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Database Design Base on GIS Gas management Network

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Abstract

To improve the efficiency and operation efficiency of gas pipeline network information management, the characteristics of the data of gas pipeline network is analyzed, the gas pipeline network data is study, and its storage model and organization ways was applied in gas pipeline network to gain information, the model of gas pipeline network is set up and. Base on analysis the gas network GIS system top entity relation, a gas pipeline GIS information system function structure is established. After The system is apply to the xi'an gas company, the management level of the company has improved. In the same time, the system has good expansion character to lay a foundation for the system exploitation.

Keywords: GIS，gas pipeline network，topology，storage

1. Introduction

Information development level is an important mark of a social comprehensive national strength and the development of science and technology, the development of the computer science meet the required and provide the possibility[1-3]. But the geographical Information System (GIS) provides for general spatial Information framework in the social Information development. GIS combine the computer technology and the space geographic data[4]. through a combination of system, the space operation and model analysis, provides useful information for planning, management and decision of earth science, environmental science and enterprise management. Because application gas pipeline GIS can greatly improve the efficiency and operation efficiency of gas pipeline network information management , achieve a more scientific management and decision making, better service for users, and make the enterprise develop itself, the gas network geographical information system (GIS) is becoming the a development trend of all the gas company to realize the scientific management. In the same time, by using GIS technique to store, manage and update urban underground pipeline network space database, through high and new technology such as GPS[5-6], wireless communication, Internet, and virtual reality and so on, and using the operation GIS data and spatial analysis technology, a wide range of real-time digital pipeline user service system is set up to realize storage and retrieval, real-time release of the information, and provide effective technical support for underground pipeline management.

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2 Demand characteristics of gas pipeline network

The data of gas pipeline is a basic network data and meet the general characteristics of network, its basic structure include arc segment and node. the network node entity (such as a valve, drainage device, etc.)include three kinds of feature point such as pipe diameter change point, buried deep change point and network point of intersection. Arc segment express the pipeline section between adjacent node[7].

The gas pipeline data is different from general network data, gas pipeline is mostly designed the circularity in order to reduce the influence of the accident. generally speaking, pipeline network is composed by pipe segment and the affiliated facilities.

According to the layered concept of GIS and the characteristics of network data, the concept model of gas pipeline system is design and is expressed by figure 1.

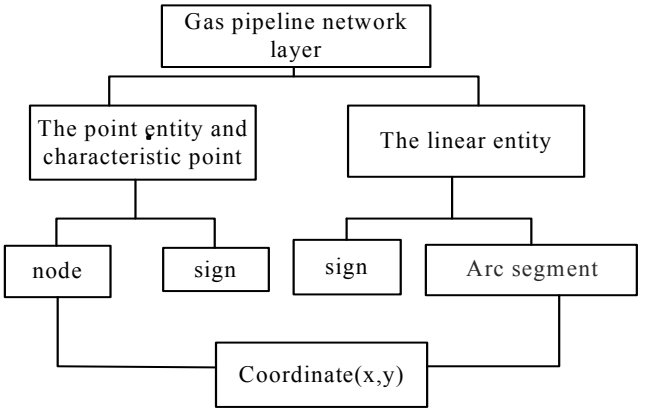

Figure 1 The concept of gas pipeline system

In the figure 1, all of professional layers of the gas pipeline network system is regard as containing in a logic layer, the layer contains two kinds of data entity, such as point entity and feature point, line entity. Point entity and the feature points is composed by mark of the characteristics of node and specified node, a point is going to by geometry coordinate, The linear entity is composed by mark of the characteristics of arc segment and specified arc segment ,arc segment is describe by series of the coordinates.

3 The gas pipeline data model

3.1The spatial data and attribute data storage ways

The data of geographic information system include two parts, that is, spatial data and attribute data. Space data describe target's space position, geometric shapes, and other objects space relation, such as dot, line, face and so on. Attribute data describe the data which are no direct relation to space position, such as the numbers, name, length, diameter, material of pipeline and so on. The spatial data and attribute data is mutual related and are not isolated[8], in the gas pipeline system, data is mainly divided into topographic map data and the pipeline data, each kind of data divided into graphic data and attribute data. Therefore, we must reasonably organize data to meet function needs of system.

