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Mining database of web-based underground mechanical information

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Abstract. The signal sources of sensor system from mechanical in underground environment were described firstly, and then a kind of networks was presented. System structure of the powered communication system and its hardware were designed, main motion flow of the monitoring equipment was pointed out in this paper based on fully mechanized mining face for complete sets of electric control equipment. From the perspective of the work condition, the system can meet the requirements for the measurement and control in accuracy, real-time capacity and high reliability. The application of database technology into web-based underground working interface information to realize the data processing of remote device monitoring of coal mining underground working interface has been described in this paper.

Key words. Sensor networks, remote sensing, web-based, mchanical information.

1. Introduction

The equipment in the underground coal working face includes shearers, scraper conveyors and hydraulic support and it takes hydraulic monitor system as the core. Sensor networks mainly include coal rocker rise, data acquisition and processing, and according to the shearer's position, the speed of the hydraulic support can be adjusted to make it go along with the scraper conveyor.

The production process and production environment of underground coal are complicated. The drifts and roadways are narrow and small, workers move frequently, and work environment is complicated. With the technical development in coal mining, there is an urgent need for a quick, accurate, flexible network. At the same time, a perfect network is important for the mine safety and efficient production. This paper analyzed the signal sources of network and the monitoring system in mine firstly, and then presented a kind of multiple access system.

Along with the rapid development of network technology, the obtaining and trans-

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formation method of more and more coal mining enterprises is turning to the Web browser. And the research focus of information transmission technology has been shifted from traditional information transmission to the Web browser information analysis and management on Internet. The new emerging Internet service of coal mining will substitute the monitoring network with information transmission as the only goal. Using mining technology through Web will guarantee the safety and efficiency of underground working interface information processing, which has made the information transmission between remote terminal and control center more convenient and reliable.

2. METHODS

2.1. SENSOR NETWORKS

Hydraulic supports, shearers, scraper conveyor are the core of automated and unattended underground system of mechanized mining face, among which, hydraulic support monitoring is the most complex, and the signals of the shearer's relative position and their status are received by sensor based on Bluetooth technology through the hydraulic support. Bluetooth technology is also used to control the hydraulic stepper to support blade machines, and therefore, hydraulic support networks should be the core of the unattended mining face system.

The signal sources of underground sensor system in coal mine not only come from single parameter of monitoring system, but also from many parameters in one aspect and many parameters in various aspects. The sensor signals of the network in mine include switching-signal, analog signal, digital signal and so on. The distribution range of transmission rate is wide from 100bps sensor to picture transmission monitoring network date of 216Mbps each path; Modulation methods in mine include baseband modulation, Amplitude Modulation, Frequency Modulation, Frequency Shift Keying, Phase Shift Keying and so on.

Fig.1 shows the network system. This system transmits sensor signal based on Bluetooth modulation method, and services can be easily implemented. It can provide multi-class access for services of different types in mine. This network employs wireless communication for moving consumer and power line communication (PLC) for stationary consumer in mine lane to combine wire sensor mutually with wireless sensor by tandem adapter.

Bluetooth is used as the basic modulation scheme for broadband networks for this network system in order to resist noise. The hydraulic support of monitoring sensor is completed by coal face control unit to ensure efficient, safe, continuous and stable production, and hydraulic support's shift speed and traction speed are appropriate for shearer [1].

Shearer drum is the key component for cutting coal, and its power consumption accounts for 80% -90% of the total installed power of shearer[2].

This network system may transmit the signals of measuring sensor and monitoring sensor such as the air density, the wind velocity, and dust density of the monitors for the production. The three-machine supporting system comprises of scraper con-

veyor, shearer, hydraulic support in coal face, and according to the forward speed of shearer, the hydraulic support can be adjusted to go along with the scraper conveyor, integrating the three-machine interaction into an organic whole.

2.2. Web Information of Transmission Underground

The mechanized mining face monitoring automation platform comprises of three parts including shearer cutting condition monitoring and control system, hydraulic support pressure detection and control system, scraper conveyor monitoring system. According to location of the shearer, the face monitoring platform can adjust the speed to follow up the hydraulic carrier of the scraper conveyor, so that the three-machine interaction becomes an organic whole.

