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Research Article

Storage and Management of Open-pit Transportation Path

Jiusheng Du[1,*], Zheng Hou[2] and Yijin Chen[1]

[1]*College of Geoscience and Surveying Engineering, China University of Mining and Technology (Beijing), Beijing, 100083, China*
[2]*Mining Department, Henan College of Industry and Information Technology, Jiaozuo, 454000, China*

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Abstract

This paper is aiming at the actual demand of open-pit mine daily production scheduling and positioning monitoring. After extracting data from existing topographic maps and other information, it discusses the feasibility of using this data to establish thematic database. By considering the extensive application of GPS data, utilizing new spatial data types of SQL Server 2008 for data storage and management. Extracting data algorithms such as the node spatial data, the regional boundary and the path are implemented, then spatial data storage and management is also realized. It provides the basis for the production of decision-making and production cost savings.

Keywords: Path, Spatial Data, Open-pit

1. Introduction

As foreign truck dispatching system of open-pit are introduced, and the flourishing development of corresponding system in China, both of managers and users are increasingly aware that data mining is very important to the daily operations of open-pit [1], [2], [3]. By considering the actual demand of open-pit mine daily production scheduling and positioning monitoring, it has become a practical demand that using the extracted data of transportation paths and other relevant information to establish thematic database. Now this demand will be satisfied, because as database software from Microsoft, SQL Server 2008 has the functions to handle spatial data [4].

2. Data Extraction

In general, there are various maps available for reflecting the actual open-pit, such as topographic map, topographic map of mining area, transportation system diagram, and so on [5]. These maps can be called base map, and extracting data of transportation paths from them can save a lot of manpower and resources. More importantly, the data can satisfy the needs of establish thematic database. In this paper, Auto CAD maps (Auto Computer Aided Design，hereinafter referred to as CAD) are taken as the example.

2.1 Base Map Processing

Because each base map is unique, the method of extracting road centrelines is classified into two categories: if the path in a map is a double line, the centre line of the double line can be used as the path; whereas, if the path is a single line, it can be used directly.

When we talk about path, region is another necessary concept. Because region means the transportation origin destination, such as gatehead, refuse dump, crushing station, heap gold (the unique of metal). Obtaining accurate boundaries of these regions is a requirement for describing paths. Based on this work, the transport state of each truck in the path can be judged timely.

2.2 Region Coding and Statistics

To facilitate description and management of path, region coding is needful. Regions should be coded based on their actual names, so the code is easily understood and organize by users.

2.3 Path Coding and Statistics

By convention, gatehead is used as the starting point for a path, and unloading point (such as refuse dump, crushing station, and heap gold) is used as the end of a path. In CAD map, most of the path which is from the starting point to unloading point is not a complete three dimensional poly-lines, and consist of short paths. So the short paths should be coded, then an array of them express a complete path.

Table 1: Short Path Distance Table

ID	Distance (meter)
1	751
2	598
3	772
⋮	⋮
29	332
30	277

* E-mail address: rosepig.djs@gmail.com

Table 2: Full Path Distance Table

ID	Starting point	Unloading point	Distance (meter)
1	1	2	751+598+461+488+772
2	1	3	751+598+461+488+570
3	1	23	751+598+432
4	1	24	751+598+362+1442
5	1	25	751+598+362+1888+328+277
6	1	26	751+598+362+1888+328+332
7	6	4	499
⋮	⋮	⋮	⋮
70	18	25	1205+523+362+1888+328+277
71	18	26	1205+523+362+1888+328+332
72	19	21	424
73	20	22	564

2.4 Filter Nodes

Nodes are the three-dimensional points which are comprise paths. The efficient nodes will be stored in database, and they should meet the following rules:

Integrity: by coding each region and short path, all the nodes of paths in CAD map has been successfully extracted.

Uniqueness: according to region boundaries and paths, all the nodes are sequentially coded. By comparing a node with existing nodes, repeating nodes are eliminated. This work is realized with VC++ language in Visual Studio 2008 development platform.