The spatial data and attribute data generally have three connection ways. the first is that attribute data is as part of the spatial data; the second is that attribute data and spatial data is seen a complete unit ; the third that attribute data and spatial data is solely organized, advantages of this method is that spatial data and attribute data can manage their respective object, which can bring disaccord between spatial data and attribute data, outstandingly in data update.

In the gas pipeline system, Because quantities of data are large, the third way is used. In the way, attribute data is saved in relational databases, spatial data is expressed by a map files.

3.2 The organization ways of spatial data and attribute data

Organization model of network data is a kind of static object mode and focus on the network data organization method. Now commonly network data organization method has POLYVRT model and DIME mode.

Organization model of network data is a kind of static object mode and emphasize organization method of the network data. Commonly organization method has POLYVRT model and DIME mode[11].

The character of the POLYVRT model is that every space object is make of the basic object in addition to the node object, only the coordinates of nodes is really saved, any complex object is seen as a logic structure and can be define by a set of nodes and topological relationships. POLYVRT model record information of the arc segment, which can well reflect the relationship between network nodes and the linear elements, so the POLYVRT model is suitable to the network analysis which irrelevant line Segment in the linear elements.

DIME model records detailed information of each line segment, it is suitable for network application such as founding buffer, cross section analysis.

In the network data, each arc segment information has a specific attribute information and is described by endpoint nodes and sampling points, so organization model of network data use POLYVRT model. In addition, in the gas pipe information system, surface entity is only used to display and not analyze, so surface entity is expressed by sampling points of the arc segment of the surface boundary. when we describe the point, the arc segment and surface, we only describe the topological relationship between point and the arc segment and ignore the topological relationship between dot and surface, arc segment and surface, thus we can obtain a simplified POLYVRT model. The data of gas pipeline incarnate ring network in the space characteristics. In graph theory, the network topology data usually is stored by the adjacency matrix and adjacent table.

The adjacency matrix is a matrix expressing adjacent relation between vertices in the graphic. Suppose G = (V, E) is a map with n vertex, the sequence number of vertex is 0,1,2... , n-1, adjacency matrix of G is can be defined n order square showed by formula 1.

The adjacency matrix express adjacent relation between vertices in the graphic. Suppose $G=(V,E)$ is a map with n vertex, the sequence number of vertex is 0,1,2... , n-1, adjacency matrix of G is an order phalanx, V is the acme aggregate which is not empty, E is a binary Relations of V, that is， E is ordered couple or disorder pair aggregate of vertex of V, $E(G)$ is the edge aggregate from diagram G . This space complexity of approach is $O(n^2)$, and time complexity of search algorithm is the $O(n)$. The storage structure used to express dense diagrams can be make full use of storage space, but if it used for thin figure, will make adjacency matrix become a sparse matrix, which waste storage space.

Adjacency list is a expressing diagram way. Using the adjacency list, Unidirectional Chain Table with adjacency relations is set up for the every vertex, its head finger is stored by vector. Unidirectional Chain Table With adjacency relations setting up for vertex Vi is called Vi Adjacency list. The every crunode of V_i adjacency list store an edge information which starting point or endpoint is V_i . The space complexity of storage way is $O(n+e)$, the time complexity of a searching vertex output edge algorithm is $O(n/e)$, the time complexity of a searching vertex input edge algorithm is $O(n+e)$, n for vertices, e for the size.

Through analyzing the gas pipeline network, the topology structure of the network is a sparse diagram if it is expressed with diagram. So, topological relationships of network data is expressed with adjacency list, to analyze network topological relationships, out-degree and in-degree information of culmination is save to the node in the adjacency list.

4 Establishing the gas pipeline database and part realization

4.1 The function of gas pipeline GIS information system

According to the needs of the users, we can sort out the top entity relationship figure of the gas pipeline system, it is showed by figure 2.

