

Coal Mine Geology Digitization Management System Development

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Abstract: Geological data information is the important foundation of the mining engineering design and production management. According to the mining engineering of mine geological information management and processing requirements, it established mine geological information database and geological model by using the unified management model of relational data and graphic data. Through geological data management module and the geological mapping management module, it can realize the comprehensive functions of collecting and managing basic geographic data, drilling data, the underlying data of bedrock geology, the underlying data of engineering geology. Automatically set up the integrated graphicsgeological of model and geological data.

1. Preface

With the gradual deepening of mining and the need of digitalization construction of mine geological data, mine geological data also gradually increased and complicated. Data redundancy caused a lot of inconvenience to mine safety production and management. Geological information digitization management system is based on mine geological information and mine production management needs, using geological relationship and graphic visualization to process data. The establishment of mine geological information database and visualization geological entity model has improved the efficiency of mine further exploration, safety production and management.

2. system data sources

There are more data in the field of mine surveying, which involves all fields of production. From the preparation of the mine to the operation of the project, it is impossible to leave the geological data support. The basic data mainly comes from: the mine geological and topographic map (provided by the National Basic Geographic Information Center), the location of geological exploration line and the borehole data (provided by the geological exploration department), and all kinds of data observed in the mine production process. Such as coal seam, fault and other data [1].

3. characteristics of geodetic data in coal mines

The geodetic data of coal mines have the following characteristics

(1) geodetic data are representative.

It is a universal form of representing the state and properties of geological bodies. It describes the shape and trend of geological bodies.



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(2) geodetic data are available, reusable and substitutable.

Surveying, drilling, sampling and geophysical prospecting are all the acquisition and acquisition methods of geodetic data.

(3) geodetic data are timeliness.

It is acquired in different time periods, accumulated and increased for a long time, and the data of time series are formed.

(4) geodetic data are diverse.

The data sources, locations, fields and carriers' differences form the diversity of data.

(5) geodetic data are uncertain.

The data of various space, resources and environment often have some uncertainty and fuzziness.

(6) correlation of geodetic data

Various forms of data have various forms of connection.

4. geological data management application

The geological information database based on the collection of all kinds of basic data such as geography, drilling, exploration line, bedrock geology, hydrogeology, geological structure and engineering geology can realize real-time management, maintenance and visualization of all kinds of information, and deal with some complicated businesses, such as correction of borehole coordinates, real-time management and classification of various reports and accounts, etc. [2-4].

4.1. drilling data management

Borehole data are three kinds of data obtained by drilling method, including drilling data, comprehensive results and logging results. Each type of data is related to each other and complements each other. Drilling results include rock names, lithology, taking rate, core length, thickness, depth of accumulation, etc. Comprehensive results include stratigraphic units, coal seam numbers, cumulative depth, layer thickness, true thickness and true thickness accumulation. Logging results include depth, thickness, logging curves and other data. The system can be input according to all kinds of data characteristics, and finally saved to the corresponding table of geological database.

For geological exploration, the general drilling depth is very large, often more than a few hundred meters. At the same time, due to the different lithology of drill holes and the influence of drill pipe rigidity, in 3D space, the borehole often presents a curve shape, and the depth of drilling is actually the curve length of drilling point from the hole. It is often necessary to carry out many inclinations at different depths. In the process of geological exploration drilling, it is the most accurate way to express the drill hole with the differential equation describing the shape of the borehole curve. However, the calculation of this method is large, and in general, the drill pipe has strong rigidity and the degree of curvature of the borehole will not be great. When the differential method is used, the accuracy of the improved method is very small for the spatial variation of the borehole. Therefore, the borehole can be simplified into a broken line. When the inclinometer works, the n can be arranged according to the depth of different drilling holes ($n=0,1,2\dots$).

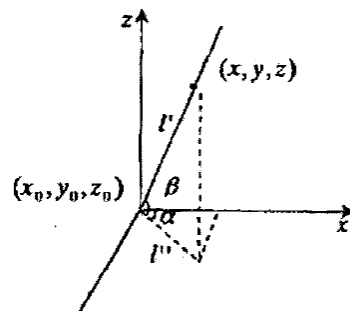


Fig. 1 geographic coordinates of drill holes at any depth

When drilling data processing, when the number of inclinations is $n > 1$, the spatial form of boreholes can be regarded as n broken line, and every borehole inclining point is the broken point. The point of any folding point and broken line can be calculated from the Kong Shen, dip angle and azimuth angle of the corresponding inclinometer point (Fig. 1) [5].

The formula is as follows:

$$l' = l - l_0 \quad (1)$$

$$l'' = l' \cdot \cos \beta \quad (2)$$

$$\begin{cases} x = x_0 + l'' \cdot \cos \alpha = x_0 + l' \cdot \cos \beta \cdot \cos \alpha \\ y = y_0 + l'' \cdot \sin \alpha = l' \cdot \cos \beta \cdot \sin \alpha \\ z = z_0 + l'' \cdot \sin \beta \end{cases} \quad (3)$$

According to the above principles, the system can automatically coordinate the boreholes according to the logging results and drilling data, and get the accurate coordinates of coal (rock) points in each coal seam (rock strata) (Fig. 2, Fig. 3).

