle system

The basic ideas of particle system is ^[4]; using a lot of tiny particles primitive, which have certain life cycle and attributes as a basic element to show irregular fuzzy object.

Fracturing, stopping water, acidification, the cutting technology etc that used in increase production, are simulation the liquid like water, oil and foam. Take acidification for example, its principle is through the acid on the rock cementation, or space, crack formation, restore or improve the gap and fracture permeability. So in the simulation, we should inject acid underground, acid in the rock go on chemical reaction, and viscous liquid turn into bubble etc.

Below is the definition of the acid particles data structure:

```
class particle
{
    float p_lifetime;    // The life cycle of particles
    int p_type;          // The type of particles (liquid or gas)
    float p_color;       // Particle color
    float p_alpha;       // Particle transparency
    float x,y;           // Particle position
    float vx0, vy0;      // The initial velocity of particle
    float vx, vy;        // The current rate of particles
    float d;             // Particle position
    float xd,yd;         // Particles movement in the x, y direction
}
```

Through the particles construction and realization above, we can simulation acidification process better. In the system we use polygon to replace point particle, and use the texture mapping technology to make acid pictures map to the polygon. It can not only improve the efficiency of the draw, and can enhance the authenticity of the simulation. Figure 3 shows the acidification simulation result.

3.3. Database design and inquire technology

We design data structure according to the information organization, access method, relevance, replaceable treatment method^[5]. Combined with production database structure, according to the needs of each module and the relationship between the data flow design, we determine the following several sets of data table:

(1)3d model information Table(MODEL)

3d model information table used to store the name of the model, the path and the corresponding tools name and relevant information, the system call tools model through the table data and assemble dynamically, table structure is shown in table 1.

Table 1. Table MODEL structure

Data item	Key code	Code name	Type	width	decimal	For null
Tools name	Y	GJMC	VARCHAR2	30		no
Model path	Y	PATH	VARCHAR2	50		no
Model name	Y	GCZJ	VARCHAR2	50		no

Tool model	GJXH	VARCHAR2	20		yes
Model length	MXCD	NUMBER	8	3	yes
note	BZ	VARCHAR2	200		yes

(2)Dynamic SQL statements table (DYNAMICSQL)

Dynamic SQL statement table use to store SQL statement that access the database of each oil production plant, system query of the database of each oil production plant given in the table, table structure is shown in chart 2.

Table2. Table DYNAMICSQL structure

Data item	Key code	Code name	Type	width	decimal	For null
oil production plant name	Y	FACTORYNAME	VARCHAR2	30		no
Table name	Y	TABLENAME	VARCHAR2	30		no
Static SQL statements		SQL	VARCHAR2	3000		yes
Dynamic SQL statements		SQL_DYNAMIC	VARCHAR2	3000		yes
Key word		KEY	VARCHAR2	300		yes

(3)Development data table of oil production plant

Oil field production data amount is large, including oil production management, underground work, development trends, static development, dynamic development, oil field experiment test etc, 44 tables in all, so we do not need a detailed list here.

For the use of the system more convenient, we adopted inquires dynamic form technology and fuzzy query technique.

In the realization of dynamic form, we can show required field in a database to users in the form checkbox, users can choose interesting fields to form customization. And in the internal implementation process, user's choosing field is also based on multiple inquires construction data set process. The system will treat all input inquires "logic and" conditions or "logic or", and pass combined inquires into the bottom logical library of dynamic form, operate interactively by processing function of the logical library and database, eventually return the data that meet the conditions and show to the user in the form of form.

If users don't remember well number, they can use fuzzy query method. Fuzzy query well number, system call a database to find the matching well number when users input a character from the beginning "—", this could be more user-friendly. In realization, system use the database fuzzy matching inquiries, basic query statement is: SELECT field FROM table WHERE a field Like conditions, about conditions, SQL provides four matching mode:

1、% : means any zero or more characters. It can match any type and length of characters, in some cases if it represent chinese we need to use two (%%) ^[6].

For example SELECT * FROM [dba01] WHERE JH LIKE '%-S4%', it will find out record that JH (well number) is G152-S44, G152-S443, G153-443, G154-463 which contains S4-.

2、_ : means any single characters. It can match any single character, it is used to limit characters length of the expression.

For example SELECT * FROM [dba01] WHERE JH LIKE ' G152-S4_%', it will find out G152-S44、G152-S443,etc.

3、[]: means one of the characters (similar to the regular expression) list in brackets. Specify a character, string or range, required match object is any of them.

For example `SELECT * FROM [dba01] WHERE JH LIKE '[GZN]10'`, it will inquire data that contain G10, Z10 and N10, rather than GZN10.

4、[^]: means a single character not listed in the brackets. It is the same as [], but it requires that match object is any character but not the specified character.

3.4. System realization

We use 3dsmax to construct system model, after model has been created we derive model for s3d form with plug-in module in 3dsmax, and import s3d in the webmax for further editor, after the completion release into n3d at last.

We use Visual studio.net 2008, c # language for system platform, Oracle database on the back stage.

System operate in browser/server mode on local area network, client is browser on the front stage, users install 3d browser plug-in through the automatic download (or manually download), operate in the browser; server provide the WWW services and Oracle database service on the back stage.

4. Conclusion

The wellbore information dynamic processing and display system is the use of virtual reality technology to display 3d and manipulate, dynamically draw strata and dynamically display assignment measures. According to the actual application feedback, this system can provide a complete inquiry, analysis tools for engineering design personnel, and directly shows the problems of the various parts information, the well completion status and production measures and so on. It also guide the construction work in well site, help drilling crews and other subjects crews interact and cooperate together, and it can be used in the complex accident prevention treatment, real-time data analysis and decision, etc.

The feature of this system is spatial, integration, real-time, modeling, visual. The research for 3d visualization technology and its software system has important significance for constructing "digital oilfield" and increasing our country's oilfield information level.

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