

Research on 3D Model Restoration Algorithm of Digital Core Image

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Abstract— The formation of digital core image by scanning core surface is very important for permanent preservation of core surface data. It is of great scientific value for geologists to study the image characteristics of the outer surface of the core and realize the 3d image of the outer surface of the digital core through the 3d coordinate transformation algorithm, so as to restore it to the same appearance as the real core. In this paper, OpenGL open graphics library is implanted into the programming language Java to form a three-dimensional core model for construction, and its appearance is restored and lifelike. Research on 3d digital core reconstruction technology can solve the problems of core-taking cost and difficult to take samples due to geological conditions, and has certain research significance and value to the research of core data and the prediction of underground oil and gas state.

Keywords— Core Digitization; Core Image Restoration; 3 D Coordinate Conversion Algorithm.

I. INTRODUCTION

Core data are high reliability data directly drilled from underground geological body, which is the basis of oil and gas exploration and development. Current core has been stored in the database a huge amount of various core image, but the 2 d core section images lack of intuitive connection between each image, on the one hand, through the observation of the traditional two-dimensional core image will spend a lot of energy to study the core status, on the other hand, when the image is too complex will reduce the accuracy of the observation data finally. In recent years, with the wide application of virtual reality technology and augmented realization technology, 3D imaging has become a hot research field. Due to the limited conditions of core acquisition and the need for intuitive core image, 3d digital core reconstruction technology has been developed. Most of the reconstructed 3D digital core shapes are cubes or cuboids, but these do not conform to the spatial structure of the cylinder in the well. Based on the image format stored in the computer system core image, consider using image recognition technology to identify the sandwich and analysis, based on the core image, through the intelligent graphics algorithm to automatically identify core sandwich, reconstruction of the deep section of 3 d digital core columns, thus forming can directly identify the core image, further build three-dimensional model of specialized application software.

II. DESIGN OF 3D MODEL RESTORATION ALGORITHM FOR CORE OUTER SURFACE

A. Core Image Preprocessing

The core image contains depth information and well information, and the original image is pre-processed. Firstly,

the core region is extracted and the noise is processed, which is mainly some artificial marks on the core image. Then, the depth data on the core are extracted, and based on this, the image size and the actual size are recognized and converted. Finally, the results are applied to the recognition and depth reversal of interlayer data in the region to be processed. This realizes the output of the actual depth and thickness of the interlayer and provides support for the batch identification of the core photos.

B. Core Image Segmentation

Different cores have different features such as color, gray scale, geometry, and spatial texture. Based on these characteristics, we can distinguish the image by different regions, which do not intersect each other, and each region is consistent with a specific region. According to the segmentation algorithm, the automatic recognition system obtains the threshold value of R, G, B color value as the threshold constraint value of image binarization segmentation. This is the optimal segmentation value calculated according to the gray value of the image and different algorithms. If the threshold value is small, the noise of the image will increase obviously. If the threshold value is large, a large amount of valid information will be removed when the image is binarized. This is a crucial step in image processing, which directly affects the image recognition and understanding and determines the final performance of the image processing system.

C. Core Image 3D Imaging Output

According to the data obtained from the previous image recognition and image segmentation, in the output stage, calculation and transformation are carried out according to the recognized interlayer, and finally the model is constructed, and the interlayer length, interlayer width and length-width ratio can be output.

D. 3D Coordinate Conversion Algorithm Design

OpenGL converts 3d coordinates to screen coordinates through four transformations, and the algorithm design process is described below.

The first three transformations (Model, View, and Projection) are all 4*4 matrices operated by four-dimensional vectors, so (x,y,z) needs to be transformed into (x,y,z, L) by adding W components.

Then multiply the matrices of the first three transformations to the left by this vector, and do the homogeneous division of the resulting four-dimensional vector (all components divided by the W component),

Then use the x and y components to perform a fourth transformation (Viewport) to obtain screen coordinates.

$$(x,y,z,w) = \text{projectMatrix} * \text{modelViewMatrix} * (x,y,z,1)$$

$$x = x/w$$

$$y = y/w$$

$$z = z/w$$

Take the viewport pixel coordinates (x, Y) on the screen and convert them to the screen coordinate system:

$$k1 * x + b1 = x'$$

$$k2 * y + b2 = y'$$

Find the conversion coefficient between two coordinate systems.

The origin of the viewport pixel coordinate system is in the center of the screen, and the origin of the screen coordinate system is in the upper left corner.

$$K1 = w/2; b1 = w/2$$

$$k2 = -h/2; b2 = h/2$$

E. Core Image Rendering

The core model is constructed and rendered using the JOGL interface. JOGL is a derivative of OpenGL. OpenGL (Open Graphics Library) is an extremely powerful application programming interface (API) used to Render 2D, 3D vector Graphics, composed of more than three hundred function libraries. In order to get the most realistic state of the core model, we need to calculate the effect of the light source on the rock body and make adjustments to get the most realistic color effect. On the other hand, because the surface of rock samples collected may not be absolutely neat and smooth, it is necessary to fine-tune the texture of the rock surface for running-in alignment. With these tweaks, we can get a relatively realistic look of the underground core, and OpenGL's rendering capabilities take care of that.

