Application of big data technology in prediction and prevention of rock burst

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Abstract. Coal and rock dynamic disasters, especially the impact ground pressure dynamic disasters, are major safety technical problems in deep resources mining in China. In view of the basic theory and key technology of ground pressure monitoring and early warning during coal mining, in order to reveal the scale and timing effect of physical field response and the relation with energy accumulation-release, the cooperative relation and equivalent transformation mode of multi-field multi-parameter precursor information, constructing the monitoring and warning index system, big data technology is used to study the characteristics of ground pressure stress-energy-physical parameter coupling feed-off and time-space evolution, while considering the whole mechanical process of ground pressure development, and establish the theory and model of multi-field multi-parameter monitoring and early warning under the background of big data based on space-time complementarity; The purpose of this paper is to establish the theory and method of intelligent identification and early warning of impact ground pressure through studying the intelligent identification method and expert system of the main control factors, disaster risk and precursor information of impact ground pressure under big data. In order to ensure the correctness and accuracy of monitoring information, construct the integrated monitoring and warning technology of shock ground pressure-electric-seismic multi-source information under the complex geological conditions of coal mine, this paper on the one hand studies the accurate monitoring, extraction and identification theory and optimization algorithm of shock ground pressure precursor information based on multi-parameter information fusion, on the other hand develops the active controllable stress inversion technology and equipment based on vibration wave CT, the continuous real-time monitoring theory method of ground stress, and ultra-low frequency electromagnetic radiation monitoring technology. Finally the theory and technology system of impact ground pressure risk identification and monitoring can be concluded.

1. Introduction
The word big data first appeared in the famous futurist Toffler's Third Wave, which summed up the "4 features V" big data: Volume (large volume), Velocity (fast), Variety (variety), and Value (value). In his book The Age of Big Data, Victor Mayer Schoenberg describes future data as a fundamental resource in the workings of the economy, like land, oil and capital [1]. The joint monitoring and
warning system of coal mine impact ground pressure, electromagnetic radiation monitor, ground sound monitor and microseismic monitor are arranged on the monitoring points of coal mine tunneling roadway or transportation roadway of coal mining face, return air roadway of coal mining face and monitoring point of coal mining face respectively, the control receiver is arranged in the mining roadway, the ground monitoring system station is installed on the ground, the electromagnetic radiation monitor, ground sound monitor and microseismic monitor are all connected with the control receiver, and the control receiver is connected with the ground monitoring system station. In the process of monitoring interaction, complement each other, use systematic advantages to systematically analyze the monitoring results, ensure the high quality monitoring and early warning effect, provide a rigorous and scientific monitoring and early warning method, for coal mine safety production free of impact ground pressure hazards escort. The coal mine impact ground pressure monitoring system is based on the new generation of information technology, such as Internet of things, intelligent technology, cloud computing and big data, with comprehensive perception, real-time transmission and intelligent on-line processing as the operation mode, and has established an intelligent real-time monitoring system for the remote 3D stress field of stope surrounding rock, which has the advantages of automatic monitoring, data sharing and remote control [2].

In order to provide theoretical and technical support for early warning, information construction and disaster prevention and mitigation measures under the complex environment of underground space, the dynamic stress risk warning index and model are established in the coal mine impact ground pressure monitoring system [3].

Big data application is more mainly reflected in the safety warning, it is recommended to stop the factory, this warning is very important. For example, Wangjialing water permeable accident, at first is clear water, and later turned red, indicating that this is very close to the place where there is water, experienced workers know to run quickly, but Wangjialing company does not know, they are workers drilling wells for coal mines, do not know these things. If there's a warning, that's gonna avoid it [4]. The relationship between equipment failure and equipment load, coal output, production enterprise and equipment design is analyzed from the data of equipment monitoring, and finally the status report of equipment is put forward according to the factors such as opening and stopping time, humidity, vibration, etc. From the data of roof monitoring, the law of roof pressure is analyzed, which provides the basis for the design and management of roof support.

