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Risk Assessment of the Mine Environment Information Based on Multi-Sensor Information Fusion

SONG Qiang[a], WANG Ai-min[b] and SHI Hui-chao[a *]

[a] Mechanical engineering department of Anyang institute of technology, Anyang, China
[b] Computer science department of Anyang normal University, Anyang ,China

Abstract. In recent years China's frequent mine incidents, the scene of the accident left a lot of information and the remnants of environmental information, with mine difficult after coal mine accident dangerous environment of many characteristics, based on multi-sensor information fusion (MSF) of the coal mine environment Risk assessment of the new algorithm, which adopts BP neural network algorithm and establishes model of coal mine environmental information risk of neural network model predicted the three-layer back propagation neural network, the neural network to connect the entire network structure is 5 × 12 × 5, the five input variables are the H2S (%), temperature (℃), wind speed (m / s), methane (%), CO (%), the five output value is the level of security. The simulation experiments show that the model can accurately assess environmental risk coal mine the extent of the model and can verify the effectiveness and feasibility. The application result shows that the prediction with this method can achieve higher better utility and expensive value.

Keywords: neural network fusion; risk assessment; multi-sensor information fusion.

1. Introduction

In the coal mine, complex and bad environment, which has great influence on the physical and mental. Particularly in mining accidents, often accompanied by the gas explosion, gas outburst, gas poisoning, fires, flooding and other incidents. Environmental information of the underground includes gas, temperature, wind information. Mine gas mainly comes from the danger of methane, carbon monoxide,hydrogen sulfide. At the same time environmental information consist of temperature, oxygen concentration, wind speed, and so on. Mine accidents are complex reasons, which is a combination of chance and necessity, the existence of various types of disasters sudden, catastrophic, disruptive and secondary characteristics. Accurate detection of environmental information is essential for mine safety, in order to detect dangerous region includes the contents of the gas, CO, wind speed and temperature, and other environmental information. Therefore, we need to develop a set of multi-parameter detection integration with high reliability, low power, small size of the integrated detection system. At the same time leading to dangerous substances mines and energy in many cases is the gradual accumulation of different factors and are often superimposed effect. Therefore, the design of a wide range of environmental information can be considered a multi-sensor data fusion system, which is an accurate assessment of mine risk the inevitable demand. In recent years, multi-sensor information fusion has received significant attention for both military and nonmilitary applications. Data fusion techniques combine data from multiple sensors, and related information from associated databases, to achieve improved accuracies and more specific inferences than could be achieved by the use of a single sensor alone.

In this paper, We adopt multi-sensor data fusion, technology for coal mine of information for integrated environmental assessment, which has achieved good effect. The goal of the study is to assess of the

* Corresponding author. Tel.: 13523323305; fax: 0373-3924759.
E-mail address: songqiang01@126.com.

environmental impact of the mining system. The results of the study will be used for new mines planning in according with environmental performances and supplied economic values.

2. Multi-Sensor Information Fusion(MSF) Technology

The field of multi-sensor information fusion is fairly young and has only recently been recognized as a separate branch of research. It has been considered from widely different perspectives by scientists of various theoretical backgrounds and interests. In fact, data fusion is a multi-disciplinary subject that draws from such areas as statistical estimation, signal processing, computer science, artificial intelligence, weapon systems, etc. The general problem arising in all these cases is one of how to combine, in the best possible manner, diverse and uncertain measurements and other information available in a multi-sensor system. The ultimate aim is to enable the system to estimate or make inference concerning a certain state of nature.

Traditionally the type of applications to which data fusion has been applied have been military in nature. In the last twenty years, there has been a significant increase in the number of real problems concerned with monitoring problems such as fault diagnosis, safety of complex systems (air-crafts, rockets, nuclear power plants), quality control, plant monitoring and monitoring in biomedicine. These problems result from the increasing complexity of most technological processes, the availability of sophisticated sensors and the existence of sophisticated information processing systems, which are widely used. Solutions to these problems is of crucial interest for safety, ecological, and economical reason .

In addition, the data fusion can also be seen as a fusion of different sources, different models and different media in different times and different information that the organic integration of sensing. Finally, we can obtain more accurate description of the object. Multi-sensor data fusion has the following advantages: ① fault tolerant - in a single sensor failure or error in the circumstances, the system can still work normally and reliable; ② complementary to each other - the sensor targets reflect the common characteristics and reflect, to achieve different Sensor information complementary to each other, improve the utilization of information and understanding of the system to reduce uncertainty; ③ real-time - with less time to get more information and greatly improve the efficiency of identification.

