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Research on Monitoring Processing and Early Warning Model Based on Big Data Analysis

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Abstract: *With the continuous development of deep mining, mining environment is getting worse, and the risk of ground pressure rockburst caused by deep high stress is becoming increasingly prominent. In order to rationally develop deep resources and effectively prevent and control safety risks, a real-time monitoring and early warning model of deep mining based on big data analysis is put forward, and a data platform model of ground pressure disaster risk control that connects, analyzes, makes decisions, dynamically predicts and synergistically controls is established, so as to realize the intelligent perception and early warning of ground pressure disaster information and help safe and efficient exploitation of deep resources.*

Keywords: *Big data, Deep mining, Ground pressure monitoring, Risk analysis, Disaster warning*

1. Introduction

In recent years, the resources of non-coal mining are almost exhausted, and the mining environment is deteriorating gradually. With the development of deep mining, the mining temperature is getting higher and higher, especially the risk of earth-rock explosion caused by high stress in deep is becoming more and more prominent. In order to rationally develop deep resources and effectively prevent and control the potential safety hazards in deep mining, it is urgent to establish and standardize a real-time monitoring system of ground pressure that adapts to the complex conditions of deep mining, so as to provide a strong guarantee for the safe mining of deep resources.

With the continuous development of science and technology, micro-seismic monitoring equipment has made continuous breakthroughs in digitalization, multi-channel, high-precision positioning and other aspects, and has been gradually applied in the field of mining. Because micro seismic monitoring, application and management belongs to the multidisciplinary field, under the condition of insufficient professional and technical personnel at this stage, many micro seismic monitoring data not timely analysis and processing, micro seismic monitoring data between mine collaborative analysis and utilization, reduce the efficiency of the monitoring information, the micro seismic monitoring data of the depth of mining ground pressure disaster precursor information processing and disaster early warning has brought great difficulties.

Therefore, the construction of real-time monitoring, processing and early warning system based on big data analysis has great development space[1-2].

2. Research status at home and abroad

At present, the ground pressure monitoring methods commonly used in non-coal mines are displacement, stress and microseismic monitoring which microseismic monitoring technology is the most widely used.

The application of microseismic monitoring in non-coal mine began in the mid-1980s. At present, IMS microseismic monitoring system of South Africa Institute of Mineral Seismology is the representative, formerly the ISSI microseismic monitoring system. Since 2005, the ISSI microseismic monitoring system has been used in many metal mines for rock explosion monitoring and early warning. The ESG microseismic monitoring system of ESGSolutions of Canada has been widely used in deep mining in South Africa, Canada, America, Chile and other countries.

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Generally speaking, the related technologies, industries and engineering applications of microseismic monitoring have shown a development trend from theoretical research to product promotion, from local trial to global promotion, and from primary analysis to professional services, which has become the main means of power disaster monitoring and safe production management in non-coal mines.

On the basis of introducing foreign advanced technologies, some domestic scientific research institutions and companies have also carried out comprehensive application research of microseismic monitoring technology, and gradually formed a series of microseismic monitoring technologies and methods represented by University of Science and Technology Beijing, Wuhan Institute of Geotechnical Research of China Academy of Sciences and Beijing Research Institute of Mining and Metallurgy.

Through the comprehensive analysis, there are some problems in microseismic monitoring and processing at present.

① The algorithm has a low degree of automation, which requires manual intervention. At present, most traditional algorithms rely on artificial feature extraction, which requires a large number of manual settings, making the algorithm rely on the understanding and cognition of human experts. At the same time, the performance of the algorithm is very sensitive to the choice of super-parameters, which is not conducive to being popularized in different projects.

②The existing deep learning architectures will encounter insufficient representational ability and computational redundancy when dealing with ultra-long sequence signals, which are not suitable for processing super-long signals. Defects in the model itself can easily lead to performance bottlenecks.

③ The performance of the deep learning model is closely related to the quality of the training data. Using the laboratory data or the seismic data as the training data for the model training and evaluation cann't reflect the real performance of the model in actual monitoring project.

④ Due to the differences in geological conditions such as lithology, development degree of joints and fissures, fault distribution, rock formation level, and sensor embedding methods, cutoff threshold, response frequency, peak value, etc. Among different projects, the data of different projects often have great differences in distribution. This makes it difficult for models trained in a particular project to generalize to other projects. It is generally necessary to rebuild the dataset training model, which consumes huge manpower and time. In addition, it is difficult to deploy models when a large amount of data is not available in early training[3-4].

