

Design and Implementation of Automatic Drawing System for Geological Section

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Abstract: The geological section map uses the specified geological elements to express the characteristics and attributes of the geological body at a certain depth below the section line. By analyzing the functional requirements of the automatic geological section drawing system, the structure and functional modules of the system are designed in detail. The system was developed with AutoCAD as the platform and C# as the development language with the help of CAD secondary development technology. Taking the geological section of Xishimen iron ore mine as an example, the system proved to be efficient in drawing the section, and significantly improved the speed and quality of the section drawing.

1. Introduction

Geological section is a map reflecting the form of tectonics in a certain direction, attitude of stratum, thickness change, stratigraphic contact relationship, fault location and other geological phenomena and their interrelationship at a certain scale. It is one of the bases for systematic analysis of the geological conditions of the designated area, development and utilization of underground resources and engineering construction.

Currently, there are two research directions for automatic drawing of section, secondary development based on CAD ^[1] and development technology based on GIS components ^[2]. In this paper, based on the previous research, we design and study an automatic section drawing system by using CAD secondary development technology and combining with section drawing standards.

2. System Analysis and Design

2.1. System Objectives

The development of the automatic geological section drawing system is based on the .NET framework with the support of computer mapping, CAD secondary development and other technologies to realize the automatic drawing of geological section. The specific objectives of the system can be divided into the following points:

- (1) Standardization of borehole, stratum, fault and fold data.
- (2) Define the distribution pattern of strata according to the stratigraphic pinch-out law and deduce the section line growth law and strategy.

- (3) Mapping faults and folds based on fold and fault data and completing the construction of stratigraphic lines.
- (4) Smooth stratigraphic lines using B-sample interpolation algorithm.
- (5) Generate closed fill areas to complete the filling of the lithological pattern.

2.2. System Requirements

2.2.1. System Data Requirements

The automatic drawing system of geological section map needs borehole, stratum, fault and fold data. The system processes stratum pinch-out based on borehole and stratum data, and then completes the structure of stratum line by combining fault and fold data. Finally, fill the lithologic pattern according to the drilling and stratum data.

2.2.2. System Functional Requirements

According to the drawing process of sectional drawing, the system shall have the following functions:

- (1) Data import. Import borehole, stratum, fault and fold data through Excel table.
- (2) Geological section generation function. The system connects the continuous stratigraphic points of the same stratum into stratigraphic lines by comparing the data of each stratum in each borehole, and constructs geological bodies such as pinch-out and lens with stratigraphic lines according to the law of stratum pinch-out for discontinuous stratum. Then combined with the fault and fold data, the corresponding mathematical formula is applied to express the fault and fold with lines and polygons. Finally, combining the existing stratigraphic line, fault and fold curve, the structure of the stratigraphic line is completed.
- (3) The B-spline interpolation algorithm is used to smooth the stratum line, apply the method of converting spline curve into polylines, combine with stratigraphic lines and fault lines to generate closed fill areas, and complete the filling of lithological patterns.

2.3. System Database Design

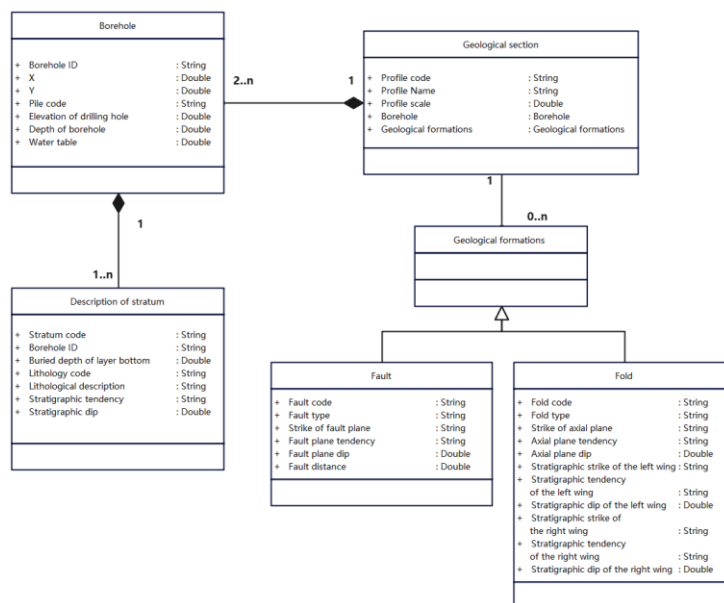


Figure 1: Logical model of system database

In the whole geological section automatic drawing system, the logical model of the system database is shown in Figure 1, which includes data such as borehole, stratum, fault and fold.