Table 3, table 4 and table 5 reflect the process of filter nodes:

Table 3: Node Coordinates

Point ID	X	Y	Z	Note
1	354398.329	4615950.238	2106.801	Gatehead
2	355612.157	4616966.548	2176.281	Gatehead
⋮	⋮		⋮	⋮
18	354802.332	4616831.252	2193.049	Region 2
19	354761.751	4616834.323	2193.049	
⋮	⋮		⋮	⋮
183	354398.329	4615950.238	2106.801	Path1
184	354374.955	4615945.353	2106.912	
⋮	⋮		⋮	⋮

Table 4: Regional Node Mapping Table

Region ID	Region type	Nodes
1	Gatehead	1
2	Refuse Dump	18-50，18
3	Refuse Dump	271
4	Refuse Dump	50-18,50
⋮	⋮	⋮
23	Crushing Station	17
24	Heap Gold	652
25	Heap Gold	160-112,160
26	Heap Gold	114,162-182,112,114

Table 5: Short Path Node Mapping Table

Path ID	Length	Nodes
1	750.5283	183-215
2	597.9692	215,216-239
3	583.7864	240-271
4	569.5764	272-285,253-267
5	488.25	271,286-312
6-1	522.5589	313-338,239
6-2	460.5919	311,338-341,313-337,237
⋮	⋮	⋮
24	432.2231	569-583,17
25	361.8413	313,584-606
26	1400.5	606-656
27	1888.063	606-630,657,631,658,……664,665,650,666-694
28	327.7783	694-697
29	177.616	697-699
30	60.4044	697,700

2.5 Path Node Mapping Table

By using table 2 and table 5, full path node mapping table is obtained.

Table 6: Full Path Node Mapping Table

Path ID	Starting point	Unloading point	Nodes
1	1	2	1,183-214,214,215-238,311,338-341,237,270,285-311,239-270
2	1	3	1,183-214,214,215-238,311,338-341,237,270,285-311,271-284,252-266
3	1	23	1,183-214,214,215-238,565-579,17
4	1	24	1,183-214,214,215-238,312,580-602,565-579,17
⋮	⋮	⋮	⋮
70	18	25	534-536,489,491,537-543,312,……690-693,693,696
71	18	26	534-536,489,491,537-543,312,……,646,660-690,690-693,693-695
72	19	21	15,555-564
73	20	22	16,508-516,501,517-518,504,505,519-520

3. Coordinate Transformation

When GPS (Global Positioning System) is used in survey, GPS receiver obtain GPS coordinates which belong to WGS-84 coordinate. In China, especially in the open-pit, BJ-54 coordinate is still widely used. This two coordinates are different in many ways, so coordinate transformation is necessary [6].

In truck dispatching system of open-pit, truck terminal obtain GPS coordinates timely. In addition，the paths we talk about are exactly for truck dispatching system. So the coordinates of paths should be WGS-84 coordinate. Since the coordinate of CAD base map is BJ-54, they should be transformed to WGS-84 coordinate. The seven-parameter space transformation model can be used to obtain WGS-84 coordinates from BJ-54 coordinate [7], [8].

4. Storage Path

For convenience of use, the data of regions and paths are stored in the thematic database of truck dispatching system. This database is based on SQL Server 2008.

4.1 Establish the Database

SQL Server 2008 supports the geometry and geography data types for storing spatial data. These types support methods and properties that allow for the creation, comparison, analysis, and retrieval of spatial data. The planar spatial data type, geometry, is implemented as a common language runtime (CLR) data type in SQL Server. This type represents data in a Euclidean (flat) coordinate system. The geography spatial data type, geography, is implemented as a .NET common language runtime (CLR) data type in SQL Server. This type represents data in a round-earth coordinate system. The SQL Server geography data type stores ellipsoidal (round-earth) data, such as GPS latitude and longitude coordinates. The geography type is predefined and available in each database.

Table 7: Analysis of Data Types

Properties	Geometry	Geography
The shape of earth	A plane	A ellipse
Coordinate system	Projection or natural	Planar geography
Coordinates	(X, Y)	Latitude, longitude
Measurements	Unit is the same as the coordinates	Depend on the spatial reference identifier
Orientation of spatial data	Not enforced	Enforced
Default SRID	0	4326
Indication range	Unlimited	Less than half of the ellipsoid
Direction of ring	Not enforced	Enforced
Computation complexity	Simple	Complex

The database of truck dispatching system is a thematic database, which has following features: specificity, integrity, validity, expandability and limitations.

When a thematic database is established, the following rules should be considered: practicability, pertinence, stage and advancement. Table 8 shows tables in the thematic database of truck dispatching system.

