Application of Computer Three-dimensional Modeling in Engineering Engineering

Kaizhao Jin¹,

¹Chengdu University of Technology, Chengdu Sichuan, 610059

*Corresponding author e-mail: zsl@cdut.edu.cn

Abstract. With the development of science and technology and the development of our society, new technologies are continuously applied in our country's engineering. Due to the complex geological phenomena such as faults, pinching, and outcrops in geological bodies, in order to express these phenomena when modeling 3D strata, regardless of whether it is a surface model, a volume model or a mixed model, there are problems of space division or surface intersecting. Due to the complexity of geological body topology, data errors and computer accuracy problems, these models often fail in the actual modeling process. Using level set theory can effectively solve this problem. Level sets use implicit functions to express surfaces, which can realize the expression of complex geological bodies and topological operations such as merge, intersection, and difference. In 3D geological modeling, after generating various geological interfaces by interpolation, these geological interfaces are expressed in level sets, and various complex topological operations are completed by level theory, and a 3D geological model expressed in level sets is established. On this basis, by inserting various engineering activity interfaces expressed by level set, and using level set theory to perform topological operations, geological models after various engineering activities can be constructed. Reuse algorithms to extract various geological interfaces or engineering activity interfaces, and construct stratigraphic models that can be used for real-time visualization or engineering evaluation (such as finite element calculation) or geological models after engineering activities. By establishing a three-dimensional geological model of the area where the construction project is located, architectural designers and construction personnel can analyze and study complex geological conditions, and provide technical support for engineering. By studying the three-dimensional geological model, this paper analyzes the engineering geological conditions and potential risks of the construction process in the study area, and proposes risk control measures, which can provide scientific decision-making basis for building design, construction, and risk prevention and control, and has a high promotion value. Experimental research results show that the application of computer three-dimensional modeling in engineering engineering can effectively reduce the cost of the project, ensure the quality and schedule, and greatly improve the construction efficiency of the project.
Keywords: Computer, Three-dimensional Modeling, Engineering, Applied Research

1. Introduction

In recent years, with the rapid development of computer technology, remote sensing technology, photogrammetry technology, etc., it has become a reality that spatial information can be quickly obtained and 3D landscapes can be reconstructed [1]. It is worth noting that the emergence and development of 3DGIS visualization has made a qualitative leap in human perception of the surface environment. The visualization of 3D geographic information systems is an important part of all virtual reality systems (including spatial environments). Because the research goal of 3DGIS visualization is 3D space, it must be able to model the information related to the 3D target. 3DGIS modeling mainly includes 3D modeling of buildings, terrain, grasslands, fences, trees, sky and other landscapes [2].

The design of the 3D geological modeling information system needs to follow seven principles: standardization, high efficiency, openness, networking, sharing, scalability, and good operability [3]. Standardization means that the design of fields and databases must meet the existing national standards, and the texture and color of geology must also have the characteristics of customization; efficiency means to simplify the operation process as much as possible, and realize the operation of the program with high-quality data structures and algorithms [4]. Note that the low-level should be developed using STL in C++; openness allows multiple data formats to coexist, and can achieve data exchange with CAD, MAPGIS, ARCGIS, etc.; in order to improve performance, the three-dimensional geological modeling information system supports two Operation mode B/S, C/S. The main function of the B/S mode is to edit and remotely publish the results of 3D modeling, and it also supports collaborative modeling by many users; the C/S mode focuses on managing data, constructing and analyzing geological models, etc. [5]. The high-speed and accurate operation of the system can be ensured when the two cooperate with each other; the sharing is to update and manage various information materials in real time through the point source database to ensure that the database is always in the latest state; operability means to achieve secondary development; operation Friendly means that users can modify and dynamically edit the model, so that it is convenient for users to integrate geological cognition into the modeling results, which is more humane [6].

