Research on the method of coal gangue interface in caving process based on image recognition

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Abstract

China's thick coal seam resources are widely distributed in China and are abundant in reserves, thus becoming the main mining coal seam in China to achieve high production and high efficiency.The strategic thinking of today's coal enterprises is to reduce costs and increase production and production efficiency.Making top coal caving mining become mainstream mining technology, But the mining face is the most frequent occurrence of coal mine accidents, And today, we should pay attention to safety mining and realize mechanization, automation, informatization and unmanned coal mining.Coal gangue recognition is one of the key technologies to realize unmanned mining. The method of coal gangue recognition in the process of caving coal mining is studied. The existing recognition methods and advantages and disadvantages are studied and analyzed, and a variety of methods based on image realization of coal gangue recognition are put forward.

Keywords

Caving coal mining ;Coal gangue identification ; image identification; unmanned coal mining face.

1. Introduction

The technology of top coal mining has been developed rapidly in the late 1980s to the middle of twenty-first Century, which makes the technology of top coal mining in our country develop rapidly and make the level of mining in the forefront of the world. Top coal mining has the characteristics of high yield, high efficiency, low tunneling rate, less working face moving times, great adaptability to geological conditions, and mechanized mining for steep and thick coal seam.But there are also problems in safety technology and technology as well as mining theory. For example, the rate of coal caving mining, the inevitable loss of coal mining. Gas accident and underground spontaneous combustion in the process of caving mining.Safe and efficient production is the purpose of coal mine production. To achieve this goal, we must make underground mining unmanned, informationized and mechanized. The number of do wnhole workers can be reduced, and the monitoring equipment can be monitored on the well, and the coal control can be carried out according to the mining conditions.Therefore, in the process of top coal caving, coal gangue recognition technology is very important. Therefore, the author analyzes the method of coal gangue recognition in the process of top coal mining, studies the existing identification methods and advantages and disadvantages, and puts forward a variety of methods based on image to realize coal gangue recognition. In order to improve the application scope and accuracy of coal gangue identification.

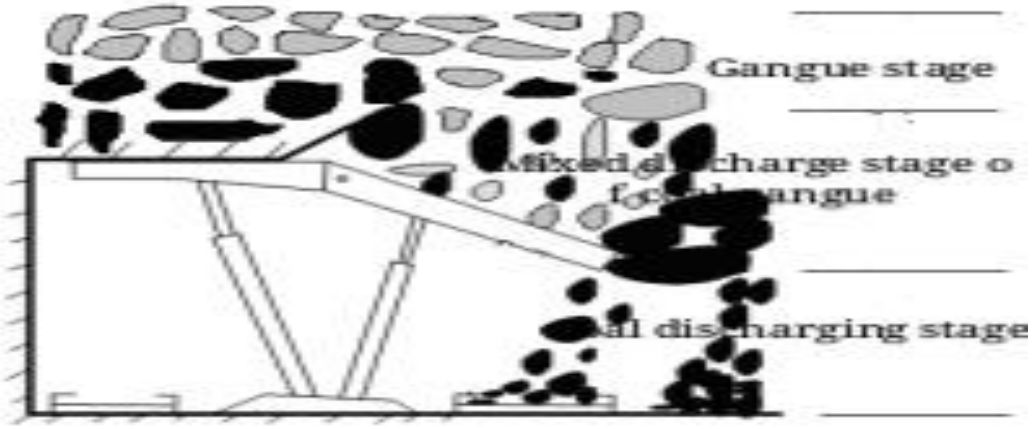

Figure 1. A schematic diagram of three stages in the process of coal discharg

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2.1 Research Status of Coal Gangue Identification Technology