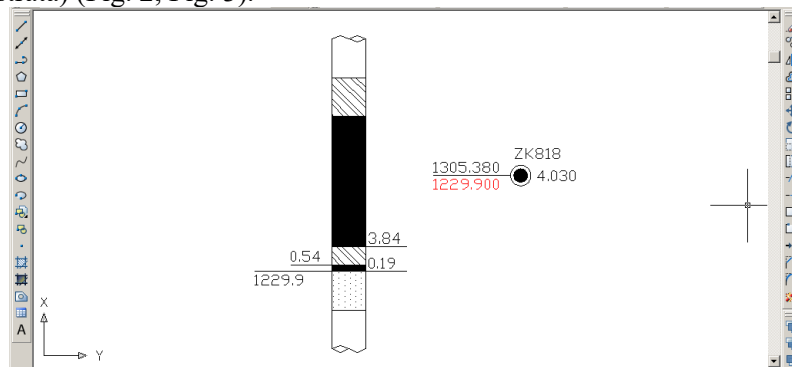


Fig. 2 drilling and drilling columnar drawing

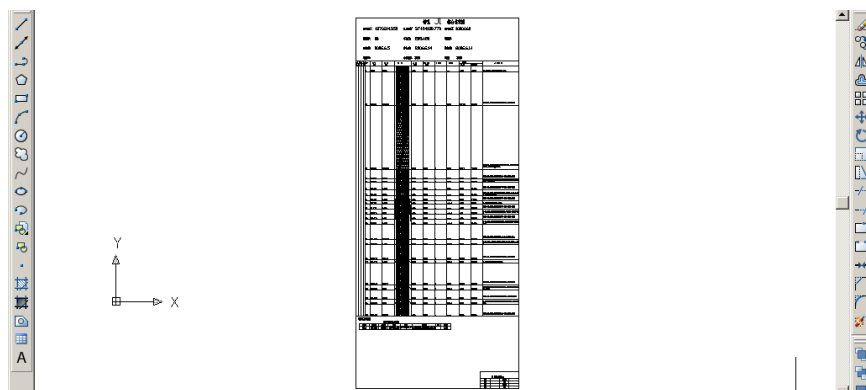


Fig. 3 drawing of comprehensive histogram

4.2. tin modeling of coal seam entity

4.2.1. Tin model building

The coal seam entity model generation module calculates the height and height of the coal seam roof and floor according to the location coordinates of exploration boreholes or measuring points within the scope of the mine field, and uses the interpolation method to calculate the height of the coal seam roof and floor height, and then generates the triangulated triangle net, which is stretched into the top and bottom entities of the coal seam through the triangulation network, and the solid model of the coal

body is generated through entity intersection and union operation. It reflects the spatial form of coal seam and its geological structure.

To set up a solid model of coal seam, we first need to find out the coordinate set of coal seam in the current coal seam from the borehole database. This point is irregular discrete points, and the discrete points must be interrelated to form the surface of the coal seam floor, that is, the tin model.

4.2.2. triangulation interpolation

Triangulation interpolation usually involves the following steps:

(1) retrieval of grid nodes

It is known that the plane coordinate P (x, y) of a certain point is located at the point where the insertion point height of TIN module is Z.. To determine the location of the point where TIN is located, the nearest point Q1 of the distance point can be obtained by calculating the distance, and the triangle with Q1 as the vertex is taken as the basis of judgement. The triangle of P is found. The criterion is whether P is judged by whether the vertex of the triangle is located on the same side of the corresponding edge of the vertex. The coordinates of the point will be subdivided into the straight line equation of the corresponding edge. If the point is not in the triangle with Q1 as the vertex, take the next point close to P times, repeat the above calculation until finding the triangle of P, that is, find the three point coordinates used to interpolate the point height.

(2) elevation interpolation

If P (x, y) is located in triangle Delta, $Q_1 Q_2 Q_3$ The coordinates of each vertex of the triangle are respectively (x_1, y_1, z_1) , (x_2, y_2, z_2) and (x_3, y_3, z_3) There are equations:

$$\begin{vmatrix} x & y & z & 1 \\ x_1 & y_1 & z_1 & 1 \\ x_2 & y_2 & z_2 & 1 \\ x_3 & y_3 & z_3 & 1 \end{vmatrix} = 0 \quad (4)$$

or

$$\begin{vmatrix} x-x_1 & y-y_1 & z-z_1 & 1 \\ x_2-x_1 & y_2-y_1 & z_2-z_1 & 1 \\ x_3-x_1 & y_3-y_1 & z_3-z_1 & 1 \end{vmatrix} = 0 \quad (5)$$

$$\text{Order } x_{21} = x_2 - x_1; x_{31} = x_3 - x_1$$

$$y_{21} = y_2 - y_1; y_{31} = y_3 - y_1 \quad (6)$$

$$z_{21} = z_2 - z_1; z_{31} = z_3 - z_1$$

The height of P point is

$$z = z_1 \frac{(x-x_1)(y_2 z_{31} - y_3 z_{21}) + (y-y_1)(z_2 x_{31} - z_3 x_{21})}{x_2 y_{31} - x_3 y_{21}} \quad (7)$$

4.2.3. contour tracing

The height elevation in the geological elevation model can be represented by the contour model. Each elevation corresponds to a contour line, and a series of contour and elevation databases are constructed into a set of geological elevation models.