The original engineering geological data comes from various sources, large amounts and various types. The exploration results submitted by the exploration department include remote sensing data, topographic survey data, field survey data, geophysical survey data, drilling data, trenches and flat pits, etc. [7]. These data are in tables, documents, charts, and engineering drawings. Therefore, the engineering geologists of the engineering survey will obtain a large amount of discrete and discontinuous data during the geological survey. The storage, query and management of these data are all discrete. Analyzing the distribution law of geological bodies based on these original geological exploration data will inevitably bring great difficulties and workloads to geologists [8]. Faced with a large amount of output data, even if they can predict the distribution of various information in the studied geological area, it is still difficult for geologists to analyze its distribution. The graph is the most intuitive data interpretation. They are used to reflect geological information through maps. The use of computers to display the distribution of geological information is the hope of geologists. The use of computer technology for 3D geological modeling and analysis, and the development of a 3D visualization information system for engineering surveys is an inevitable trend [9-10].

2. Algorithm establishment and optimization

Construct the three-dimensional computer model needed in this article through differential equation expressions:

\[ X_n = x(t_0 + n\Delta t) = h[z(t_0 + n\Delta t)] + \omega \quad (1) \]
In this equation, \( h \) is the multivariate function of the three-dimensional model; it is the error function that appears in the modeling process, and its size determines the size of the error in the modeling process. The feature training set of the 3D geological structure model, the vector subset meets the following conditions

\[
\Sigma = \text{diag}(\delta_1, \delta_2, \delta_3, \ldots, \delta_r), \quad \delta_r = \sqrt{\alpha}
\]  

Let be a solution of the calculation model, the initial characteristics satisfy

\[
\{x_0\} = [x_{01}, x_{02}, \ldots, x_{03}]^T, \quad \{I\} = [1 \ 1 \ 1]^T
\]  

For feature analysis of multivariate variables, new parameters of new three-dimensional geological structure models can be carried out based on statistical measurement values

\[
\{x_0\} = \{\varphi_x\} x_1
\]  

Collect and analyze big data on the 3D geological structure model through recursive analysis to construct new functions

\[
\beta x_1 + \eta x_{ob} + c_{ob} x_{ob} + k_b x_{ob} + p(t) = -\eta x_g
\]  

Among them:

\[
[B] = \begin{pmatrix}
2\xi_1 w_1 & 0 & 0 \\
0 & 1 & 0 \\
1 & 0 & 1
\end{pmatrix}, [A] = \begin{pmatrix}
w_1^2 & 0 & 1 \\
0 & k_b & 0 \\
0 & 0 & -1
\end{pmatrix}
\]  

Use big data analysis methods for quantitative analysis:

\[
X_n: X \rightarrow \{-1, +1\}
\]  

Perform classification error calculation:

\[
X_n = P(T_m(x_i) \neq y_i) = \sum_{i=1}^{N} w_m i m e x p(-a_{m} y_{i} T_{m}(x_i))
\]  

Calculated coefficient:

\[
X_n = \frac{1}{2} \log \frac{1 - \varepsilon_m}{\varepsilon_m}
\]  

Complete the above formula to obtain the quantitative recursive extraction results of the features of the 3D geological structure model:

\[
x_{ob} = \sum_{j=1}^{S} u_{p_j} Y_j(t) \quad x_1 = \sum_{j=1}^{S} F_{u_j} Y_j(t)
\]  

3. Modeling method

3.1. Three-dimensional geological model

First, analyze and sort the collected price data, and process the collected data according to a certain method. As a sample of the three-dimensional geological model, select the input value and the preset output value. Then, using random values as the connection weights between the hidden layer, the input
layer and the output layer, learn and train to obtain the output value, which completes the initial neural network. Then compare the output of the initial neural network with the expected output, compare the two, whether there is a large difference, further analyze the result, modify the corresponding connection weight according to the size of the difference, and make the final output. The error with the expected output is gradually reduced until the requirements are met, which becomes a mature neural network model. Finally, according to the needs of 3D model construction, the model that needs to be built is taken as the input value, and the corresponding 3D model of rock and soil is obtained through the calculation of the model.