Coal gangue recognition is one of the core technologies to realize unmanned mining, and it is also a powerful guarantee for safety production. Improving coal gangue automatic recognition can not only monitor and adjust the cutting position and height of the shearer in the mining process, but also prevent the cutting machine from cutting to the gangue to cause the wear and damage of the cutting teeth, and also improve the recovery rate. To reduce the loss of coal and reduce the content of gangue during caving mining to improve the quality of coal mining. More importantly, it can effectively prevent and control personnel accidents caused by gas leakage and explosion and underground natural fires.At present, people have done a lot of research and experiments in the field of coal gangue identification. In recent years, the research methods used in this area are as follows:

2.1.1 Gamma Ray Method

Gamma ray method can be divided into two categories, one is natural gamma ray and the other is artificial gamma ray.The natural gamma ray method is because of the radioactive elements such as potassium and uranium in the gangue. The attenuation value of energy and strength in the gamma ray emitted from the roof rock is identified by the coal gangue as the thickness of the coal seam is different. It is suitable for high gas coal wells. This method has the advantages of no radioactive source, easy to manage non-contact measurement and not easy to damage, but the coal seam with a certain thickness in this method reduces the recovery rate and has poor adaptability to the coal seam when it is detected. In addition, the accuracy of rocks with low or no radioactive elements is low.

2.1.2 Artificial Gamma Ray Method

uses artificial radioactive sources and detectors to identify coal gangue according to the intensity of reflected gamma ray to judge the thickness of coal seam, but the artificial gamma ray will do harm to people, and the safety measures can not be guaranteed, so this method is no longer used.

2.1.3 Infrared Imaging Detection Method

The infrared detection method is to use the cutting tooth of the Shearer to cut the temperature of coal or rock, and the thermal distribution spectrum collected by the infrared camera is used to identify the coal gangue. However, only when the method is cut to rock can the coal gangue interface be measured, and it is difficult to measure the coal and rock when the prash coefficient is close to the rock, so it is only suitable for the mine with large difference in the coal and rock, in addition to the temperature and humidity of the working environment, so that the correct rate of coal gangue recognition is greatly affected. Restrictions.

2.1.4 Coal Gangue Identification Method based on Vibration Technology

The vibration sensors are arranged in different positions, such as the scraper conveyor and the support tail beam and the shearer components, to collect the vibration frequency of the coal and cut the rock at different positions and then to process the information of the collected vibration signals, and the coal gangue recognition is carried out according to the design algorithm. This method can not measure the thickness of coal seam, and can only be identified when the shearer is cut to rock. And the vibration signals collected are very closely related to the geological conditions, mining machine types and coal rock characteristics. It is necessary to analyze the actual conditions of different mine geology and mining equipment, so the practicability of the method is not too strong.

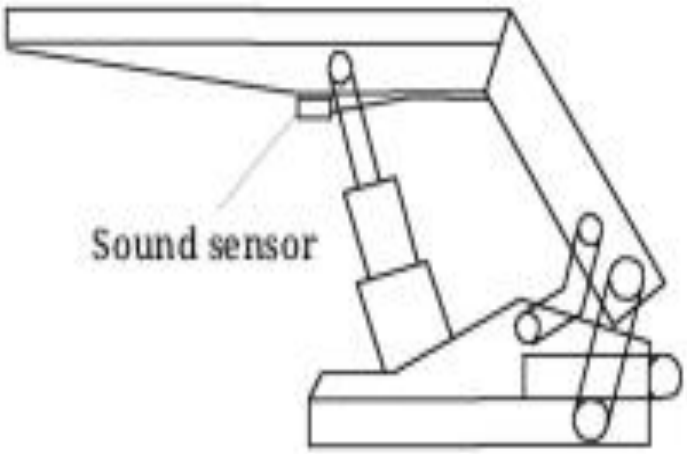

Figure 2. The sensor is arranged on the top plate.

2.1.5 Radar Detection Method

Based on the difference of coal medium, when the coal seam is penetrated by electromagnetic wave, the electromagnetic wave will be reflected on the interface of coal gangue identification. The thickness of the top coal and the level of the gangue are obtained by processing the signal. The shortcoming of this method is that the thickness of the top coal seam is too large to weaken the signal and even fail to receive the signal. It has a serious impact on the accuracy.

