The Research on Integrated Visual Information Management System of the Mine Ventilation and Safety

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Abstract

This article is a summary of research results on integrated visual information management system of the mine ventilation and safety used in No.2 coal mine of An Jia ling, and a GIS-based graphical system is developed, including the system function design, the system database construction and collation, integration and management of data. The system which used in mine ventilation and safety management, has truly achieved informatization, intelligentization and modernization, improved the management and efficiency of the mine ventilation and safety management departments, provided technical support for the coal leaders to make right decisions and improved emergency response in the mine disaster.

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1. Introduction

In the mine production process, the mine ventilation and safety is a very important part, and three mine disasters in five such as gas disaster, dust hazards and fire are associated with the ventilation and safety management, the level of which will determine the safety of the mine. The information management is an important part of the mine ventilation and safety management. However, currently in our country, the level of ventilation and safety information management is still relatively backward in many coal mines, which hasn’t completely gotten rid of the traditional manual operation. There are a series of problems including low efficiency, personnel duplication, difficult to find data, long cycle of information transmission, and sometimes even safety information and incidents are reported and handled untimely, resulting in serious casualties and property loss. Therefore, studying the coal mine ventilation and safety information management is very important in the coal mine safety production. The visualization research has extended to various different kinds of fields since a research report included in the National Science Foundation came up the visualization of scientific computing in February 1987. A great number of mine ventilation management systems of computer simulation and...
visualization have been developed these years owing to many scholars’ study and research [1], [2], [3], [4], [5], [6], simulated the mine ventilation network by the computer from different aspects, and achieved encouraging results. The level of ventilation management computer applications has been greatly increased from the initial simple numerical calculation to today’s graphics processing, from a single ventilation network processing to integrated simulation platform, and from CAD-based graphics and VB (or VC + +) graphical visualization techniques [1], [2], [3], [4], [5], to the GIS-based graphical visualization techniques as well[6]. However, from the practical application point of view, management systems that can generally adapt to different mines, suitable for different levels of operators are rarely used. Also, the current ventilation systems are more about information management research, but less studies of mine gas control, fire prevention and other safety information visual system.

To this end, it is much essential to develop the GIS-based integrated visual information management system of the mine ventilation and safety to raise the overall level of the mine ventilation and safety management, and this article is exactly a summary of research results on integrated visual information management system of the mine ventilation and safety used in No.2 coal mine of An Jialing.

2. System Design

2.1 systems functional structure

The system consists of five sub-systems including geographic information management, basic information management, ventilation network calculation, presented monitoring information, systems management, whose functional components shown in Fig 1:

• (1) Map information management
  The map to zoom, pan, layer control and other editing functions were achieved based on GIS. At the same time, the map with the attributes of peer review was also achieved.

• (2) Ventilation-based information safety management
  It has the basic information management functions related mine ventilation and safety, including basic information about the mine, roadway information, fan information, pipe network information, and you can add, modify, delete the records, you also can query the data.

• (3) Ventilation network calculation
  According to the ventilation resistance measurement data, it can the data and prepare wind network solver algorithms, calculate ventilation network and make analog collation of the air flow state during fire.

• (4) Underground monitoring information display
  I can exchange real-time data with mine safety monitoring system, not only read and display algorithms for the exchange data files in accordance with the given data format, but also display the basic information and running status information on the map.

• (5) System Management
  Table 1 shows the system operating environment. It is lower of system operating environment requirements, user-friendly, easy to non-GIS personnel operation the application.

<table>
<thead>
<tr>
<th>NO.</th>
<th>Categories</th>
<th>Environmental Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Software deployment model</td>
<td>Servers are deployed in the mine ventilation or control room team, the clients are deployed in the LAN places need to use the system.</td>
</tr>
<tr>
<td>2</td>
<td>Software distribution model</td>
<td>User interface use client/server(C/S)mode deployment, client management and maintenance use C/S mode</td>
</tr>
<tr>
<td>3</td>
<td>Network platform</td>
<td>No.2 coal mines of An Jialing area network</td>
</tr>
<tr>
<td>4</td>
<td>Operating system platform</td>
<td>Windows Server2000, 2003 Server, XP Professional</td>
</tr>
<tr>
<td>5</td>
<td>Database platform</td>
<td>SQL Server2000 above</td>
</tr>
<tr>
<td>6</td>
<td>Development environment</td>
<td>Model development using VB + ArcEngine</td>
</tr>
<tr>
<td>7</td>
<td>Host system</td>
<td>The use of high-end PC servers</td>
</tr>
<tr>
<td>8</td>
<td>Storage Systems</td>
<td>Unified storage on a PC server</td>
</tr>
<tr>
<td>9</td>
<td>Data backup system</td>
<td>Cold backup (regular manual backup)</td>
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</table>
In addition, the management of systems users and permissions are achieved to ensure that only authorized personnel can enter the corresponding application, and operate as the limit authorized. All users' identity and the corresponding password are saved into the password table by the systems. The identifier and password in the table are in pairs. When a user wants to register into the system, systems must first submit his identity and password, and the system retrieves the password table according to the identity corresponding password. If the password matches it, the user is a legitimate user, and the system receives the user, otherwise user will be rejected by systems.