2. Analysis of impact factors of impact ground pressure accident

Every day, our coal production enterprises produce massive data, but the level of information construction of coal enterprises is still very low. The information resources of enterprises (data acquisition equipment, information infrastructure such as network, storage, computing and other resources) are still at the level of meeting the requirements of traditional information processing. Most enterprises have data storage capacity of about 100 T, servers have less than 100 data, data cannot be stored for a long time, let alone data analysis, historical data is thrown away [5]. Without historical data, real-time data alone cannot be used for data analysis and processing, and the value of data does not work.

At present, the technology of enterprises can only deal with structured data, and the unstructured data and semi-structured data in big data can not be processed. The social resources serving coal enterprises can not meet the requirements of the era of big data. Only individual enterprises begin to analyze the big data of gas monitoring, roof monitoring and equipment monitoring [6].

Impact ground pressure refers to the violent dynamic phenomenon caused by the instantaneous release of elastic deformation energy from rock and coal seam in coal mining face or roadway. Because the occurrence of impact ground pressure is completed in an instant, giving personnel a short time to avoid, so the impact ground pressure accident will lead to casualties and equipment damage. The impact range of impact ground pressure is about 100 meters and the impact range is large, so the impact area of impact ground pressure accident is not only mining face, roadway, chamber also affected damage [7]. Moreover, the impact ground pressure may also cause other accident disasters
and further aggravate the accident. The impact ground pressure accidents are dangerous, which often encountered in the mining of coal mine and metal mine, but the cause of the impact ground pressure is complex and the prevention and cure is difficult, which becomes one of the most headache problems in the mining of coal mine.

There are many factors involved in the impact ground pressure accident. By establishing the index system of the impact ground pressure accident, the analysis process can be simplified, and the detailed analysis of the impact ground pressure accident in Longyun coal industry can be made more clearly and clearly. The impact ground pressure accident index system analyzes the causes of accidents from three levels: factors, events and subsystems.

Table 1. Index System of Impact Ground Pressure Accidents.

| Level I indicators (subsystem level) | Level II indicators (Event Level) | III. Indicators (factor level) |
|-------------------------------------|-----------------------------------|--------------------------------|
| Geological conditions               | Geological structure              | Fault F1                       |
|                                     | Coal seam roof                    | F of roof integrity2           |
|                                     | Physical and mechanical           |太深的影响3. 频繁的影响4.煤体的影响5.煤体的影响6.煤体的影响7.煤体的影响8.煤体的影响9.煤体的影响10.煤体的影响11.煤体的影响12.煤体的影响13.煤体的影响14.煤体的影响15.煤体的影响16.煤体的影响17.煤体的影响18.煤体的影响19.煤体的影响 |
| Mining technology                   | Coal mining methods               | F of extractive activities10F for roof drainage11and small bearing capacity F roadway support system12 |
|                                     | Anti-flushing technical measures not in place | Drill not paying enough attention F13Failure to F timely changes in the system14Anti-scour technical measures F poor pertinence15Don't pay enough attention to the F of shock ground pressure16 |
| Management                          | Impulse monitoring and warning is not in place | Failure F of Stress Monitoring System17Failure to deal with early warning F18 |
|                                     | Impact prevention site management is not in place | Optimization of construction process and time F not studied19imperfect operating procedures F20: Inadequate F of personal protection21F of inadequate regulation22 |
|                                     | Anti-scour education training is not in place | Anti-scour safety education training F not in place23 |
| Personnel                           | Practitioners                     | F of low awareness of anti-scour safety24 |
|                                     | Monitoring staff                  | F of low professional quality25 |

3. BP neural network

Artificial neural network does not need to determine the mathematical equation of the mapping relationship between input and output in advance, only through its own training, learn some rules, and get the result closest to the expected output value when given the input value. As an intelligent information processing system, the core of artificial neural network to realize its function is algorithm. BP neural network is a multi-layer feedforward network trained by error back propagation (referred to as error back propagation) [8]. Its algorithm is called BP algorithm. Its basic idea is gradient descent method. Gradient search technique is used to minimize the error mean variance of the actual and expected output values of the network.