3. Microseismic monitoring, processing and early warning model based on big data analysis

3.1. Overall thinking

The overall design idea of the microseismic monitoring and processing based on big data analysis and the early warning model is shown in Figure 1, mainly including three modules: information collection, data analysis and intelligent early warning. Information collection is mainly used for the collection and preprocessing of data of various monitoring system of ground pressure, including static information and dynamic sensing information.

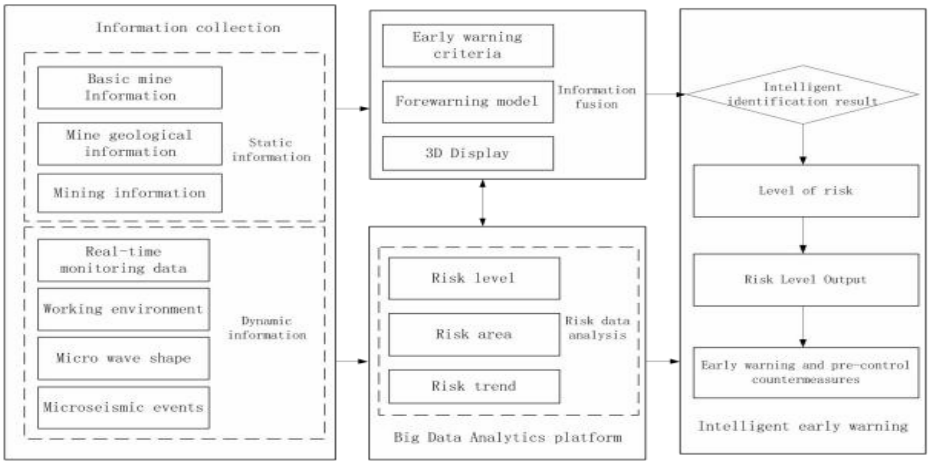

Figure 1: General idea of the model

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Static information refers to the basic data of mine information, mine geological information and mining information; Dynamic perception information includes the correlation and law of monitoring data, working condition environment, microseismic waveform and event. After completing the data collection, a ground pressure multi-source information database is established, and a unified holographic early warning model including static geology, working condition environment and monitoring data is established through multi-source information analysis and organic integration. On the basis of the above, a big data platform for ground voltage prevention and control with interconnection, analysis and decision-making, dynamic prediction and collaborative control is developed to realize the intelligent perception and early warning of ground voltage hazard information.

3.2. Risk identification and early warning system

Based on the risk of big data, identification early warning system as shown in figure 2, model with monitoring system operation monitoring, real-time waveform integrated display and results data display function, can adopt modular design idea development, can real-time monitoring and integration display, using big data analysis microseismic automatically pick up events, to achieve the goal of system integration control and the data comprehensive management.

It has the following specific features.

1) The integration of multiple sources of information. Aiming at the massive monitoring information, a distributed real-time data acquisition system with high throughput and low delay is developed to collect multi source and heterogeneous data such as microseismic, displacement and stress monitoring. Develop multi-source data extraction and conversion technology supporting microseismic, displacement and stress monitoring to analyze and store different data formats. In addition, multiple early warning and prediction decision categories are formed. Classified and stored data clustering and analysis, and each decision category is trained separately to form a corresponding real-time identification model. In order to overcome the problem of "data imbalance", over-sampling method is used to process the characteristic data. Considering the characteristics of monitoring data, the data stream processing and analysis method of time window method is adopted; Considering the heterogeneous characteristics of the monitoring data, the ensemble learning method should be adopted to train, learn, identify and classify the data blocks. Finally, the results of each classifier are fused by decision[5].

In the above-mentioned research process, a number of data science experiments will be carried out to determine the learning model and identification method, explore and reveal the coupling relationship between multi-source information, and determine the scope and degree of mining stable area, risk area and mutation area.

2) Level classification: according to the ground pressure disaster risk level given by the big data analysis platform and based on "5G" network communication technology, the disaster early warning information release system is constructed to realize the intelligent and rapid release of ground pressure disaster risk information. The safety level of the working face (safety level, warning level and early warning level) is given, and the working state of mining equipment (fast mining, slow mining and stop mining) is regulated to form an intelligent mining mode of low pressure fast pushing, medium pressure slow mining and high pressure stop mining, so as to achieve safe and efficient mining in deep non-coal mines.

