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RESEARCH ON THE MANAGEMENT OF LARGE –SCALE TERRAIN DATE

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ABSTRACT

In order to realize the independence of platform to the maximum degree and for the convenience of compatibility with Geodatabase, this paper uses independent form in the object design, which means that it defines by universal data type instead of depending on the data type related to the database. It can develop its own data management software by such design, and it is also very easy to realize the butt joint with an existing database. It provides an effective modeling method for the management of large-scale terrain data.

Keywords: *Large-Scale Terrain Data(LTD)，Digital Elevation Model(DEM)，TIN Model(TM)*

1. INTRODUCTION

In real life, different mines will not be identical at the aspects of habit, management, organization, operation, management strategy and so on, and they have their own modes and characteristics. For GIS and software technology, it shows the differences of user operation mode, database format and so on. According to the research on several mines and the experience accumulated from related works over the years, the current main problem is that the mine produces a lot of data during the production process, and it fails to manage and use the existing data efficiently. Some mines established the database system, but the data type and category of it are still imperfect, and the maintainability and compatibility are bad. After abstracting the problem and discussing with the workers of the mine, I divide the contents of the mine spatial database into terrain, landform, measurement, geology, tunnel network and so on, so as to study the problems of theory and method for designing and establishing the spatial data on this basis.

The terrain data are enormous. Although the modeling algorithm is relatively mature, most software has obvious time lag for photorealistic rendering at present. The system response time will become long along with the increase of data load quantity. In this thesis, it increases the data set rejection based on view point and the function of automatic simplification of detailed degree in the research, and the data volume for processing is controlled within a certain range, so as to accelerate the terrain rendering speed.

In this thesis, there are four sections. Section one presents the introduction of the thesis. In Section two, we propose the construction of a land surface model. In Section three, we will deal with design of data model. Section four gives a conclusion to the whole paper.

2. THE CONSTRACTION OF LAND SURFACE MODEL

Land surface model is the model establishing for terrain surface and it forms the basis of digital mine. The specific modeling methods will be different according to different input data sources. The terrain is represented in the forms of triangulation irregular network (TIN), contour line and regular grid. Actually, these three types of terrain mode can interconnect with each other. The triangulation irregular network can be obtained by the triangularization of scattered points. The contour line can be fitted by interpolating the elevation point based on the triangulation irregular network. The regular grid can be obtained by regular sampling based on TIN or contour line, and vice versa (as shown in Figure 2.1). The reverse operation is performed for reducing the data volume on the basis of preserving the feature points.

2.1 Triangulated Irregular Network Model

The scattered point set is triangulated to form continuous triangle patches.The set of which forms the triangulation irregular network (TIN). TIN has a series of obvious advantages, and the most obvious

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characteristic is that it can realize the modeling of land surface by different resolutions. It adopts less point for the area with flat terrain, and more points for the area with large terrain changes. TIN has more optimized space complexity with respect to the grid model.

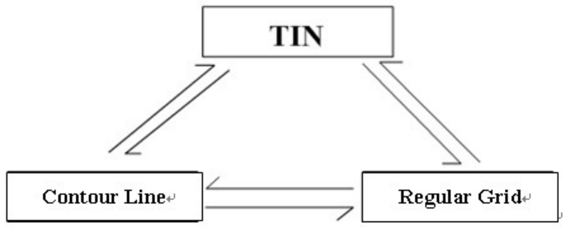

Figure 1: The Representations can Interconvert with Each Other

There are three basic requirements for constructing TIN model:

1) TIN is unique. The triangulation network will not be changed along with different sequences of the points input to the point set;

2) The basic triangle forming TIN should look like a regular triangle (equilateral triangle) to the largest extent;

3) The total side length of the triangle is minimum.

There are many algorithms for constructing TIN, an outstanding one of which is Delaunay triangular network construction algorithm. Supposing V is the limited point set of two-dimensional space, e is the segment formed by the points of this point set, and e is the set of element e. Therefore, one triangulation of the point set V is the graph of a two-dimensional space, which meets the following conditions:

1) The side in the graph does not include other points except the endpoints in the point set;

2) The sides without common endpoints will not intersect;

3) The fundamental plane in Figure 1 is triangle, and the set of the triangle forms the convex hull of a point set in V.