3. System database construction
From the point of geospatial databases and basic properties, No.2 coal mine of An Jialing underground mines ventilation safety integrated visual information management system can be divided into two categories, they are spatial database and property database. The spatial database stores the space location-related information in file formats “Shape” file which is used by GIS software commonly, such as ventilation roadway map and distribution of monitoring points map. The property database stores the description of the ventilation and safety-related status information in SQL Server 2000 in storage, such as roadway names, fan status, etc. Spatial data and property data using the ID number associated with each other in order to facilitate investigation.

The two databases with spatial database and property database can be divided into two five small parts: geographical data, mine basic data ventilation system data, monitoring data, fire simulation data, data dictionary (see fig 2). Basic property data and geographic data is connected via the related words.

4. Data Collation, Integration and Management

Before running the systems, you have to make the collation, extraction and integration of geographic data and basic data.

During data integration, this system uses a data conversion method. The mine map data is from AutoCAD format map file. With the system’s data conversion function, the file will be converted into geographic format data for the systems, that is ArcGIS format.

After the system development finished, the personnel of system maintenance and daily management input the information. You don’t have to input the basic information of monitoring equipment and operating status information, it will be achieved directly from the data exchange file by reading the monitoring system.

In the system, a layer manager was developed using ArcEngine controls, so that the different layers and their corresponding information can be displayed on the same interface simultaneously.

System also integrates the network calculation and fire simulation software MFIRE developed by the U.S. Bureau of Mine ventilation, and the changes of the ventilation system in underground fire can be simulated in the corresponding layer, as well as prompt the correct Escaping escape routes.

5. The Main functions

In this system, the GIS is applied to the mine ventilation and safety information management and the visual system and mine safety monitoring systems are combined. The ventilation network calculation software was coupled in this system. The functions mainly are:

(1) the GIS is applied into the field of mine ventilation and safety, the secondary development is achieved in the approach of DDE / OLE, and the ventilation and safety information visualization management is also achieved

(2) The system has a good interactive feature, and it has achieved the automatic connection and two-way query between the electronic maps and databases, in which thematic maps can be output as needed. Compared to the previous monitoring software with graphics and data separated, the system has successfully achieved to correspondingly and synchronously output the data and graphics.

(3) The system is involved in more comprehensive data, covering the mine ventilation and safety data management in all aspects, such as safety monitoring data, ventilation and resistance measured data, fire simulation data.

(4) Function to integrate the ventilation and safety visualization system, production monitoring and scheduling system is set aside to guide the coal mine safety production.

6. Conclusions and outlooks

GIS-based integrated visual information management system of the mine ventilation and safety is with a high degree of visual, interactive, good man-machine interface coordination, good stability, fast response, strong safety and good comprehension. The system which used in mine ventilation and safety management, has truly achieved informatization, intelligentization and modernization. It has improved the management and efficiency of the mine ventilation and safety management departments, provided technical support for the coal leaders to make right decisions and improved emergency response in the mine disaster, which will play an increasing role in promoting the sustainable development of coal mine safety production.

Prospects of development of coal mine ventilation and safety management, visualization
technology will be the main future trends. In the ventilation and safety visualization system, the display is much better, data processing is more simple and effective, simulation of disaster is more accurate, and integration of information is much better, which will benefit the coal production services. Meanwhile, the WebGIS development on the basis of the existing system make all staff can operate the system with computer networks, which is closer to the actual point of the exercise on a computer to implement the contingency plan, and this will greatly improve the overall safety level, and improve the intrinsic safety.

References


[2] YangLei. The research and implementation of mine ventilation visualization software [D]: (Dissertation) Shenyang: Northeastern University, 2004


[6] ZhangFeng. The research GIS-based mine visual information management system [D]: (Dissertation) Tangshan: Hebei University of Technology, 2005