2.1.6 Dust Detection Method

The coal and rock will produce pulverized coal and rock powder when the coal and gangue are encountered in the coal mining operation. By detecting the proportion of the composition of the dust, the coal gangue interface is judged, but the disadvantage is that it is easily affected by the original dust. This method can not judge the thickness of top coal, but can only identify whether the pick is cut into the top rock.

2.1.7 Active Power Detection Method

The cutting capacity of the coal cutting machine within a unit time is constant, and the useful power needed by the cutting machine is increased when the gangue is cut, and the coal gangue recognition can be realized by detecting the useful power. This method is the same as the infrared imaging detection method, which is suitable for the coal coal and the rock with big difference of the prune coefficient. Well, only the cutting to the gangue can be identified.

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2.1.9 Based on Terahertz Spectroscopy

When the frequency of the electromagnetic wave reaches the terahertz band, the photon energy of the terahertz wave will be absorbed after the terahertz photon energy level is equal to the vibrational level of a lot of dielectric and material, so the light intensity will change to form the terahertz spectrum. By studying the terahertz spectrum, the physical information of the detection material will be obtained. . This is a novel method with great potential for development. The terahertz spectrum has a higher signal to noise ratio, penetration and identification of material components.

2.2 Recognition Method of Coal Gangue Based on Image Recognition

The latest image recognition methods are based on gray threshold method, texture feature extraction based on variation function and local variance graph, coal gangue recognition based on Gauss mixed clustering, coal gangue recognition based on image multi wavelet transform, coal gangue recognition based on image texture, binary cross diagonal texture moments Coal gangue identification method, low resolution coal gangue identification method based on Curvelet transform, and coal and rock identification method based on maximum pooled sparse coding.

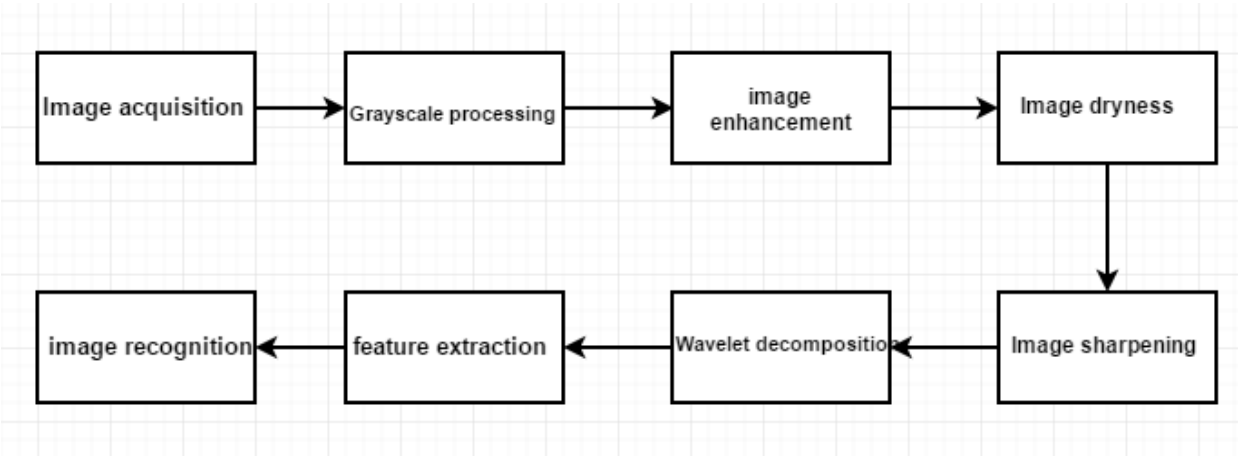

Figure 3. Flow chart of coal gangue image recognition

2.2.1 Based on Gray Threshold Method

This is one of the traditional image segmentation methods. The collected images are displayed on the histogram according to the gray level. The gray level and the grade of the original image can be clearly seen in the map, in which A and B represent the gray level of coal and the gray level of the gangue respectively, and the X indicates the gray level dividing point of coal and gangue, and the maximum use of the coal and gangue. The gray level threshold X is obtained by the method of variance between two classes. This method is applicable to the recognition of high accuracy when the difference of grayscale color gradation is obvious.