It must meet two rules for the Delaunay triangulation:

1) Empty circle rule is that the finally constructed Delaunay triangular network is unique, any of four points will not be concyclic, and no other point is included in the circumcircle of any triangle of it.

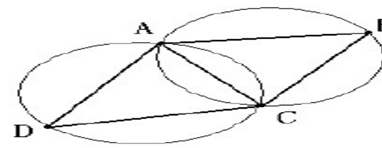

Figure 2: Empty Circle Rule

2) Maximization of the minimum angle is that the minimum angle of the triangle which is formed according to Delaunay triangulation rule in the set of triangular networks formed by given point set is maximum, which means that the minimum angle of six interior angles will not become large by exchanging the internal diagonals in the convex quadrilateral formed by two adjacent triangles as shown in Figure 3

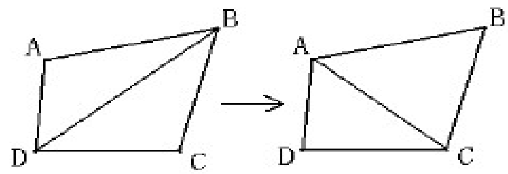

Figure 3 : Maximization of the Minimum Angle

It is not difficult to find that Delaunay triangulation has a series of obvious characteristics:

1) The finally constructed triangular network will be the same regardless of the sequence of the points in the point set;

2) The non-concurrent sides of the triangle formed by three nearest points will not intersect;

3) The minimum angle of six interior angles will not be increased by exchanging the diagonals in the convex quadrilateral formed by any two adjacent triangles;

4) If the minimum angles of every triangle in the triangular network are arranged in ascending order, the value of the angle in the arrangement of Delaunay triangular network will be maximum;

5) Increasing, deleting or moving a vertex will only influence the adjacent triangle but will not influence the nonadjacent triangle;

6) The most outer geometrical line of the triangle forms a convex hull.

There are many algorithms for constructing the Delaunay triangular network, wherein an insertion algorithm is as follows:

1) Constructing a point list which is initialized by scattered points; constructing a triangle chain table used for storing the generated triangles;

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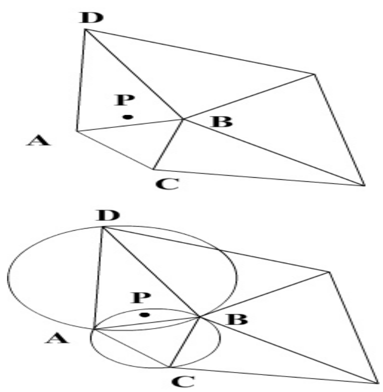
2) Constructing a super triangle of all points in the surrounded point set, which is put into the triangle chain table;

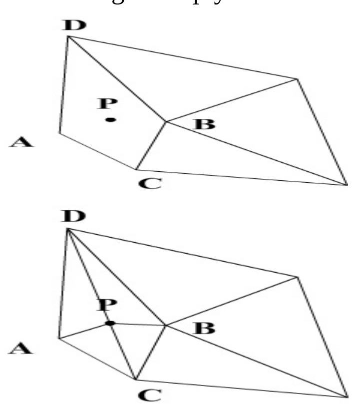
3) Traversing the point list and performing the insert operation. Traversing the triangle chain table, finding out the triangles that the circumcircle of which includes the current point, deleting the common side of the triangles influenced by this point, and connecting this point with each vertex influencing the triangle, so as to finish the insert operation of current point (as shown in Figure 4);

4) According to the rule of maximization of minimum angle, the partial patch with current point as its center is optimized, and the optimization result is stored into the triangle chain table;

5) Circulating to step 3 until all points in the point list are inserted.



(a) Positioning of the point to be inserted
(b) Test of largest empty circle



(c) Deletion of influencing side
(d) Establishing of new side

Figure 4: Schematic Diagram of the Insert Operation of Current Point

Figure 4 shows the process of inserting the current point P, it finds that the influencing triangle of point P is ΔABC and ΔABD according to the test of largest empty circle towards the point P and the triangle in the chain table, the common side $\overline{AB}$ is the influenced side, so $\overline{AB}$ is deleted, and $\overline{AP}$, $\overline{BP}$, $\overline{CP}$ and $\overline{DP}$ are added at the same time.

