Research on 3D Geological Modeling Method of Tunnel Engineering Computer Based on Geological Cross-section

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Abstract. In the construction of geological cross-section tunnel engineering, the traditional two-dimensional modeling method has been unable to meet the current needs of people's cognition of underground geological structure. Therefore, 3D geology and tunnel excavation model can display information more intuitively, and provide basis for the investigation, design, and construction of tunnel engineering. In this paper, the significance of 3D geological modeling method of tunnel engineering computer is briefly introduced, and the construction of 3D geological model is discussed for readers' reference.

Keywords: Geological Cross Section, Tunnel Engineering Computer, 3D Geological Modeling, 2d Modeling

1. Introduction
Due to the limitation of surveying technology, many problems cannot be confirmed. Therefore, during the tunnel process, tunnel engineering designers hope to establish 3D geological and tunnel excavation models with the help of computers to intuitively display the information inside the tunnel, to provide a basis for the investigation, design, and construction of tunnel engineering.

2. Research status of computer 3D geological modeling method for tunnel engineering at home and abroad

2.1. Development of computer 3D geological modeling methods for tunnel engineering
3D geological modeling is to build a digital model based on various original geological data that can reflect the structural morphology, structural relations, and the change rule of the internal attributes of geological bodies through appropriate visualization methods.

To show the real geological environment. 3D geological modeling has been widely studied abroad. Houlding first proposed it and established a basic theoretical system by combining geology, space, statistics, and other disciplines [1]. Most of the subsequent studies were conducted on this basis. According to the limited data of geological drilling and the characteristics of current stratum distribution, Christian elaborated some basic methods and techniques to realize 3D visualization of geology. Mallet proposed a discrete smooth interpolation method in view of the complex characteristics of geological body structure and the shortcomings of traditional interpolation methods.
At the same time, some researchers also proposed a multi-angle smooth spline curve to make the values of relevant nodes as smooth and approximate as possible to the sampled data. Ramos et al. combined deep learning technology to conduct 3D geological modeling and achieved good results. The British Geological Survey (BGS) completed a nationwide subsurface coverage depth of 1 between 2009 and 2012. 5 ~ 6. The 3D geological model of 0 km has realized the visualization effect of the underground geological structure. The 3D geological model data are shared across the UK, which greatly promotes the development of 3D geological modeling [2].

2.2. Domestic 3D geological modeling method of tunnel engineering computer
Research on 3D geological modeling technology started late in China. By combining engineering geological information management technology with large-scale hydropower projects, Chai Hejun et al [3], developed a 3D visual model system for rock mass structure, which greatly expanded people's understanding of the space of complex rock mass structure. A method of tunnel generation and excavation simulation based on 3D geological modeling and interactive technology is proposed by using virtual visualization technology. By this method, the physical and mechanical properties and distribution rules of surrounding rock of the tunnel at a specified spatial location can be obtained [4]. Lv Xikui was proposed based on parametric modeling technology such as 3 d tunnel model building method, this method will be inside the tunnel structure, by adjusting the related parameters of tunnel structure of the parts, can effectively establish a variety of landscape in a short time the 3 d model of the tunnel, and intuitively in tunnel 3 d design with 3 d scene image to display. In general, there have been some relevant studies in the field of 3D geological modeling, but due to the particularity of tunnel engineering, there are few studies on the combination of 3D geological model and tunnel engineering.

3. Construction of 3D geological model
First, the geological data are obtained and collated. Secondly, preprocess the geological profile data to normalize and reconstruct the 3D surface model of geological body. Finally, create a tunnel model in the 3D geological model body, and build a 3D geological and tunnel visualization model.

3.1. Preprocessing of model data
The main purpose of section data preprocessing is to obtain 3D spatial coordinates of section contour sampling points to generate geological database and create geological section contour. The preprocessing of sectional data includes the following two parts.

3.1.1. Extraction of cross-section data
By extracting the elevation of each point on the boundary line of each layer and the horizontal displacement of the relative line centerline, automatic extraction can be realized through the coordinate transformation from the global coordinate system to the local coordinate system (Figure 1 is the 3D model construction) in the cross-section CAD drawing.