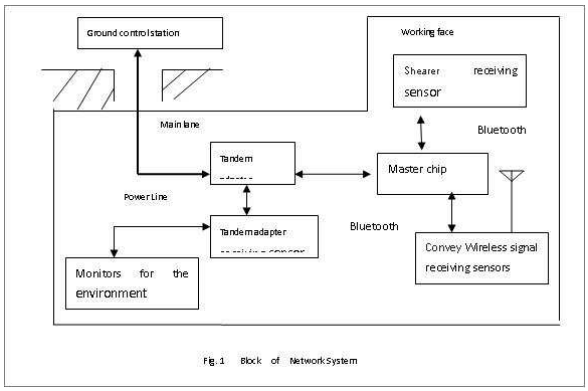

Fig. 1. Block of NetworkSystem

The monitoring platform is used for monitoring and controlling the seam of the mechanized coal face, the connection with the instrument, the combination of the relay and bus systems. From the hierarchy of the system, it can be divided into three parts, the topmost is ground stations, the monitoring stations is located in the middle of the underground tunnel, and the coal face equipment installed in the unit is the bottom

The three machine supporting comprises of scraper conveyor, shearer, hydraulic support in coal face, according to forward speed of shearer, the distance between the hydraulic support can be adjusted to follow up with the scraper conveyor, so that the three-machine interaction becomes an organic whole. Equipment includes shearers, scraper conveyors and hydraulic support, with hydraulic monitor system as the core. Monitoring sensor network of shearer mainly includes coal rocker rise, data acquisition and processing, and according to the shearer's position, the speed of the hydraulic support is adjusted to follow up with the scraper conveyor. The remote monitoring system uses three tandem structures: the control center, monitoring unit and monitoring sensor [3]. More and more enterprises begin to use an RFID technique [4].

The Internet-based Web browser includes not only providing information and services through Internet by the enterprises, but also contains the information trans-

mission inside the enterprise or among enterprises. It is not only the integration of hardware or software, but also the activity conducted by remote terminal, transmission system, control station and relevant partner on the Internet, Intranet and Extranet using Internet technology and existing information system[5].

Mining data warehouse overall framework model for Web is shown as Fig. 2

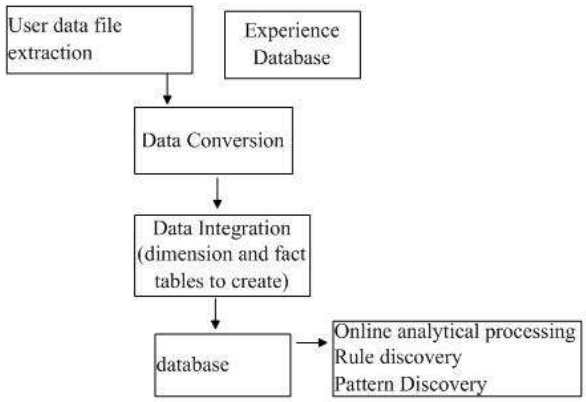

Fig. 2. Mining data ware house overall framework model for Web

Monitoring system mainly includes monitoring level and supervision level. In the field, the equipments are taken as the controlled objects, the information can be uploaded to Ethernet communication module, the control information can be conveyed to control objects with B / S architecture via the controller. Along with increasing connections the Web server exceeding the maximum connections, normal visiting time becoming very long, or error page appearance. Using mining technology in combination with database technology, taking advantage data stored in the database management system, Web has obtained the access mode and node of groups or individual user to provide process speed; to assist users' information transmission. The web-based database and management has been designed in this paper and been realized based on the above mentioned purpose.

Sort out valuable information or mode from the information received by coal mine. Regard database as an effective tool for synthesizing and consolidation of multidimensional space data and providing such functions as data conversion, data search, data integration as well as analysis and processing, which can be integrated with other data mining methods such as association rule discovery, path analysis, cluster analysis in order to strengthen the development and application of integrative knowledge at multiple levels of abstraction, establish and develop database, and use the mining techniques to process data analysis as well as use mining to provide a processing platform for Web use data analysis and Web use mining[6]

Based on the data collected in database and the Web use mining characteristics in analysis phase, using the existing mining methods and technologies, such as statistic analysis, route analysis, cluster analysis, association rule discovery and online analytical processing, to screen unrelated and redundant information, thus to form the mode and information which are wanted by the users. And to conduct visualization

and analysis on the knowledge and mode need to be researched.

The system adopts B/S(Browser/Server) system structure, which is the general browser/server structure [7]. With the continuous development of Internet, B/S structure has improved the C/S structure. The modes of user side have been unified by virtue of Web browser, putting the main processing of system centrally on server, which only need to conduct management on the server, thus to relieve the burden. It is a trouble to conduct management and maintenance within the traditional C/S structure [8], especially in the multi-layer management system, every software shall be maintained. In the B/S structure, user side can use browser without any need to conduct maintenance.

In the remote monitoring system development practice, controller and device / process constitute a closed control loop.

In the remote monitoring system of B / S structure, the monitoring server shall not only complete monitoring task, but also need to complete the HTTP protocol interaction between various client-sides.