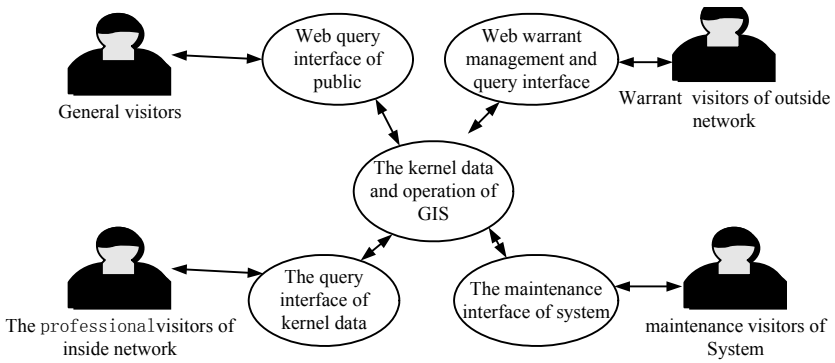

Figure 2 The top-level entity relationship figure of gas pipeline GIS system

The core of Xi'an city gas pipeline GIS system is xi an electronic map and the gas pipeline data appended the map; these data management and maintenance will be the core of the system. On this basis, this system will use the many structures to realize different purpose query. and perform other non-core online transaction processing (such as message board, reporting, etc.). Considering the gas pipeline system GIS is basis for intending users implementing all function of GIS, we must layout all function of the system, and is as much as possible to consider data and technology compatibility. So, complete gas pipeline GIS information system function structure design is showed by figure 3.

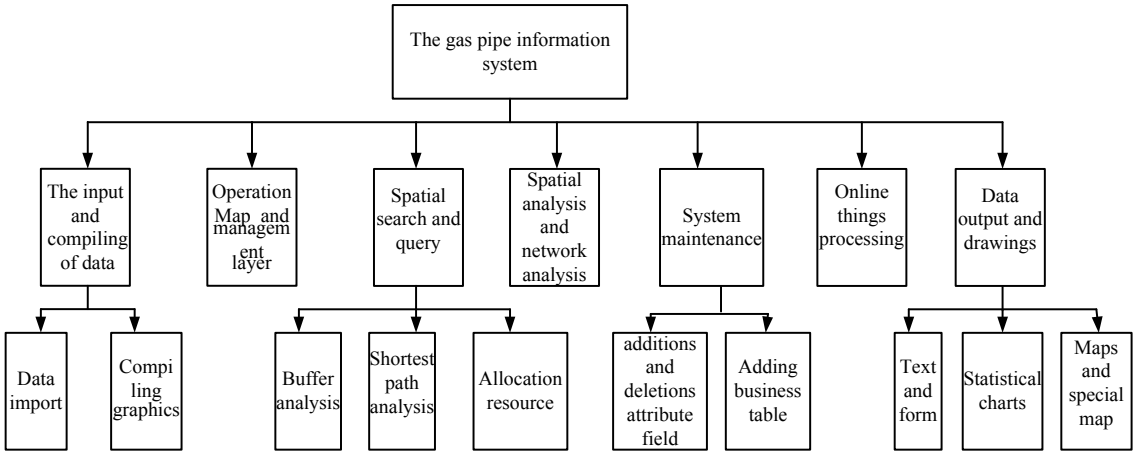

Figure 3 The function of gas pipeline GIS information system

4.2 Data input

Base on the function analysis, genus design, the map matching, and C/S framework basically is realized. The data inputting is basic work of the system. In the system there are three kind data inputting, entity data inputting, checking content inputting and outburst incident inputting. the pipe port inputting of entity data inputting is showed by table 5.

Table 5
Inputting pipe port information

Port ID number	X coordinate(longitude)	Y coordinate(latitude)
T16	108.890671	34.265535
T17	108.894432	34.264959
T18	108.893986	34.260971
T19	108.894837	34.269138

5 Conclusions

Base on fully understanding the needs of xi‘an city gas company, the function of the system is detailed analyzed. By the analysis and comparison, the system structure of web GIS is designed. When the system is used in xi’an gas company, human, material and financial are really saved, in the same time, the management efficiency is improved. GIS gas manage network may process and solve some other problems, for example, The web GIS of the information technology is applied to urban establishment management, then to improve the management technical level of city facilities. Using web GIS to manage city establishment, may realize the dynamic, timely and comprehensive management of the city facilities, provide the right resources, information and data, and promote the urban sustainable development. Making use of GIS make full use of existing some equipment, software and data, minimize system renewal. if users have a new requirement, develop new model can be linked original system, that is, system has a good scalability.

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