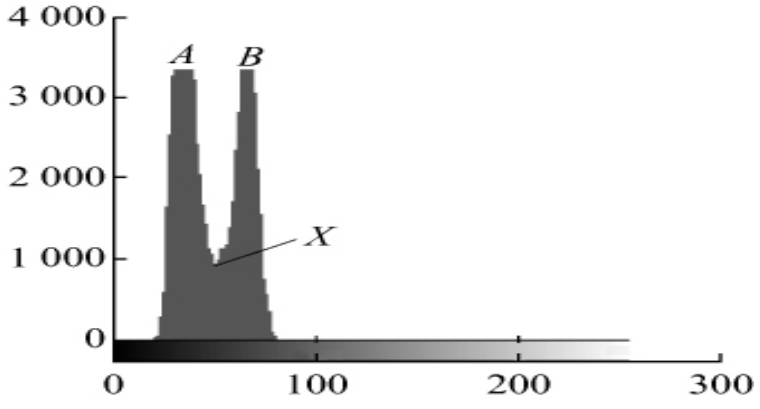

Figure 4. Histogram of grayscale distribution of images

2.2.2 Texture Feature Extraction Based on Variogram and Local Variance Map

On the basis of the traditional LBP algorithm, the concept of local variance graph is proposed. The image texture features are extracted from the spatial distribution of local variance, and the variation function is introduced to reuse the traditional LBP lost texture information. The extracted features are more accurate. Meanwhile, the efficiency of the algorithm is guaranteed, and the texture recognition is robust to the selection of the texture recognition. The accuracy of coal gangue recognition rate is high. The result of texture extraction is better than that of RILBP, ULBP, LBPV, MS-LPCM and so on.

2.2.3 Coal Gangue Recognition Method Based on Gauss Mixed Clustering

According to the actual situation of the work, 3 Gauss models are selected to correspond to coal and gangue and other (mainly including support information). The final parameters of an arbitrary Gauss model are calculated by the same algorithm. This method is more versatile than gray threshold method, and can avoid the unreasonable threshold selection in gray thresholmethod .

2.2.4 Coal Gangue Recognition Based on Image Multiwavelet Transform

After extracting the multi wavelet transform of coal gangue image, the standard deviation of the frequency band coefficients under the fixed window size is used as the texture measure and the normalized multi band eigenvector is generated. The texture features are identified by the simple Bias classifier. This method has the highest recognition rate when the size of the image window with a resolution of 128 * 128 is 9 and the frequency band F5-F16 is chosen to construct the feature vector.

2.2.5 Coal Gangue Recognition Method Based on Image Texture

Because of the great difference in the texture of coal and gangue, the texture of coal and gangue is extracted by the gray level symbiotic matrix, and the texture data is obtained by RBF neural network analysis, and the recognition of coal gangue is realized. This method has high recognition rate, simple operation recognition speed and huge hair. Show the potential of research.

2.2.6 Coal Gangue Recognition Method Based on Binary Cross Diagonal Texture Matrix

The binary cross diagonal texture matrix of the coal gangue image is first extracted, and then the rock image feature vectors are constructed by measuring the angular two order moment energy, correlation, variance, inverse difference moment, entropy, difference entropy and mean, contrast, inertia moment and related information information. This method has a high accuracy rate, can greatly reduce the time of single image feature extraction, and improve the real-time performance of coal gangue identification.