2.1. The Main Method of Multi-Sensor Data Integration

At present commonly used data fusion method can basically be summarized as two major types of random and artificial intelligence, random methods as a weighted average method, Kalman filtering, estimation of the bass, DS reasoning, and other evidence [2-4], artificial smart category are fuzzy logic, neural network, expert systems etc.[5-7]. It can be predicted artificial intelligence and neural networks and other new concept, new technology in the multi-sensor data fusion will play an increasingly important role. Usually the method used by the application of specific identification, based on various methods and the complementarity between the actual and often two or more ways combination of multi-sensor data fusion.

In the multi-sensor system, X_i is the measurement data provided by the ith sensor, X_j is the measurement data provided by the sensor, X_i and X_j comply with Gauss distribution. The PDF (Probability Distribution Functions) curve is regarded as characteristic function of sensor, $p_i(x)$, $p_i(x)$. x_i is a measurement data of , x_j is a measurement data of X_i .

In order to reflect the variation , the confidence distance measure is inducted, suppose

$$d_{ij} = \int_{x_i}^{x_j} p_i(x/x_i)$$
$$d_{ii} = \int_{x_i}^{x_j} p_j(x/x_j) \quad (1)$$

where

$$p_i(x/x_i)=\frac{1}{\sqrt{2}\pi\sigma_i}\exp\left\{-\frac{1}{2}\left(\frac{x-x_i}{\sigma_i}\right)^2\right\}$$

$$p_j(x/x_j)=\frac{1}{\sqrt{2}\pi\sigma_j}\exp\left\{-\frac{1}{2}\left(\frac{x-x_j}{\sigma_j}\right)^2\right\}$$

d_{ij} called as the confidence distance measure of the measurement data provided by the *ith* sensor and the measurement data provided by the sensor.

3. Neural Network Algorithm and the Fusion Model

Many information fusion algorithms, including a Bayesian decision theory, Kalman filtering, fuzzy fusion, neural network integration. Artificial neural network is typically made up of a large number of single neurons called nodes, which is a large-scale information processing system. It mainly imitates processing system from the general structure and functions, rather than realistic details of reproduction, which pays more attention to their neural activity and the information flow. Each neuron is an independent information-processing units, which respectively operates and processes the information received, and then obtain the results. This will enable distributed storage system restore the original information, if some neurons are damaged. Therefore it has more characteristic with greater fault tolerance and associative memory. At the same time, as a real-time processing large amounts of data capacity, and information processing procedures right and wrong style, according to the external criteria for a study, which neural network has more features with self-organization, self-learning, adaptive characteristics, which makes neural networks has been widely used.

3.1. Neural Network Model

Artificial neural networks have the abilities of self-adaptive, self-organization and self-learning, and have the advantages of robustness and fault tolerance to the input of data samples or rules. BP network model is the back-propagation network, which is the most developed arithmetic in neural network, adopted and applied widely at present. The BP network model is typical multilayer network, with three layers of input, hidden, and output, between layers using full-connection, that meaning there is no connection within the layers . It has been proven that the three layer BP neural network can realize any continuous Mapping , and approximate any nonlinear function with arbitrary precision. Three-layer BP network model is established, with the structure shown in Fig.1.

Neural network model structure of mine environmental information risk is the 5 × 12 × 5, which is three-layer back-propagation neural network. As shown in Figure.1, the neural network connect the entire network. Import variables of the five networks are H2S (%), temperature (℃), wind speed (m / s), methane (%), CO (%); 5 Output variables is the level of security. The model for each hidden layer neurons have an additional input, each with 10 hidden layer of value, the value of the additional import is 0.5, which weight value learns in the course of back-propagation .

Each neuron of model has simple non-linear equations. Import neurons consists of a simple degree of membership processing function, since the scope of variables from the actual values into the equation of the most linear part, that is between 0.2-0.8. Hidden layer and the output neurons are the non-linear processing functions as follows:

$$y_j=\frac{1}{1+e^{-\sum_i w_{ij}x_j+w_j\theta}} \tag{2}$$

where y_j is output of the current neurons j; w_{ij} represents the weight value from neuron i to neuron j ; y_i is the output of above neurons; w_j is neurons adjustable threshold; θ is the bias.

