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The Study and Application of Safety Information Management System of the Coal Mines

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Abstract

The Safety Information Management System of the Coal Mines is established based on Intranet of the TCP/IP agreement. Web Server Information is classified and managed in order that safety production management, accident prevention, training management and emergency exercise are achieved by different permission users according to CGI, ASP and PHP technology.

1. Introduction

As the rapid development of the coal mine enterprises, the safety information of the coal mines appears characteristics such as multiple data types, large data quantity and complicated contents. The implementation of essence safety and coal mine “six systems” sets up higher requirement to safety information management of the coal mines. The traditional way of manual processing information has been unable to meet the requirements of information management of the coal mines at the new times, only can highly efficient and accurate information management way meet the demands, therefore, to introduce the computer technology into the daily safety information management of the coal mines emerges as the times requires. In recent years, the computer information management method of the coal

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mines has developed rapidly; the safety information management system of the coal mines based on computer network technology is the safety information management procedure which is based on the technology development of CGI and Web\cite{1}. Thanks to its advantages such as simple interface operation, stable system, accurate and rapid data processing and reasonable database classification, the system is widely used in the coal mine enterprises.

![Diagram of System Design Principles](image)

**Fig.1 Design Principles of the System**

2. **Establishment of the Safety Information System**

2.1 **Composition and Technology of the System Hardware**

2.1.1 **Design Principles of the System**

The Client of safety information management system of the coal mines that is designed by taking advantage of the computer network technology realizes remote control of the Server through concentrator, and the Server displays the data after processing on the control screen through lower computer, realizing the users’ access; and the platform management staff to inquire, revise and sort out the information record situation at any time, which is shown as Fig. 1. The Server chooses special server, network card above 100 mega and its matching concentrator as well as the lower computer according to the demands of the hardware system. The management staff control LED by the infrared which is clear and convenient to be operated.

2.1.2 **Setting of the Server**

The system is established based on Intranet of the TCP / IP agreement. The data language between Web server and database is transferred through CGI technology to conduct data exchange\cite{2}. When uses it, the administrator can save, inquire, revise and resave the data in the database by inputting IP address or DNS domain name of the corresponding servers. The data platform of Intranet realizes the data communication for the safety information management system of the coal mines, while the Internet platform technology realizes the resource sharing. The server structures is shown as Fig. 2.
Fig. 2 Figure of the Server Structures

The design and research on Web server and interface.

- First point Web server. The Web server is a transfer station where information communication is carried out between the administrator and the system database. The communication can be realized through common controls such as Java applet or ActiveX etc., while various commands submitted by the administrator are conducted. At present, the mainstream Web server software is Apache and Microsoft’s IIS. IIS is mainly applied for small Intranet platform of which the operation software is Windows NT/2000/XP/2003 Server, while Apache can be operated under Windows, Linux and Unix, by comparison, Apache is a little better. Every coal enterprise shall choose appropriate Web server hardware according to its operation environment.

- Second point Web Interface design. The design of Web interface follows the principle of humanization, and the interface is to be vivid, visual and easy to be operated. To make use of Java, Flash, RIA (Rich Internet application) technology can enable Web interface to be more vivid and to be enable to go through more plug-ins content. The design of Web interface shall be chosen rationally according to the factors such as design language, size of occupation space and operation platform.

2.1.3 Information Management Technology

In order to realize the administrator’s access and use of the materials, it is necessary to design application interface procedure. The common interface procedures are web API (application procedure interface), JDBC (Java database connection) technology and CORBA (Common Object Request Broker Architecture) technology that are able to realize complex amazons3’ full-vitalization storage platform from simple del.icio.us bookmarks service, which meets the administrator’s storage, sharing, calculation, information searching and web2.0 service to the materials. Among them, the technologies of mainstream advantages are mainly CGI, ASP and PHP technologies.

2.1.3.1 Common Gateway Interface (CGI)
The full name of CGI is Common Gateway Interface, that is common gateway interface technology which is a kind of development environment and a kind of development technology as well [3]. The technology is mainly used to transfer command of the Client to be recognizable language in the database, to finish command and data exchange, and to feedback the processing results of command to users, which is applicable in UNIX and Windows systems. The CGI technology makes up the insufficiency of HTML technology, realizes numeration and form submission, search and web database functions. The functions can be realized through programming language such as Perl, C/C++, Java and Visual Basic. But the response of CGI technology is a little slow, and the internet speed will also be affected.

2.1.3.2 ASP Technology

The full name of ASP is Active Server Page. ASP is also a synthesis of the environment and technology. Comparing to CGI technology, ASP has the following advantages [4]:

· First point ASP has no script display. When ASP technology is applied, what is fed back to the users finally is HTML information after processing, and the script is saved in browser otherwise, thus the HTML code generated by ASP procedure may prevent the program from imitating.

· Second point The programming language is very simple. ASP technology can use VB language to conduct programming, thus it is easy to be realized.

· Third point Combination of ASP with “.net” technology. ASP.net technology introduced by Microsoft improves the insufficient safety of the original ASP.

· Fourth point ASP program is able to change interface according to different users, enabling the operation more individualized.

ASP program, mainly applied on Windows NT/2000/XP platform, is rarely applied under UNIX/Linux environment, thus prohibiting the wider use of ASP.

2.1.3.3 PHP Technology

The full name of PHP is PHP: Hypertext Preprocessor. Comparing to the previous two mainstream programs, PHP has the following advantages:

· First point Irrelevance of the platform, that is, PHP operates soundly no matter under UNIX, WIN32 or other platforms.