Basic BP algorithm includes two processes: forward propagation of signal and back propagation of error. That is, the error output is calculated in the direction from input to output, while the adjustment
of weights and thresholds is carried out in the direction from output to input. When forward propagation, the input signal acts on the output node through the hidden layer, and after nonlinear transformation, the output signal is generated. If the actual output does not match the expected output, it is transferred to the back propagation process of the error. Error reverse transmission is to reverse the output error through the hidden layer to the input layer by layer, and the error is apportioned to all units in each layer. The error signal obtained from each layer is used as the basis for adjusting the weight of each unit. By adjusting the connection strength of input node and hidden layer node and the connection strength and threshold of hidden layer node and output node, the error decreases along the gradient direction. After repeated learning training, the network parameters (weights and thresholds) corresponding to the minimum error are determined, and the training stops. At this time, the trained neural network can process the input information of similar samples by itself, which has the least output error and is transformed by non-line

BP neural network is a one-way propagation multilayer feedforward network composed of input layer, hidden layer and output layer. Each layer is composed of multiple artificial neurons, and each neuron in the adjacent layer is fully connected. The output of the previous layer is the input of the next layer. First, N input signal enters the network from the input layer, is converted to the hidden layer by the excitation function, and then from the excitation function to the input layer, thus forming M output signal.

3.1. Steps BP neural network evaluation

During the development history of artificial neural network, the perceptron (Multilayer Perceptron, MLP) network has played a great role in the development of artificial neural network, and is also considered to be a truly usable artificial neural network model. As the initial neural network, the single-layer perceptual network (M-P model) has the advantages of clear model, simple structure and small computation. However, with the deepening of the research work, it is found that there are still shortcomings, such as the inability to deal with nonlinear problems, even if the function of the calculation unit uses other more complex nonlinear functions without valve function, it can only solve the linear separability problem. can not implement some basic functions, thus limiting its application. The only way to enhance the classification and recognition ability of the network and solve the nonlinear problem is to adopt a multi-layer feedforward network, that is, to add the hidden layer between the input layer and the output layer. Constitutes a multilayer feedforward perceptron network [10].

(1) Establish a safety evaluation index system for large amusement facilities.

First, according to the establishment principle of safety evaluation index system, a safety evaluation index system is established, as shown in Table 3-2. Mainly from the electrical control, hydraulic pneumatic, mechanical transmission, important parts and connections, equipment foundation and safety protection of the six primary indicators to determine the 26 secondary evaluation indicators.

(2) Structure of the neural network

Choosing a Network Structure for Safety Evaluation of Large Amusement Facilities -- Single Hidden Layer BP Neural Network Structure

(3) Collection and analysis of sample data.

Collect the required data and use it as a learning and validation sample of BP neural network. In this paper, we first take the evaluation form of expert scoring and select 9 times of scoring to calculate the required sample data.

3.2. BP Neural network training

Using MATLAB R2017b neural network toolbox to build BP neural network, First select the sample 1-6 sets of values as input value 2 select the corresponding security level as output value 3 select the Sigmoid function as the transfer function. the excitation function is selected here with f(x) =1/(1+e^-x). And the trainlm function is chosen as the training function, Choose learnngdm as a learning function, 4 Network creation code should be: net=newff (minmax (P), {tansig 'purelin'},' trainlm'), Normally,
Correct weight learning efficiency 0.01-0.7. In this article, we chose 0.01, the training sample set error is set to 0.00001. After four steps, the training error reaches the desired error, this training is over. Only trained and tested networks can meet practical application requirements.

In this paper, we select the sample 7-9 sets of values, as a test sample, get a set of output results. It can be seen from the specific running process that the error between the output result of the inspection sample and the expected value is acceptable in this range. And the network output values of these three groups of test samples are consistent with the previous expert evaluation security grade results. As a result, the BP neural network security evaluation model of this roller coaster is reliable and can be applied in practice.