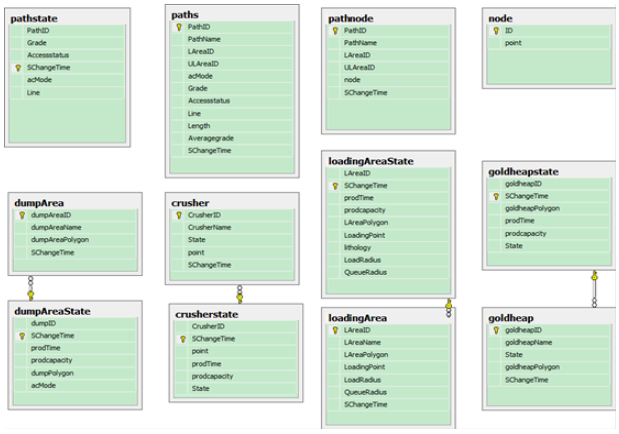

Fig. 1 Database Diagram

Table 8: Tables in the Thematic Database

Table type	Table ID	Table name
Base table	1	node
	2	areanode
	3	loadingAreaState
	4	loadingArea
	5	dumpAreaState
Table of region	6	dumpArea
	7	crusherstate
	8	crusher
	9	goldheapstate
	10	goldheap
	11	pathnode
Table of path	12	paths
	13	pathstate

4.2 Data Storage

Through the work above, data of nodes, regions and paths have been stored in text files. With C# language in Visual Studio 2008 development platform, this data can be stored into the database. Then map of regions and paths are obtained.

Fig. 2 Map of Nodes

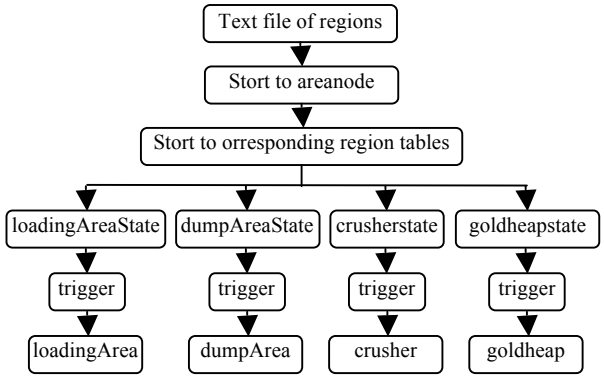

Fig. 3 shows the processes of storage of regions.

When the storage is accomplished, the map of regions is obtained.

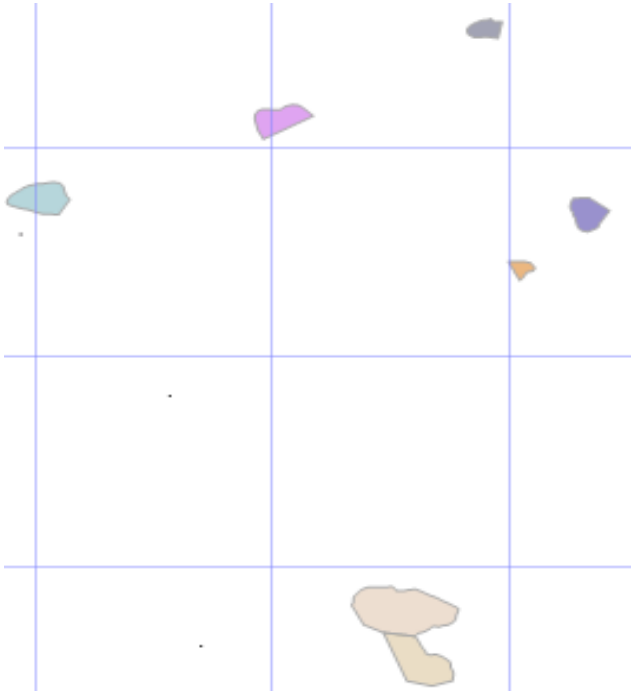

Fig. 4 Map of Regions

Based on above work, paths can be stored into the thematic database.

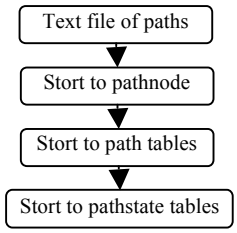

Fig. 5 shows the processes of storage of paths.

Fig. 6 Map of Paths

5. Conclusions

In this paper, a thematic database of truck dispatching system has been established, in which the data of regions and paths are stored. Users can conveniently get information by accessing it.

In further studies, the maps should be updated automatically by updating the relationship, such as the relationship between nodes and regions, and the relationship between nodes and paths. Then users update the map they use by comparing timestamps.

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