· Second point Renewal database. PHP can renew the functions in the database continuously, which enables it to represent more outstanding in the formula design aspect.

Although PHP program will cause cumbersome program transplanting when use its own database, the program is still generally considered as one of the languages with the widest application prospect.

2.2 Design of the System Software

2.2.1 Software Development

The current software development are C/S (Client/Server) and B/S (Brower/Server) modes. The safety information management systems of most coal mine enterprises in China adopt C/S mode that distributes a large number of communication data on both of the Client and Server, which reduces calculation quantity, is suitable for local area network where number of users is not large, can adopt VB the 4th language code to program and operate under Windows operation system. In B/S mode, the administrator needs handling the business at the Server only through browser, so the mode is suitable for large client group network and can be realized by adopting tools such as ASP and C++, and it is necessary to operate under the environment where .net Framework and IIS are provided with. In order to exert the advantages of two modes better, the safety information management system of the coal mines in the domestic has developed relevant research and application in which both modes nest each other.

2.2.2 Response Procedure of Software

The response procedure and operation permission of safety information management system of the coal mines are as shown in Fig. 3 [5]
2.2.3 Establishment of the Database

2.2.3.1 Database Design

Among many databases, the database of safety information management of the coal mines adopts SQL Sever database, which is mainly because it has the following advantages:

- First point It can conduct backup and compaction to the data, saving space.
- Second point With partition parallelism, it strengthens management and operation.
- Third point With star-type connection optimizer, its inquiry response is fast.
- Fourth point The group result set and change sheet enable the inquiry more simple.
- Fifth point The integration service can be expanded improving processing efficiency.

2.2.3.2 Classification of Database Contents

The database classifies according to storage information, and the safety information management system of the coal mines classifies to be the following kinds in accordance with the types of database storage data:

- First point Historical information. Such data record the basic information of the coal mines, including introduction to mine, staff allocation and production situation etc., and the operator can inquire and revise such information.
- Second point Formal document [6]. Such information mainly includes existing laws and lawful regulations in China such as safety production and "six systems" setting, and such data can be inquired, input and edited according to different operators’ permission.
- Third point Reference. Such data include thesis or books of coal mine underground monitor, emergency treatment and accident prevention that have been come out or published, the operator inquires, revises and inputs according to the permission.
- Fourth point Core. Such data record the safety production progressing of the coal mine, the establishment and operation situation of safety system (such as “six systems”) [7], allocation situation
of staff, data situation of toxic and dangerous gas at every monitor site and injury situation of former accidents. Such data need authorized operation, providing foundation for preventing the accidents from happening and guaranteeing the intrinsic safety.

- Fifth point Pictures. Such database store the picture materials and calls out them when the above mentioned operation is conducted through command, enabling the interface more vivid, as well as providing the materials for training of the coal mines at the same time. Such data can be uploaded, retained and deleted by authorization.

3. Composition of the System

The safety information management systems of the coal mine enterprise are varied because of their own characteristics. But the systems have the following sub-systems in general:

- First point Safety management. The subsystem is used to realize real-time monitor, inspection, supervision and maintenance conducted by the managers to underground safety production and “six systems”, as well as to revise the problems found in time.
- Second point Production management. The subsystem is used to monitor and guide coal output of every excavation working surface and working situation of the staff.
- Third point Accident prevention and treatment. The subsystem is used to find unsafe action of the staff and unsafe status of machine and environment by calling previous accident materials and combining monitor situations.
- Fourth point Training management. The subsystem mainly aims at aspects such as safety operation regulations, production equipment, emergency danger avoidance, escapes routes as well as use of danger avoidance equipment to train the underground working staff, which prevents “three infringe”, as well as guarantees the staff to be able to adopt right ways to avoid danger when the accidents happen.
- Fifth point Emergency exercise. Based on training management, the emergency exercise in every aspect is conducted as least once every year all over the coal mine, so that the problems are found in the exercise, and emergency pre-arranged planning is perfected gradually, reducing the injury rate of the accidents at last.
4. System User

The safety management staffs of the coal mines are ultimate users of the whole safety information management system of the coal mine, as well as the core objects of the whole system that send out commands, handle information and adopt actual actions. The users are divided into senior, medium and general users. Take one coal mine enterprise for example, senior users are the highest managers of the coal mine; medium users are affiliated medium managers and management departments; general users are basic units and individuals affiliated to real-time monitor or management departments.

Interpreted from the whole state, senior user is State Administration of Work Safety and State Administration of Coal Mine Safety; medium users are coal companies in every province respectively; general users are coal companies of bureau and every coal mine unit. Due to different authorization limits, the data calculated and managed are quite different. State Administration of Work Safety mainly take charge of safety information management all over the country; the coal companies of provincial level are in charge of safety information management within the province and need reporting to the state; companies of bureau level and every coal mine units manage the safety information of the bureau or unit and report level by level\(^{[10]}\).

5. Conclusions

The safety information management system based on Internet, Web, CGI, ASP and PHP technologies are widely admired by many coal enterprises. The system not only exerts the advantage of high and new technology in the information management aspect greatly, and what is more important is that it stores the complex and cumbersome coal safety management information in classifications, enabling the safety management more timely, more efficient and more accurate, so as to assist the managers to reach to the purpose of reducing accident rate and guaranteeing safety production.

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