![Figure 1. Construction of 3D model.](image)

3.1.2. Spatial conversion of data
After the local coordinates of each point are extracted from the geological cross-section map, they
need to be converted to the spatial 3D coordinates in the geodetic coordinate system, to convert all the cross-sectional stratigraphic data to the unified coordinate system for 3D geological modeling. The corresponding spatial 3D point coordinates can be obtained after the conversion of sampling points on each stratigraphic boundary in the geological cross-section plan.

3.2. Construction of 3D geological model
In most cases, the structure of a geological body can be regarded as a cylindrical object, that is, each fault of the geological body has only a single contour, and each fault is parallel to each other. Therefore, the triangular face reconstruction method with a set of parallel contour lines can be used to construct the geological body surface. The basic idea of this method is to connect the vertices of the upper and lower contours to form a set of mutually connected but mutually disjoint triangles by starting from a set of parallel polygonal contours of object 1.

Among the optimization algorithms, the most representative ones are the volume maximum method and the surface area minimum method. Based on the basic criteria of the reconstruction of the maximum volume surrounded by the solid surface or the corresponding minimum surface area, the form of the algorithm is relatively complex and the modeling efficiency is not high. The goal of the local optimization algorithm is to make the effective path shortest. At present, the most representative ones are the shortest diagonal method, the synchronized advance method of adjacent contour lines, the generalized tri-prism method and the "cut-and-sew" method. Local optimization algorithm is the most widely used modeling method with the advantages of small computation, fast speed, easy to implement and good modeling effect.

4. Construction of 3D tunnel model based on section
When building a 3D tunnel model, it is necessary to convert the standard designed cross-section of the tunnel into the 3D space section under the geodetic coordinate system, and then conduct modeling in combination with the 3D geological model already built [5]. The modeling process can be divided into creating a two-dimensional cross-section tunnel model and connecting adjacent two-dimensional cross-section tunnel model. The 3D tunnel model is represented by TIN model, which is conducive to the expression and rapid visualization of tunnel data structure, and facilitates the query of topological relations among various parts of the model and calculation and analysis of spatial correlation such as volume and area.

4.1. Pretreatment of tunnel excavation contour
The horseshoe tunnel section commonly used in engineering practice is studied, and the contour of tunnel excavation is pretreated by "linear approximation curve", that is, the curve is simulated by multi-section lines. The arcs were bisected according to an interval of 0.125 rad, and then the endpoints of each small arc related to straight lines to form multi-segment lines. This method kept the multi-segment lines formed after bisecting basically smooth.

4.2. Creation of two-dimensional tunnel model
To create a two-dimensional tunnel model, the intersection point of each formation line and tunnel contour should be calculated first. We then add the limiting constraint edges based on these intersections. A bounded constraint has two parts.

The steps to add the constrained edges at the intersection of formation boundary and tunnel excavation contour are as follows:

1. Traverse all stratigraphic boundaries successively. If the current formation boundary does not intersect with the fitted polygon of the tunnel excavation contour, the current formation boundary is directly added as a constraint edge. On the contrary, the intersection points are inserted into the current formation boundary and the fitted polygon of tunnel excavation contour line respectively.

2. Traverse the stratigraphic boundaries with intersecting points successively, and separate the stratigraphic boundaries from each intersection point into multiple limiting constraint edges.
(3) According to the connection line segments of each finite constraint edge and adjacent strata end points, mutually disjoint and at most
A bounded area polygon with a common edge.

5. Realization of 3D tunnel geological model
This study tested through the program design, the development of 3 d tunnel geological modeling and visualization system based on Windows operating system environment, using c + + language, call the triangle subdivision CGAL library function algorithm under the Microsoft Visual Studio 2013 platform tool set for the compilation of the code, through the Qt cross-platform GUI application development framework system interface, through 3 d graphics rendering engine OSG to realize 3 d geological model and create tunnel model and visualization. Different strata are shown in different colors [6]. According to the reconstructed geological and tunnel 3D model of the tunnel location in the geological cross-section, the tunnel excavation area shows the tunnel excavation results under different stratum conditions (FIG. 2 is the 3D tunnel model).

![Figure 2. 3D tunnel model.](image)

6. Conclusion
To sum up, through the introduction of 3D geological modeling method, the method to reconstruct 3D geological model and the application of tunnel model cutting method are understood, among which the tunnel model cutting method can be used to establish the method with stratum attributes
The three-dimensional tunnel model can intuitively show the relationship between tunnel and stratum, which provides a solution for information visualization of tunnel engineering.

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