3) Analysis platform for big data.By integrating the research results with software, a set of big data analysis system for ground pressure disaster early warning is developed, which integrates interface fusion, format conversion, statistical analysis, index priority, weight calculation, grade early warning and information model visualization.According to the characteristics of the software and information data of the ground voltage monitoring and early warning system, the corresponding software and hardware interface, and the corresponding software model, graphs and logical control configuration are developed to realize the real-time receiving and display of the evaluation results of the ground voltage monitoring and early warning system.

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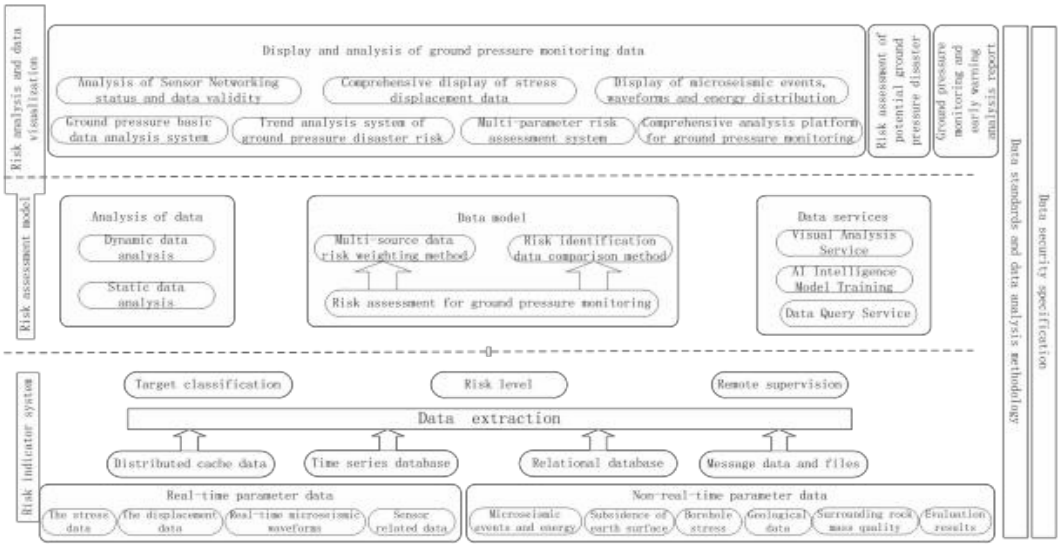

Figure 2: Risk identification and early warning system

4) Real-time data presentation. It can be accessed through the Web to realize the visualization of data. Comprises a content data conversion layer, data acquisition layer, data storage layer, data processing layer and service encapsulation layer. Among them, the data conversion layer is used to unify the format of microseismic data, and the acquisition layer is used to transmit microseismic monitoring data, basic information of mines, etc. The data transmission is based on the Internet technology and is carried out in the form of FTP text transfer protocol. The storage layer adopts the relational database to store the monitoring data and basic information of non-coal mines centrally. The data processing layer provides data processing services, including data analysis and statistics, chart generation, 3D model display and interaction control, etc., and supports the service call of the Web end. The encapsulation layer realizes the monitoring data, system running state, 2D and 3D result data display and information query by processing data provided by the layer.

4. Thinking and prospect

In deep mining based on big data analysis of microseismic monitoring system, on the basis of intelligent monitoring and early warning system, it can effectively collect geological data, real-time monitoring information, mining environment information, etc., using multiple field, source monitoring information rapid acquisition technology, conquer ground pressure monitoring data extraction, cleaning, storage technology and multi-source heterogeneous spatial and temporal monitoring data fusion problem, build ground pressure risk holographic intelligent perception and accurate early warning model, and provide intelligence for the coal mine deep intelligent security.

On the basis of accurate identification and data integration of ground pressure multi-source information, a big data platform of ground pressure monitoring and early warning with interconnection, analysis and decision-making, dynamic prediction and collaborative control is developed, so as to realize the identification and intelligent early warning of hazard information of pressure on construction site, and form an intelligent early warning mining mode supported by data model.

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