2.2 Contour Line

In a general sense, contour line means the closed curve with equal elevation point. Intuitively, the contour line can be considered as the intersecting line of the horizontal planes of different altitudes with the actual ground. Figure 2.5 shows a typical contour line. The contour line has a series of characteristics:

1) The altitudes of the ground points with the same altitude traverse are equal;

2) The contour lines except cliff within the single topographic map will not intersect;

Within the same topographic map, the altitude difference of adjacent contour lines is fixed, therefore, it is not difficult to find that the denser arrangement of contour lines reflects larger gradient of the actual ground; conversely, the rarer arrangement of contour lines reflects smaller gradient of the ground. The contour line can reflect the ups and downs and the morphological characteristics of the actual land surface entirely.

Based on TIN, the points on the contour line are calculated by interpolation along the triangle according to specified contour interval, and then these points are processed for interpolation to form a smooth curve finally.

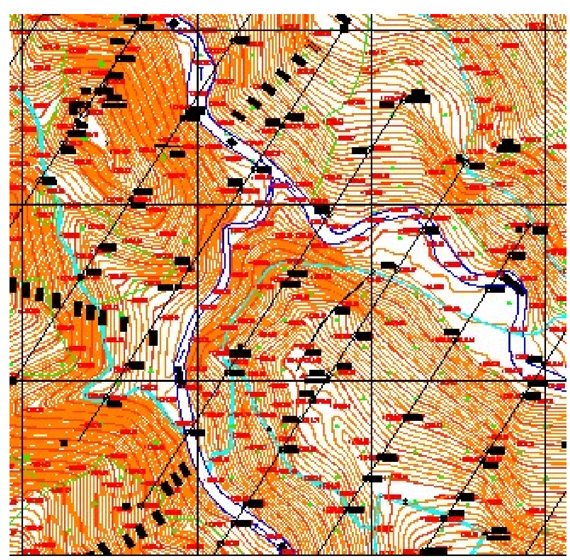


Figure 5: A Typical Contour Line Graph

2.3 Digital Elevation Model

The Digital Elevation Model (DEM) is an order

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data set of the plane coordinate (X, Y) and the elevation (Z) of the regular grid points within certain range, and it mainly describes the spatial distribution of the topographic form within the range of certain area. The DEM is the visual representation of topographic form and can derive the information such as contour line, slope map and the like, which is used for the analytic application related to terrain.

In the practical application, most finally output products for constructing the triangulation irregular network or drawing the contour line are digital elevation model.

In the concrete use, it generally relates to the storage format of genitive format or imp format used for digital elevation model, although these two file formats are stated at open document, it can be input and output the function via low level development by self. The amount of work of low level development is huge, as two standard data formats, there is a function library supporting IO, and GDAL is one of them.

GDAL (Geospatial Data Abstraction Library) is a manipulation function library of open source graphics file. It shields respect different characteristics of each image file in the form of building an abstract data model and realizes the manipulation towards various image files by the uniform port. It provides various grid data supports including many forms of support, such as GeoTiff, Img of Erdas, Jpg, Bmp and so on.

GDAL uses the concept of abstract data model for the uniform abstraction towards the geological grid data, which include coordinated system, data set, coordinate the conversion parameter, control point, wave band, color table, meta data, sub data set and so on. It can be seen that GDAL not only support the manipulation towards digital elevation model, but also supports the manipulations towards the image data in various forms. Actually, most image data are stored in the form of several wave bands, but it is one wave band for the digital elevation model in most cases, that is, elevation wave band.

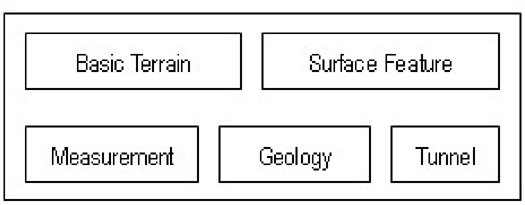

Figure 6: Sub Data Set of Mine Spatial Database

3. DESIGN OF DATA MODEL

The spatial database includes five elements of basic terrain database, geology database, measurement database, surface feature database and tunnel database, as showed in Figure 6.

4. CONCLUSION

In order to realize the independence of platform to the maximum degree and for the convenience of compatibility with Geodatabase, this paper uses independent form in the object design, which means that it defines by universal data type instead of depending on the data type related to the database. It can develop its own data management software by such design, and it is also very easy to realize the butt joint with an existing database. It provides an effective modeling method for the management of large-scale terrain data.

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