2.3. Message Generations, Conversion and Transmission

In the remote terminal gateway, since multiple monitoring equipments (including remote control used in working interface) are controlled by one gateway, and the control data required by different equipments being monitored and the length of status data returned is different, so each remote terminal shall be assigned with equipment number in data transmission, for example, the equipment numbers of hydraulic support, shearer and scraper conveyor device numbers are 01,02,03 respectively, with the length of control data and status data being indicated. In addition, there should be error detection / correction mechanism in data transmission, here adopting to add checksum into data and the rule of circulating transmission. Thus, the data transmitted in each group is consisted of different information, forming a message. Message is a kind of data with fixed format, comprising several words typically, which may contain different information. Communication between application gateway and controllers of various equipments may be realized through interruption, that is to say, when the controller of equipment receives corresponding number, it will process the control / query command comes from application gateway by way of interrupting service routine.

Then the specific generation, conversion and transmission process is described taking the movement process of hydraulic support as an example. Tables 1 is the organization forms of massage in mobile setting of hydraulic support, among which, each data code length is one byte. Equipment number 01H and command number 81H is the setting of hydraulic support panel; equipment number 01H is determined by users' selection of hydraulic support in the list of equipments; command number 8lH is determined by panel setup menu; data length 06H refers to such six bytes as "command number, movement process, control mode, execution time, driven mode, pump pressure," checksum refers to the additive result of "command number, movement process, control mode, execution time, driven mode, pump pressure". Table 1 shows the corresponding operation of the five different code values of "movement pro-

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Table 1. Information organization message

Device No.	Order length	Command number	Control method	time	Passage distance	Pump pressure	Checksum
02H	05H	61H	12H	16H	11H	10H	06H

When the user want to select "movement process " in Web page, click on the "Menu" button, to convert the options through CGI program processing, and form the message according to the agreed format, which may be sent to the serial interface of application gateway and be released via message collecting and releasing module.

3. MINING DATABASE OF WEB-BASED UNDERGROUND

3.1. Server Design

The server adopts B/S-based mode, with the overall to be fixed up by distributed system, among which there are Web server and database server. Database server and sensor at the front of coal mining interface are connected with Ethernet. Equipment information and sensor data are stored in the database, with the request to be delivered by Web server. As the Http server, Web server will response to various requests for displaying at client side, and users can also send command by executing the dynamic script. In the scheme of working interface information transmission system proposed in this paper, server is placed at ground monitoring center, without strict restriction on server design and selection and with no influence of the severe underground environment. Therefore, the approval of increase of sensor quantities and layout density has resulted in the enormous data amount that has been stored in database. The distributed system with B/S mode can be adopted to resolve the problem [9], and conduct management on information using database.

Html hypertext markup language has been adopted for the description and layout of the pages with a set of special tags and labels. The page is formed by the overlaid layers of label codes [10]. The main duties of Web browser is to read files on Html page, and to display them in the form of web pages.

The structure of the database server is shown as Fig. 3

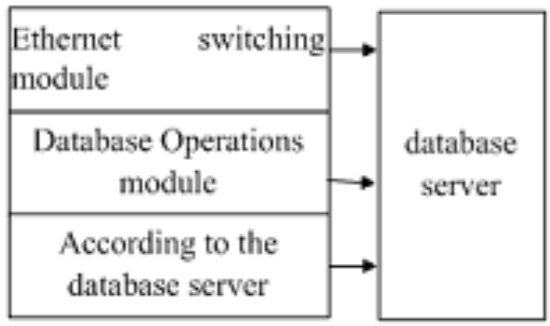

Fig. 3. The structure of the database server

B/S three-layer structure model is shown in Fig,4. In the model, the first layer is the client side, and there is only Web browser in it without any application program. The dynamic data access, remote control and other functions in terms of the status of working interface field equipment can be achieved by users through browser. The second layer is Web server layer, which is used to process all the business logic in application program, and execute the access to database and so on. Get real-time information for entering into database from the database server at the third layer, to generate HTML page information and publish it to the Web browser. The third layer is data layer, which is made of one or more database servers, responsible for

the management of working interface data in the entire application program. The database server is the core of the remote monitoring system. Obtain data from the front-end sensors in the field, and put the data into database after processing. Database server may realize the storage and management of various field data and equipment control parameters, for the access by Web server.

Database system is the core part of the remote monitoring system. Database server mainly consists of Web data response module, database operation module and Ethernet communication module. Database performance will affect the performance of the whole monitoring system. Sensor monitoring unit will transfer data to database server after analysis and processing the data acquired by it, and the data will be stored in a database table, waiting for the query by client side browser. The structure of database server is shown as Fig. 4. In B / S structure, data response is built in, so the only necessity is to develop database operator interface and gateway interaction module.