There are many attempts to combine OpenGL with Java, and the most mainstream and recognized one is JOGL, which is also supported by Sun. Therefore, it is based on Java programming language, through the call of JOGL to realize the core three-dimensional model construction.

OpenGL is a library function defined by C programming language, so it needs to be called by the C compiler. Although THE C programming language has been very powerful and mature, it also limits OpenGL's multi-language and cross-platform. So since OpenGL came out, many languages have tried to bind and port OpenGL.

The Java Virtual Machine (JVM) of the Java language is very compatible, so you can write it once and run it on different systems. Therefore, the Java language is more cross-platform than other languages, and binding OpenGL to Java can take advantage of this advantage.

III. DIGITAL CORE IMAGE 3D IMAGING MANAGEMENT SOFTWARE

This software is to restore and establish the model of the core image, and manage the restored model systematically. By using the powerful data processing, data transmission and data storage capabilities of the computer, it provides users with fast and efficient services. Finally, a core 3D imaging software with simple interface, easy to use and practical application is

developed.

The design and development of 3d core imaging mainly includes system administrators and registered users. The structure of the system is divided into the front and back: the front is mainly composed of user registration, core imaging, model management and other functions; The background is by the system management login, the administrator is mainly responsible for user management, algorithm update, model management and other functions.

A. Software System Framework Design

The overall structure of the system will adopt the popular MVC Model, which refers to Model layer, View layer and Controller layer respectively.

The three-tier architecture divides the entire project application into: presentation layer (UI), business logic layer (BLL), and data access layer (DAL)1.

Presentation layer: that is, the interface shown to the user, is what the user sees when entering the system, that is, JSP pages.

Business logic layer: It refers to a series of processing for each request of users, namely Manager Management.

Data access layer: it is the operation of the database, including adding, deleting, modifying and querying, that is, the management of the model and the preservation of images.

B. Software Underlying Database Design

The design and development of 3d core imaging software needs to provide the functions of querying, adding, modifying and deleting data information. Thus requires that the database can completely meet the outgoing and incoming of all kinds of data. Based on the analysis of the above system functions, the following data items are summarized according to the functional requirements of the design and development of core 3D imaging software:

- (1) Administrator information: Id, user name, password, name, gender, email, phone number.
- (2) User information: No., user name, password, name, gender, user email address, user phone number, add time.
- (3) Model information: serial number and picture.

According to the theory of database design: construct the optimal database mode in a given application environment, establish the database and its application system, so that it can store data effectively and meet the application requirements of various users. Change the conceptual structure of information entities to the logical structure of databases supported by Mysql.

C. Software Implementation Environment

The design and development page of core 3D imaging adopts Dreamweaver as a development tool and combines HTML and CSS style to carry out background layout and design. The Java code part uses IDEA as a development tool to realize. The database is mySQL.

The details of the development application to the software are as follows:

Web tools: Dreamweaver 8;

Development platform: IDEA;

Database: mySQL 8.0;
 Application server: Tomcat 8.0
 JDK (Java Development Kit) version: 1.8.0;

D. System Function Realization

The design and development of core 3D imaging software mainly includes user management and core image imaging model data management system.

Home page mainly login registration module, navigation bar, news and information. Users can provide help information when they are not logged in. After logging in, they can carry out 3d core imaging and manage models or personal information. All kinds of information and other messages in the home page are released by the system administrator in the background.

If there is no user account, you need to register a user account and log in to the front desk for operation. Finally, the software window is shown in Figure 1.

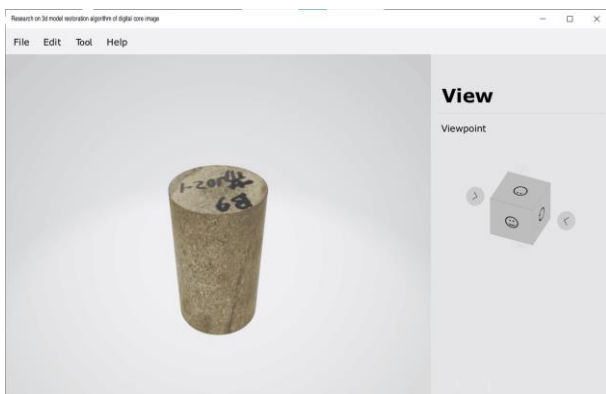


Fig. 1. Core image 3D imaging software window

IV. CONCLUSION

Through the combination of Java and graphics library interface, this paper adopts MVC three-tier architecture and calls basic DB to develop an APP that can be used for 3D digital display of underground core state. The application of this APP effectively solves the inconvenience of core data observation and collection, and the invocation of database ensures the integrity of core data. Using MVC architecture, software can have extended functions in network, can obtain remote data and analysis, so that software has a more complete functional system.

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