2.4. Detailed Design of System

As shown in Figure 2, the whole software system adopts MVC three-layer mode, which is divided into Model, View and Controller.

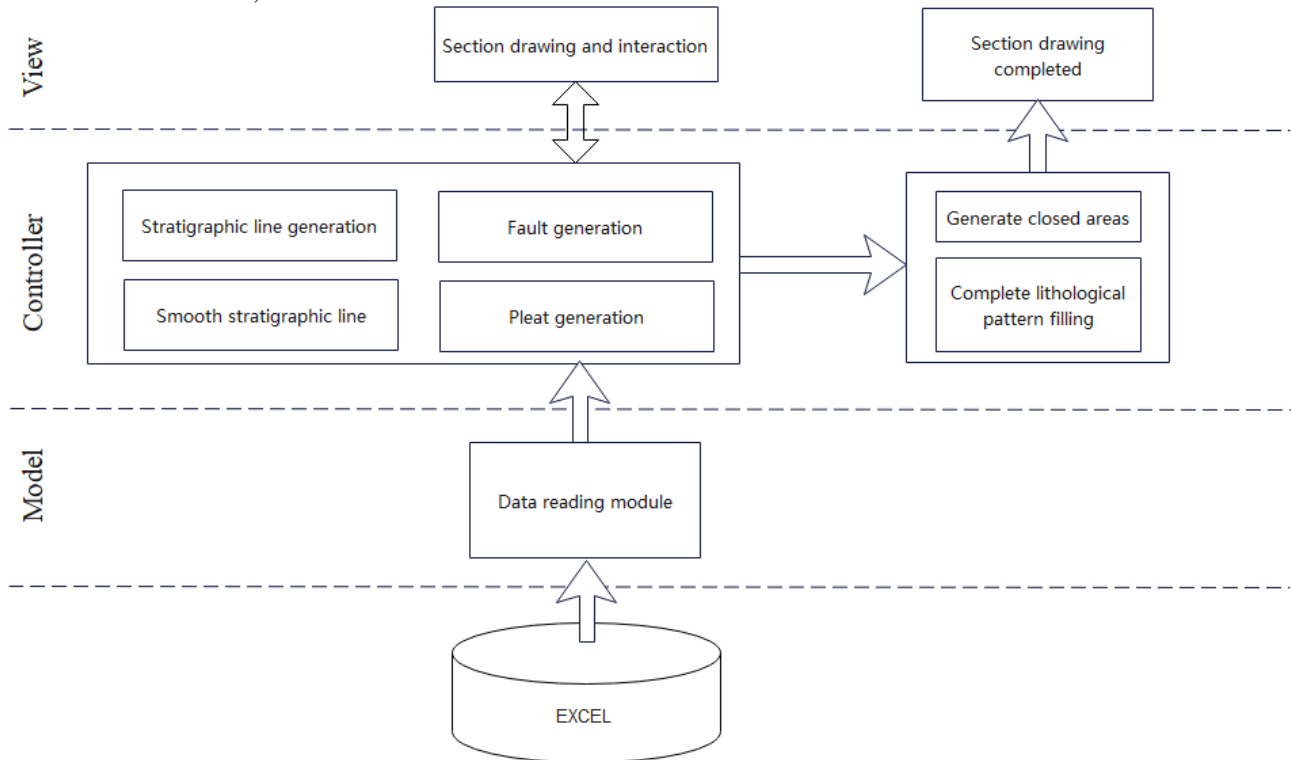


Figure 2: Software system architecture

The model layer is responsible for reading data from EXCEL table and converting it into various value objects for data transmission in the system.

The Controller layer is responsible for selecting the data in the model layer based on the instructions input from the View layer and then manipulating it to produce the corresponding results. Controller layer is mainly composed of geological section generation module and lithologic pattern filling module. The geological section generation module is divided into four parts: stratigraphic line generation, fault generation, fold generation and stratigraphic line smoothing. The lithologic pattern filling module is divided into two parts: closed area generation and lithologic pattern fitting.

The View layer consists of the stratigraphic line drawing and interaction module and the section map generation module. The stratigraphic line drawing and interaction module is divided into two parts: stratigraphic line drawing and human-computer interaction, which can edit and modify the generated stratigraphic line. The section map generation module is responsible for coordinate conversion of geological section data and lithologic pattern data to complete the drawing of the section map.

3. Implementation of the System

Based on the above research results, the automatic drawing system of geological section is developed based on AutoCAD and .NET framework.