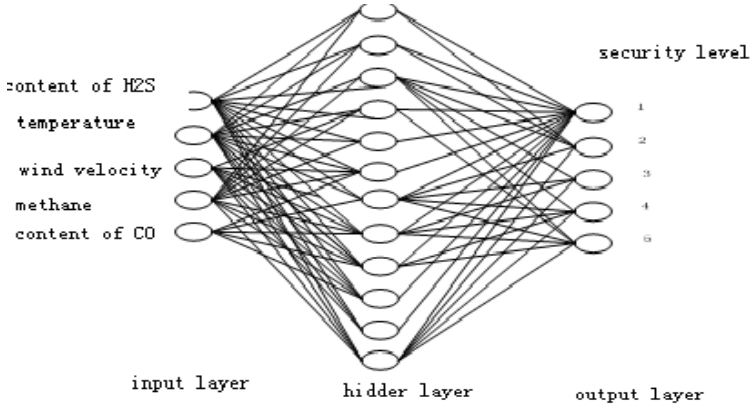

Fig 1: Multi-sensor information fusion of the neural network algorithm network model structure

Table 1:The structure of based on multi-sensor information fusion BP neural network algorithm

Import parameters	Output layer (security level)	network structure
1 H_2S (%) 2 Temperature (℃) 3 wind speed (m /s) 4 methane (%) 5 CO (%)	1 security 2 safer 3 mildly dangerous 4 moderate risk 5 severe risk	5-12-5

3.2. Determine the Number of Hidden Layer

In order to improve the accuracy of network training through the use of a hidden layer, and to obtain by the methods of increasing its number of neurons. This realization of the structure, increasing more than the hidden layer to the simple, it is implied select number of nodes appropriate hidden layer of the network unit of a direct impact on the performance of non-linear, and it resolved by the complexity of the issues relevant. However, the complexity of the problem cannot be quantified and thus not a very good analytical unit to determine the number of hidden layer.

We can use the following three ways to determine the number of hidden layer neurons.

1) n1 = n + m + a, where n1 is the number of hidden layer unit, n is the number of input unit, m is the number of output unit, a is constant between 0 and 10.

2) n1 = $\log 2^n$,where n1 is the number of hidden layer unit, n is the number of input unit,

3) n1 = nm, where n is the number of input unit, m is the number of output unit.

3.3. Determination of Transfer Function

This paper has chosen {'tansig','tansig'}, 'traingdx'} as the transfer function. Traingdx is the gradient descent with momentum and adaptive learning. Meanwhile, the proposed method can avoid neural network training into the local minimum value and get a high learning rate.

3.4. Simulation Experiment

In order to verify the accuracy of models, using trained network model of the 20 samples data for evaluation tests. Sample characteristics of the five indicators of the normalization of treatment import the network, the adjustable weight value as output value .as follow simulation Figure 2 and 3, in Figure 2,a triangle on behalf of the actual output value, an asterisk on behalf of predictive value. In Figure 3, The abscissa on behalf of abscissa training step, the longitudinal coordinates on behalf of the training process,

training goal is to 0.001,after the 187-step training, model can achieve convergence of the network.. We can see that the network training results are satisfactory, which has high precision.

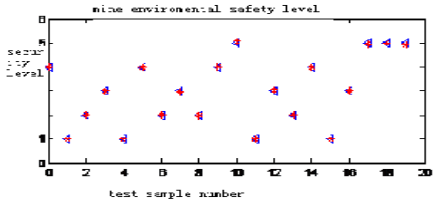

Fig2: The forecast confirmation chart of based on multi-sensor information neural network fusion algorithm

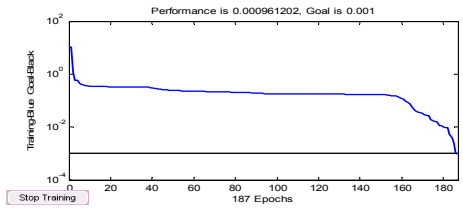

Fig3:The training chart of based on multi-sensor information neural network fusion algorithm

4. Conclusion

In this paper, multi-sensor data fusion (MSF) technology will be applied to the coal mine of information for environmental monitoring of the safety assessment, which will be detected by a number of sensor data pre-processing, the use of artificial neural network technology for its integration with more Mine environment for accurate estimates of the exact situation, such as the explosion occurred and the possibility of toxic gases harmful to the human body, according to mine risk estimates ,we must take timely and appropriate measures to deal with rescue measures. The simulation test results show that the application of neural network algorithm for the integration of multi-sensor integration of the input information, which can greatly improve forecast accuracy, but also has good model of the robustness and generalization, so the method of measurement technology has a very important role.

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