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Research Article

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Summary of Gas Disaster Prediction and Early Warning

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Abstract: Gas disaster is a relatively common kind of disaster in the process of coal mining, and its risk degree also increases with the increase of mining depth, affecting and restricting the sustainable development of coal mine safety. The safe and reliable prediction and early warning technology can improve the ability to prevent and control gas disasters in coal mines. Through the research of different scholars on the prediction and early warning of coal and gas outburst in China, we summarized and concluded the current methods of gas disaster prediction and early warning to ensure the safe production of coal mines and the life safety of workers.

Keywords: gas disaster; prediction; early warning

1. Introduction

As the depth of mining increases, the harm caused by coal gas will also increase. Therefore, it is necessary to do a good job of gas prediction and early warning in the coal mining process in order to avoid coal gas accidents.

In terms of gas disaster prediction and early warning, scholars have done a lot of research, such as: coal mine accident hazard monitoring and early warning methods, safety detection and early warning systems, self-organizing neural network early warning models and extendable coal mine safety early warning, abnormal early warning of gas content indicators, abnormal early warning of gas concentration gradients, coal and gas outburst early warning index system construction, etc. [1].And in recent years, the development of coal mine gas early warning system based on MVC [2], the application of LSTM to coal mine gas early warning system [3], the application of trend surface analysis method to gas explosion early warning model, the establishment of gas and oxygen concentration prediction model, etc. [4].

This article comprehensively describes the existing methods of forecasting and early warning of gas disasters, and introduces the content, principles and implementation processes of different methods.

2. Gas Disaster Prediction and Early Warning Based on Recurrent Neural Network

Gas disaster prediction and early warning based on recurrent neural networks [5], using efficient data preprocessing methods to process the gas concentration data monitored by coal mines, and make more effective use of data information. Under the premise of existing historical data, based on deep learning methods, the data distribution law of gas concentration overruns, coal and gas outburst disasters or omen events actually occurred underground in the past, and finally realized the prediction of coal mine gas concentration data. Time series prediction based on deep neural network method has more powerful learning capabilities than traditional machine learning methods, can automatically capture the local characteristics of the data, and can learn and model the data. Based on the information fusion perception technology, an entropy-weighted fusion algorithm is adopted to perform data fusion on sensor data at multiple points underground in coal mines. First, the monitoring data of the gas sensor is processed with missing values and outlier values, and then the entropy formaldehyde fusion of the gas concentration in the three places of the work surface, the return air outlet and the upper corner is performed separately. Finally, the data before fusion and the data after fusion are predicted by the recurrent neural network prediction model, and the prediction results are compared. On the issue of gas

disaster prediction accuracy, a gas concentration prediction model of gated cyclic unit neural network based on adaptive moment estimation is constructed. The model performs spatial reconstruction processing on the fused work surface gas concentration data, constructs a training set of the network prediction model, uses the adaptive moment estimation optimization algorithm to optimize, selects the mean square error as the loss function of the prediction model, and establishes a gas concentration model. Based on the research on gas disaster prediction and early warning of recurrent neural networks, the entropy-weighted fusion algorithm further improves the efficient utilization rate of data and the prediction accuracy rate. The gas concentration prediction model has the smallest error on the test set and will have a short running time.

3. Vibration-Induced Coal Mine Gas Disaster Warning

An earthquake is one of the familiar natural disasters. It is a vibration caused by the rapid release of energy by the earth's crust. During coal mining, mine earthquakes will occur and gas disasters will be caused. With the continuous development of the depth of coal mining, mine seismic activities are more prone to occur. At present, our country has established a perfect monitoring network for earthquakes and underground gas, which can provide some help for gas monitoring and early warning in the event of a mine earthquake [6].The essence of the vibration-induced coal mine gas disaster is that the vibration produces energy and creates conditions for the gas to gush out of the gas-containing coal seam abnormally. On the one hand, the ground stress is concentrated in the process of release, causing the gas to exceed the limit, on the other hand, it is the physical damage caused by the vibration. Due to the “first earthquake and then disaster” nature of vibration-induced gas disasters, a gas disaster early warning system can be established. Combining technical means such as mine seismic station network monitoring and underground gas monitoring, real-time monitoring of vibration data and underground gas data, the establishment of vibration-induced gas early warning model, and finally the establishment of an early warning system.

4. Early Warning of Mine Gas Disasters Based on Statistical Analysis

The early warning of mine gas disasters based on statistical analysis [7] is to take whether the gas concentration data conforms to the normal distribution as an indicator of the early warning of gas disasters, and to analyze the abnormal eigenvalues of gas concentration by example. The early warning method first processes the 48 groups of gas concentration data monitored underground and uses Matlab software for statistical analysis as the basis for statistical analysis and adopts D inspection and W inspection for inspection. Using a 95% confidence interval, when the data is significantly level >0.05, accept the hypothesis and consider that the set of data conforms to the normal distribution. The results show that there are 46 data sets that conform to the normal distribution. The use of statistical analysis method to analyze the gas concentration is a reasonable and easy early warning method. When the monitoring data of the gas concentration on the work surface begins to deviate from the normal distribution, it may be a sign of abnormal gas gushing, and timely measures should be taken.

5. Multi-Data Fusion Mine Ventilation Gas Disaster Warning

In view of the reasons why single-source data cannot accurately describe the changes in gas disasters, a mine ventilation gas disaster early warning platform based on multi-data fusion has been developed. The early warning platform can improve the early warning effect of mine ventilation gas disasters and improve the accuracy rate of mine ventilation gas disaster early warning [8].In terms of hardware design, different types of sensors are used in early warning acquisition to collect indicator data such as gas depth, temperature, and wind speed, and pass the information through the signal amplifier to convert the analog signal into a digital signal and transmit it to the single-chip microcomputer. Ulti-source data fusion technology is used to process and analyze the index data and then output the early warning results of mine ventilation gas disasters. In terms of software design, the entropy value method of data fusion algorithm is introduced to describe the characteristics of mine ventilation gas disaster changes, and the early warning level is obtained. After testing, the advantages of multi-data fusion can be used to solve the one-sided defects of single-source data, and the characteristics of mine ventilation and gas disasters can be better depicted, reliability and accuracy can be improved, and real-time performance can be achieved.

6. Conclusion

During the prediction and early warning of gas disasters, the data of gas concentration can be monitored, and the data can be processed by the entropy weighted fusion method for gas disaster prediction. and obtained the following main conclusions:

(1) It is also possible to monitor whether the gas concentration data deviates from the normal distribution to provide early warning. You can also use the mine seismic platform network and underground gas monitoring to monitor vibration data and gas data for prediction and early warning.

(2) Gas disaster prediction and early warning are one of the issues that must be considered in the process of coal mining, and safe and reliable gas disaster early warning technology can enhance the ability of coal mines to prevent and control gas disasters and further ensure the safe production of coal mines and the safety of employees' lives.

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