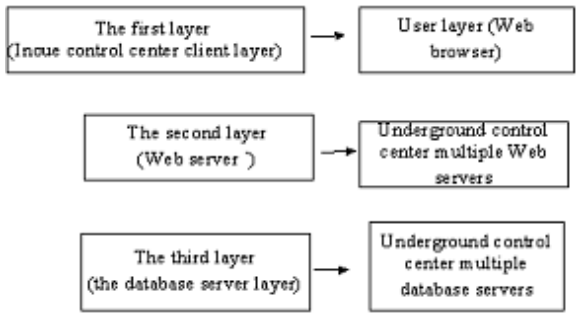

Fig. 4. The three-tier structure model of B / S

3.2. Data Selection, Conversion and Mining

Data selection is to extract the required data from the database in multiple data sources. Due to the dynamic characteristics, the data shall be extracted from the equipment profiles and the accepted database by virtue of incremental mode of Web use mining database. Equipment profiles describe the basic characteristics of the equipment, including output power, voltage, current, power factor, production date, number, etc. which are available at the site of equipment; Web use log reflects the access behavior by control center to the equipment information, and it is generally stored in 3 log formats such as CLF, ECLF and EXLF, including user IP address, state domain, proxy domain, size domain and reference domain and so on. Most of the source data that has experienced data extraction phase is noisy, incomplete and inconsistent, which is difficult to use directly and needs the data conversion, to transform it into the data form suitable for data mining and pattern discovery requirements. In the data conversion phase of Web use mining database, the user profiles and the data conversion of database are relatively simple, and there are quite lot of existing literature.

Data cleansing is to clear the access log record which is irrelevant to Web use

mining: fail access record by user request identified by state domain; the access record by Search Agent or Web Crawler identified by agent or examination of robots. txt files.

Working interface information shall enter into data preprocessing after being sent to the database, which is an important aspect of Web use mining. Data in the Web field are affected by noise, resulting in inconsistent with the actual situation, and the wrongly input data will eventually lead to erroneous mining result. Data mining algorithms can only handle the data that are in fixed format, and only part of the data can use the data mining algorithms for mining. As for data in different formats, those collected data shall be processed prior to determination of mining algorithms.

As the result of data preprocessing is the input of data mining algorithms, which directly affects the pattern and knowledge generated by data mining algorithms, and its quality is the key for assurance of Web use mining quality [11]. Generally, data preprocessing of Web use mining shall go through the following steps: data cleaning, user identification, session identification, path supplement and transaction identification.

Data cleansing, also known as data reduction, is to delete the data irrelevant to data mining tasks in the logs. Only by using the data that correctly reflect the access behavior, can the meaningful knowledge be found out. The data cleansing of Web use mining mainly includes: (l) data merge. (2) delete irrelevant data. User is identified by the information input by him/her.

Web use transition database has been obtained after data preprocessing. Data mining is a process of knowledge generation, which is to implement data mining against Web use transaction database using Web mining algorithms. The data mining technology of working interface information database adopts the classification, clustering and association rules.

Association rule research is mainly used to find the association rules and knowledge among Web page accesses in the information accessed by user. Classification is a process to divide the collected data objects into multiple pre-defined clusters or concepts in accordance with the principle of similar characteristics (for example, the same working surface, the same type of equipment, etc.). In Web use mining, Web users can be classified according to the type of access, or the Web pages can be classified according to user access mode. Classification can be accomplished in two steps: The first step is to establish a criterion, and give a description of the characteristic concepts by analysis of data; the second step is to extract the data's own characteristics, and divide it into categories according to definition, and then to conduct evaluation. Clustering is to divide the data into multiple concepts in accordance with the principle of characteristic similar, but the difference between it and classification is the unsupervised machine learning, without pre-defined concepts.

4. EXPERIMENT AND CONCLUSION

With the further development of Internet technology, the replication and aggregation of the data information receive by Web into database through database technology can be realized, to achieve multi-user sharing as well as information

management and development, then form the use mining knowledge facing Web. We can more precisely improve the design of Web site using data mining information. Convert the stored data into an access sequence set, and then to mine the access sequence set using the association rule mining algorithms, thus to find the corresponding optimal model. Through the actual application by multiple industrial and mining enterprises, it has been proved that, the Web use mining database system of information management for underground working interface proposed in this paper is effective in term of user access analysis, intelligent aided decision and other aspects, and has brought safety and efficient to enterprise production.

We tested the data network based on multiple accesses with the modulation method. The result of the test displayed that system designed based on multiple accesses with modulation method was feasible.

This paper firstly analyzed the signal sources of sensor system in mine, and then put forward the network system based on Bluetooth in mine. The system not only satisfies the general demand of production and communication monitoring, but also takes solution to emergency into consideration. This system is the result of combination of wire sensor with the sensor by tandem adapter. Wireless sensor is used in mining area and sudden accident. There are a variety of modulation methods, we can choose appropriate modulation method according to equipment transmission signals to resolve the compatibility problem of the whole system. The experiment was introduced finally to realize the high-speed data transmission, and the result shows that it is feasible.

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