By comparing the data of each stratum in each borehole, the growth law of the profile line under each mode is deduced, the trend of the profile line of the stratigraphic points is judged according to the law through the stratigraphic pattern matching, and finally the set of profile points is connected as the stratigraphic line [3]. Considering the similar generation of folds and faults, the two methods are put in the same category. The fault line on the section is calculated according to the intersection coordinates of the fault line and the stratum line and the fault displacement of the fault. Then the line of the fold is determined according to the occurrence of the two wings of the fold and the coordinates of the intersection of the fold and the profile line. The fault and fold are represented by line segments and polygons [4]. Complete the stratigraphic line structure according to the line segment and polygon combined with the existing stratigraphic line. The B-spline interpolation algorithm is used to smooth the stratigraphic line. On the basis of a smooth stratigraphic line, the stratigraphic line is converted into a polyline to generate a closed area, and finally complete the compilation of lithologic patterns according to the stratigraphic dip.

In the process of system implementation, the following representative key problems [5] are mainly solved.

3.1. Lithologic Pattern Varying With the Dip Angle

It is necessary to deal with the difficult problem of lithologic pattern filling in the bending area when drawing a section. The traditional lithologic pattern filling method fills the lithologic pattern according to the fixed stratigraphic dip angle or stratigraphic boundary, which makes the filling effect of lithologic pattern poor. According to the common morphological characteristics of lithologic patterns and combined with computer graphics technology, the lithologic patterns are regarded as the combination of multiple rock layers and a single rock layer is fitted by multiple arcs. Finally, according to the relative position of the points and line segments of the lithologic pattern, add points and line segments between the lithologic pattern layers to complete the filling of the lithologic pattern. The lithologic pattern filled according to this method can change with the change of layer dip angle.

3.2. Mathematical Relationship between Stratigraphic Boundary and Dip

When filling the lithologic pattern, fitting the lithologic pattern according to the stratum dip angle will lead to the single layer of lithologic pattern between adjacent boreholes is an arc, which is not in line with the actual situation of the stratum in reality. According to the variation of the curvature of the formation boundary, the variation of the formation dip angle between adjacent boreholes is calculated. Through two dip angles, N ($N > 2$) dip angles can be calculated. The single layer of lithologic patterns between adjacent boreholes is composed of multiple arcs, and the filling precision of lithologic patterns is improved.

4. Conclusion

Take Xishimen Iron Mine as an example, use the automatic drawing system of section in this paper to draw the corresponding geological profile, as shown in Figure 3. The system can well meet the needs of application, but in the filling process of lithologic patterns, the relationship between the dip angle and the rock boundary needs to be further studied.

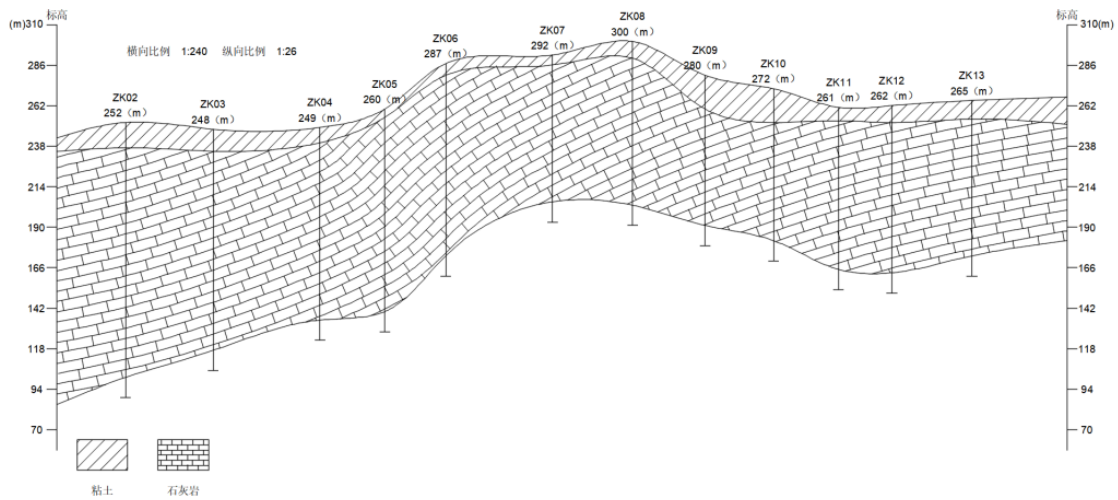


Figure 3: Geological section of Xishimen Iron Mine

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