4. Data processing and analysis

|     | A  | B  | C  | D  | E  | F  | G  | H  | I  |
|-----|----|----|----|----|----|----|----|----|----|
| M1  | 90 | 88 | 90 | 93 | 92 | 93 | 93 | 88 | 90 |
| M2  | 75 | 80 | 75 | 75 | 80 | 85 | 75 | 85 | 75 |
| M3  | 70 | 70 | 75 | 70 | 70 | 75 | 80 | 73 | 78 |
| M4  | 92 | 90 | 90 | 92 | 85 | 85 | 90 | 92 | 88 |
| M5  | 90 | 90 | 93 | 90 | 90 | 88 | 85 | 90 | 93 |
| M6  | 75 | 75 | 70 | 80 | 70 | 75 | 70 | 75 | 74 |
| M7  | 70 | 75 | 70 | 75 | 70 | 77 | 74 | 72 | 70 |
| M8  | 90 | 80 | 90 | 85 | 85 | 80 | 84 | 88 | 88 |
| M9  | 80 | 80 | 85 | 80 | 85 | 83 | 82 | 85 | 85 |
| M10 | 80 | 85 | 85 | 80 | 80 | 75 | 78 | 82 | 80 |
| M11 | 90 | 90 | 85 | 90 | 85 | 88 | 89 | 92 | 85 |
| M12 | 70 | 75 | 70 | 75 | 75 | 0  | 73 | 72 | 76 |
| M13 | 85 | 90 | 90 | 85 | 90 | 90 | 88 | 86 | 90 |
| M14 | 85 | 85 | 90 | 85 | 85 | 88 | 86 | 86 | 90 |
| M15 | 90 | 85 | 90 | 85 | 90 | 88 | 90 | 82 | 88 |
| M16 | 80 | 75 | 75 | 80 | 80 | 80 | 78 | 78 | 80 |
| M17 | 80 | 80 | 80 | 75 | 80 | 80 | 78 | 80 | 82 |
| M18 | 92 | 90 | 90 | 92 | 90 | 90 | 92 | 88 | 88 |
| M19 | 90 | 85 | 90 | 90 | 85 | 90 | 88 | 85 | 88 |
| M20 | 70 | 80 | 75 | 80 | 75 | 78 | 73 | 78 | 80 |
| M21 | 85 | 80 | 85 | 90 | 80 | 85 | 90 | 88 | 84 |
| M22 | 80 | 75 | 85 | 80 | 75 | 80 | 78 | 82 | 85 |
| M23 | 85 | 90 | 90 | 80 | 85 | 88 | 88 | 90 | 82 |
| M24 | 60 | 70 | 70 | 65 | 70 | 72 | 74 | 68 | 65 |
| M25 | 80 | 85 | 85 | 80 | 75 | 80 | 78 | 82 | 85 |
| M26 | 85 | 90 | 85 | 90 | 90 | 88 | 86 | 90 | 92 |
| Output value | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 2  |

Table 2. Expert score sheet.
Output layer selection. Divide the safety of large amusement equipment into four levels: A, B, C, D. That is, safe, dangerous and dangerous. The output grading criteria corresponding to each set of training sample values are determined according to Table 3-4.

**Table 3.** Network Output Classification Standards.

| Security level | Characterization state | G corresponding score | Corresponding output values |
|----------------|------------------------|-----------------------|----------------------------|
| A              | Security               | G > 85                | 1                          |
| B              | Safety                 | 75 ≤ G ≤ 85           | 2                          |
| C              | More dangerous         | 65 ≤ G < 75           | 3                          |
| D              | Danger                 | G < 65                | 4                          |

After the 1-6 groups of data were normalized as shown in Table 3-5, it was determined as the training sample, and then 3 groups of sample data were selected as the inspection sample.