Contour model can be generated by tin, but it must be followed by contour tracing algorithm.

The contour line rendering algorithm based on triangle search is as follows.

The triangle table recorded in tin is in the order of its record, and its basic search process is as follows:

(1) for a given contour height h , with all dot height Z_i ($i=1,2,\dots$)(n), compare, if $z_i=h$, add Z_i (or subtract) a small positive >0 (e. E. $=10^{-4}$) to make the program simple and affect the accuracy of the contour line.

(2) the triangle array is identified. Each element has its corresponding triangle. The initial value is False. In order to avoid duplication, the True is set to False.. Once the height and value are changed, it is set to

(3) in order to determine whether or not the contour line crosses any two sides of the triangle three sides. The two terminal coordinates of triangle sides are $P1(x_1, Y1, z_1)$ and $P2(X2, Y2, Z2)$.

$(z_1-h)(z_2-h) < 0$ indicates that there are contour points on the edge.

$(z_1-h)(z_2-h) > 0$ indicates that there is no contour line on the edge.

The first intersection between the contours searched and the triangle edges is set as the starting point of the search. The plane coordinates (x, y) of the contour line of the triangle edge are:

$$\left. \begin{aligned} x &= x_1 + \frac{x_2 - x_1}{z_2 - z_1} (z - z_1) \\ y &= y_1 + \frac{y_2 - y_1}{z_2 - z_1} (z - z_1) \end{aligned} \right\} \quad (8)$$

(4) search the contour line and the adjacent sides of the triangle, and interpolate the plane coordinates of each side.

(5) enter the triangle adjacent to it, repeat the above steps until the triangle edges do not have a triangle adjacent to it (the contour line appears as an open curve), or the triangle edges searched coincide with the triangle edges at the starting point (when the contour lines are closed curves).

(6) for the open curve, we need to reverse the sequence of the contours that we have searched and search it in another direction until the next boundary of the curve is opened.

(7) when a contour line is completely traced, it is smoothed out (CAD spline line). The method is the same as the contour line of the rectangular grid before. The triangle search is applied to all the triangles. After changing the contour height, all the contour lines are plotted again [8].

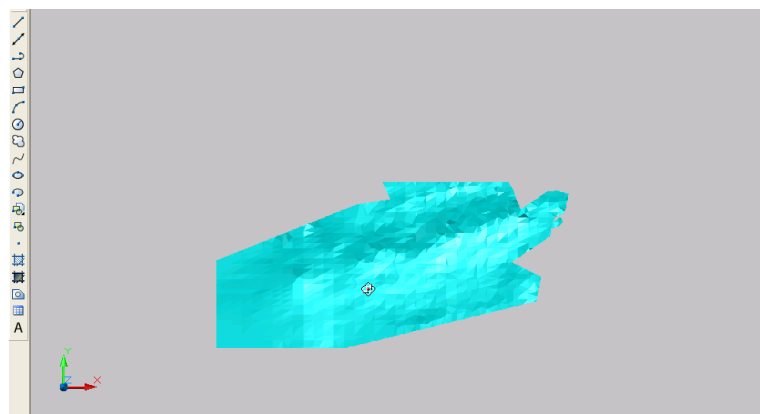


Fig. 4 3# coal solid model

4.2.4. solid modeling

The 3D model of coal and rock stratum is established by the borehole data and contour map of coal seam top and bottom. It can directly show the structural state of coal and rock strata, including coal

seam, rock structure, fault and fold structure. It realizes the basis of coal mining design and analysis of coal (rock) strata occurrence state. Fig. 4 is a solid model of 3# coal seam in Wuyang mine.

5. system data output

The form of data output is graphics, database and report forms. Among them, the graphic output part is the two development drawing interface of AutoCAD, which can realize automatic drawing, printing and output of drilling, drilling, small columnar and comprehensive histogram.

6. Summary

(1) The geological information management subsystem realizes the database management of geological data, coal seam comprehensive data and borehole data, so that all kinds of data can be standardized and networked, providing more real-time and accurate information for the design, safety production and management of mines.

(2) The system realizes real-time extraction and remote extraction of geological data, improves the work efficiency, and ensures the real-time and accuracy of geological data.

(3) According to the data and information base, we can generate visual geological models, classify all kinds of basic information, and make comprehensive drawing of all kinds of data, such as small columnar boreholes, synthetic histogram and so on.

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