2.2.7 Low Resolution Coal Gangue Recognition Method Based on Curvelet Transform

The method of Qu Bo transform is used to decompose the image of coal and rock by Qu Bo transform, and the Qu Bo coefficient of each scale layer is obtained, and the principal component analysis is used to reduce the dimension. The results are input into different k-NN classifiers, and the classification results are weighted together. Compared with the existing methods, the proposed method has higher recognition rate and average recognition rate. Up to 95%, a high recognition rate can be obtained in the case of low resolution of coal and rock images, so as to meet the requirement of real-time identification of coal and rock.

2.2.8 Coal and Rock Identification Method based on Maximum Pooled Sparse Coding

In this method, a pool operation is added to the extraction of coal and rock images, and an integrated classifier is used in classification recognition, that is, a strong classifier is composed of several weak classifiers. This method can express the texture features of coal and rock images easily and effectively, greatly enhance the distinguishability of coal and rock images, obtain high recognition rate, and have a high recognition rate. Good recognition stability can better deal with high dimensional coal rock image data.

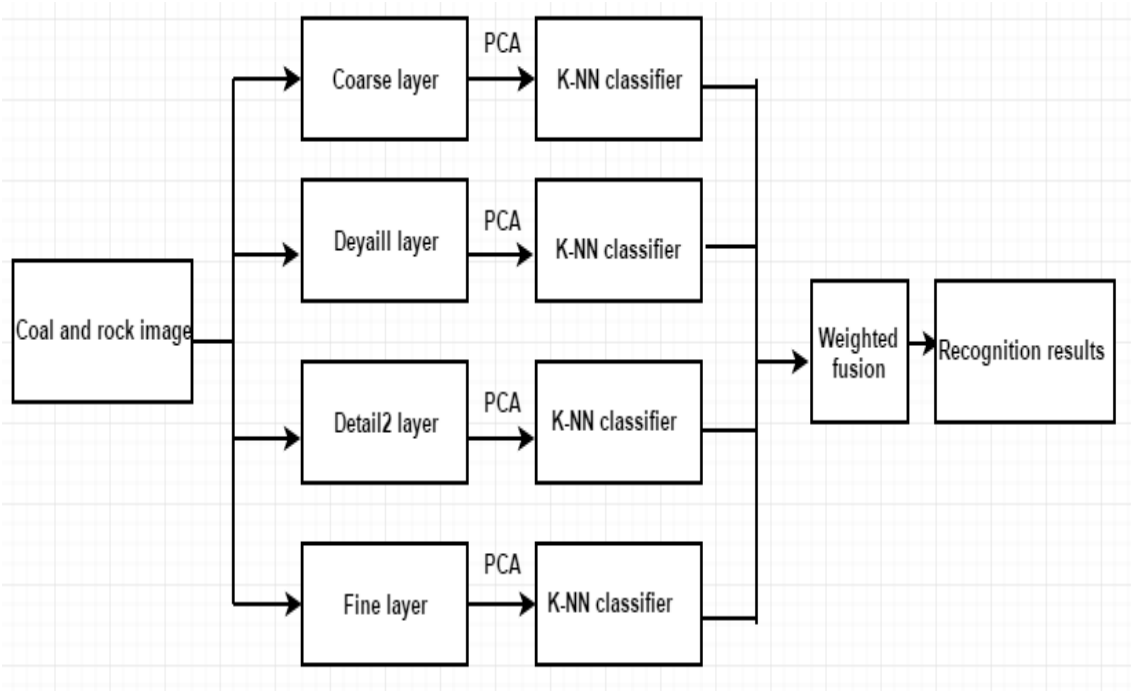

Figure 5. General framework of low resolution coal gangue identification method based on Curvelet transform

3. Conclusion

Gamma ray detection method, radar detection method, infrared imaging detection method, active power monitoring method, vibration detection method, dust detection method and other coal gangue interface identification methods have small application range and low recognition accuracy. The coal rock interface recognition method based on the features of color, gray, texture and shape, and the recognition method of multi parameter information fusion based on coal gangue interface based on image recognition can help to improve the accuracy and application range of coal rock interface recognition.

Acknowledgements

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