The objective function of the prediction model is shown in equation (13):

$$
\text{obj}(t) = \sum_{i=1}^{n} L(y_i, \hat{y}^{t-1} + f_i(x)) + \Omega(f_i) + c
$$

Equation (13) is the loss function, which is a regular term, and c is a constant. The loss function in the equation is expanded using Taylor expansion as equation (14).

$$
\Delta x \approx f(x) + f'(x) \Delta x + \frac{1}{2} f''(x) \Delta x^2
$$

After performing Taylor expansion, the objective function becomes equation (15):

$$
\text{obj}(t) \approx \sum_{i=1}^{n} \{ L(y_i, \hat{y}^{t-1}) + g_i f_i(x) + \frac{1}{2} h_i f_i^2(x) \} + \Omega(f_i) + c
$$

In formula (15):

$$
g_i = f'(x) = \frac{\partial L(y_i, \hat{y}^{t-1})}{\partial \hat{y}^{t-1}}
$$

$$
h_i = f''(x) = \frac{\partial^2 L(y_i, \hat{y}^{t-1})}{\partial \hat{y}^{t-1}}
$$

The positive term in formula (15) is:

$$
\Omega(f_i) = \gamma T + \frac{1}{2} \lambda \sum_{i=1}^{T} w_i^2
$$

In formula (18), T represents the number of leaf nodes of the tree, W represents the weight on the leaf node, which is the weight on the leaf node, and both are hyperparameters. Equation (18) can be known as known, so it can be melted into the constant term and treated as a constant, so continue to simplify the objective function to:

$$
\text{obj}(t) \approx \sum_{i=1}^{n} \{ g_i f_i(x) + \frac{1}{2} h_i f_i^2(x) \} + \Omega(f_i) + c
$$

At the same time, formula (18) is incorporated into the objective function formula (19) to obtain formula (20):

$$
\text{obj}(t) = \sum_{i=1}^{n} \{ g_i f_i(x) + \frac{1}{2} h_i f_i^2(x) \} + \gamma T + \frac{1}{2} \lambda \sum_{i=1}^{T} w_i^2 + c
$$

The construction of the computer's three-dimensional engineering model is realized by the above method.

4. Data evaluation results and research

| Computer 3D technology application value | Reduce project costs | Save rock and soil mining time | Reduce project duration | Reduce project investment |
|----------------------------------------|----------------------|-------------------------------|------------------------|--------------------------|
| Survey results                         | 15%                  | 32%                           | 12%                    | 10%                      |

The survey data results in Table 1 show that computer 3D modeling technology has significant
advantages in engineering engineering projects. In terms of project cost, it can achieve a relatively low cost for the project, which can reduce the cost of the project by about 15%. With the continuous improvement of the technology, it is believed that the project cost can be reduced even more in the future. And it can also save a lot of time in terms of rock and soil mining time. The use of computer three-dimensional modeling technology can reduce the rock and soil mining time by nearly 32%. In terms of project construction, the use of computer 3D modeling technology has greatly reduced a series of problems during construction and can reduce the project duration by about 12%. The advantages of computer three-dimensional modeling technology in engineering engineering projects are not only those listed in the table, it also has great advantages in other aspects. For engineering engineering projects, computer three-dimensional modeling technology is indispensable ring.

**Figure 1.** Accuracy of computer 3D model

On the basis of synthesizing the data of multiple civil engineering projects, the dynamic forecast results of the project quantity and other aspects using the budget model of this paper are shown in the figure. According to the results of the budget, 81% of the engineering distribution in the construction of the computer 3D model and actual construction is very accurate, and the accuracy of the computer 3D model is still very high; 16% of the data shows that the computer modeling of the three-dimensional model has a certain degree of deviation, but there is also a certain reference value for engineering. The final 3% of the computer three-dimensional model construction data results and the actual results have a large deviation. In summary, it can be seen that the reliability of the dynamic modeling results of the computer three-dimensional model in the engineering engineering project is still very high, and the model can bring great convenience to the project, and has the ideal and the development of the project.