**Table 4.** Sample and Safety Level.

| Serial number | Training sample values | Sample value tested | |
|---------------|-----------------------|---------------------|---|
|               | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    |
| M1            | 0.86 | 0.74 | 0.86 | 0.94 | 0.91 | 0.94 | 0.94 | 0.74 | 0.86 |
| M2            | 0.43 | 0.57 | 0.43 | 0.43 | 0.57 | 0.71 | 0.43 | 0.71 | 0.43 |
| M3            | 0.29 | 0.29 | 0.43 | 0.29 | 0.29 | 0.43 | 0.57 | 0.37 | 0.51 |
| M4            | 0.91 | 0.86 | 0.86 | 0.91 | 0.71 | 0.71 | 0.86 | 0.91 | 0.80 |
| M5            | 0.86 | 0.86 | 0.94 | 0.86 | 0.86 | 0.80 | 0.71 | 0.86 | 0.94 |
| M6            | 0.43 | 0.43 | 0.29 | 0.57 | 0.43 | 0.29 | 0.43 | 0.40 | 0.57 |
| M7            | 0.29 | 0.29 | 0.43 | 0.29 | 0.29 | 0.49 | 0.40 | 0.34 | 0.29 |
| M8            | 0.86 | 0.57 | 0.86 | 0.71 | 0.71 | 0.57 | 0.69 | 0.80 | 0.80 |
| M9            | 0.57 | 0.57 | 0.71 | 0.57 | 0.71 | 0.66 | 0.63 | 0.71 | 0.71 |
| M10           | 0.57 | 0.71 | 0.71 | 0.57 | 0.57 | 0.43 | 0.51 | 0.63 | 0.57 |
| M11           | 0.86 | 0.86 | 0.71 | 0.86 | 0.71 | 0.80 | 0.83 | 0.91 | 0.71 |
| M12           | 0.29 | 0.43 | 0.29 | 0.43 | 0.43 | 0.29 | 0.37 | 0.34 | 0.46 |
| M13           | 0.71 | 0.86 | 0.86 | 0.71 | 0.86 | 0.86 | 0.80 | 0.74 | 0.86 |
| M14           | 0.71 | 0.71 | 0.86 | 0.71 | 0.71 | 0.80 | 0.74 | 0.86 | 0.71 |
| M15           | 0.86 | 0.71 | 0.86 | 0.71 | 0.86 | 0.80 | 0.86 | 0.63 | 0.80 |
| M16           | 0.57 | 0.43 | 0.43 | 0.57 | 0.57 | 0.57 | 0.51 | 0.51 | 0.57 |
|    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|
| M17| 0.57| 0.57| 0.57| 0.43| 0.57| 0.57| 0.51| 0.57| 0.63|
| M18| 0.91| 0.86| 0.86| 0.91| 0.86| 0.86| 0.91| 0.80| 0.80|
| M19| 0.86| 0.71| 0.86| 0.86| 0.71| 0.86| 0.80| 0.71| 0.80|
| M20| 0.29| 0.57| 0.43| 0.57| 0.43| 0.51| 0.37| 0.51| 0.57|
| M21| 0.71| 0.57| 0.71| 0.86| 0.57| 0.71| 0.86| 0.80| 0.69|
| M22| 0.57| 0.43| 0.71| 0.57| 0.43| 0.57| 0.51| 0.63| 0.71|
| M23| 0.71| 0.86| 0.86| 0.57| 0.71| 0.80| 0.80| 0.86| 0.63|
| M24| 0.00| 0.29| 0.29| 0.14| 0.29| 0.34| 0.40| 0.23| 0.14|
| M25| 0.57| 0.71| 0.71| 0.57| 0.43| 0.57| 0.51| 0.63| 0.71|
| M26| 0.71| 0.86| 0.71| 0.86| 0.86| 0.80| 0.74| 0.86| 0.91|

Output value: 2 1 2 2 2 2 2 2 2
Security level: B A B B B B B B B

**Figure 1.** Error Convergence Chart.
Figure 2. Error Distribution.

Figure 3. Local Bayesian networks of rock burst.
From table 11, figure 12, it can be seen that when the number of neurons in the hidden layer is 4, the training time is the shortest BP the neural network training. According to the previous analysis, it can be seen that the number of iterations is the smallest, and the error is also the smallest.

BP the neural network has the ability to store and organize data, it does not need to determine the relationship between input and output previously, but only needs to compare and analyze the self-learning experience and measured data.

5. Conclusions

Under the background of big data, relevant personnel should strengthen the prediction value of impact ground pressure disaster with the help of monitoring and early warning system when preventing and controlling impact ground pressure disaster. It is necessary to solve the heterogeneous problems of operating system, data storage and time frequency in the establishment of the system. Therefore, heterogeneous data integration technology is also one of the key technologies to carry out the work of shock ground pressure disaster prediction.

In order to reduce and eliminate the influence of the heterogeneity of data sources on the prediction information of impact ground pressure disasters, heterogeneous data integration technology can manage the prediction data with different sources and formats, and improve the convenience of the relevant personnel to query the disaster information in real time without hindering the original prediction mechanism of the mine.

Based on big data technology, the core of the design of the early warning system for ground pressure disaster lies in the data storage section. For the data heterogeneity in coal mine safety detection and prediction mechanism, the early warning system of impact ground pressure disaster can be established by means of heterogeneous data integration technology.

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