**Figure 2.** The impact of computer 3D modeling technology in the construction of engineering projects

The data shown in Figure 2 is an investigation of the application of computer three-dimensional modeling in an engineering engineering project on a site. From the data in the figure, it can be seen that
the application of computer three-dimensional modeling technology in the engineering engineering project is for this project. It still has a very large impact, and has a certain degree of influence on the mainstream ideology of the staff. 85% of the results show that the application of computer 3D modeling technology in engineering engineering projects has a great impact on all aspects of the project, and 12% of the results show that the application of computer 3D modeling technology in engineering engineering projects has a great impact on the project. All aspects have a greater impact. 2% of the results show that the application of computer 3D modeling technology in engineering engineering projects has little effect on all aspects of the project. 1% of the results show that computer 3D modeling technology has no effect on all aspects of the project. According to the results of this investigation, the application of computer 3D modeling technology has a great impact on all aspects of a engineering engineering project. With the support of computer 3D modeling technology, the workers on the construction site are relieved during the construction of the project. A lot of burden. Especially after the continuous development of computer three-dimensional modeling technology and some breakthrough progress, it gradually began to receive the attention of construction site workers. Computer 3D modeling technology has brought great changes to the construction application of engineering engineering projects. Better information processing and data analysis for projects through computer three-dimensional modeling technology is of great significance for improving project efficiency.

5. Conclusion
The focus of 3D geological modeling is the research of geological intersection. It is a comprehensive discipline that spans the geological field and the computer field. This determines that it must be inseparable from geographic knowledge and computer knowledge, which invisibly improves The difficulty and challenge of 3D geological modeling research. However, with the joint efforts of professionals, we will definitely break through the crux of three-dimensional geological modeling, use information technology to drive the geological field, improve the safety factor, and complete geological exploration with high quality. Three-dimensional geographic information system has penetrated into various application fields of the society. Both digital earth and digital city need to use three-dimensional geographic information system as the core technology. Dimensional modeling and visualization can intuitively and conveniently provide geological models for engineering stability evaluation, excavation and management, monitoring and early warning, and provide comprehensive information for engineering engineers to correctly judge and analyze engineering problems. It is the development of engineering engineering in the future one of the main directions.

References
[1] A G A , B A B , D P C C , et al. Computer therapy for the anxiety and depression disorders is effective, acceptable and practical health care: An updated meta-analysis[J]. Journal of Anxiety Disorders, 2018, 55(10):70-78.
[2] Tsuyoshi H , Toshiyuki F , Atsushi K , et al. PROGRAPE-1: A Programmable, Multi-Purpose Computer for Many-Body Simulations[J]. Publications of the Astronomical Society of Japan, 2018(5):943-954.
[3] Roy, R, Casiano. Correlation of Clinical Examination with Computer Tomography in Paranasal Sinus Disease:[J]. American Journal of Rhinology, 2018, 11(3):193-196.
[4] Ma J , Yu H . Study on the computer desktop image compression technology based on clustering algorithm[J]. Paper Asia, 2019, 2(1):11-14.
[5] Yuda Y P , Azis M N L . 3D modeling the gamelan of saron as a documentation of cultural heritage preservation efforts[J]. Journal of Physics: Conference Series, 2019, 1375(1):012036 (8pp).
[6] Ryu B H , Wang C C , Chang I . Development and Geotechnical Engineering Properties of KLS-1 Lunar Simulant[J]. Journal of Aerospace Engineering, 2018, 31(1):04017083.
[7] Kataev N , Kolganov A . The experience of using DVM and SAPFOR systems in semi
automatic parallelization of an application for 3D modeling in geophysics[J]. Journal of supercomputing, 2019, 75(12):7833-7843.

[8] Dey U, Kumar C S. A web-based integrated GUI for 3D modeling, kinematic study, and control of robotic manipulators[J]. Computer Applications in Engineering Education, 2020, 28(4):1028-1040.

[9] Aljalloud A, Rossato L N, Steinseifer U, et al. Perceval® Valve Falls Flat: In-depth Analysis of Stent Deformation through CT Scan and 3D Modeling[J]. Structural Heart, 2020, 4(sup1):134-135.

[10] Hu Z, Shan W. Analysis of the Groundwater Resource Pollution of Coal-Fired Power Plants and Its Impact on Geotechnical Engineering Properties by Numerical Simulation Technology[J]. IOP Conference Series: Earth and Environmental ence, 2020, 450(1):012002 (11pp).