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Study on Coal and Rock Damage under Multiphase Coupling

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Abstract

At present, coal and rock dynamic disasters occur frequently, and the temporal and spatial evolution law of coal and rock damage is the key problem of stable control of coal mining. The infrared radiation evolution law of damaged fracture surface of composite coal and rock is studied to realize non-contact prediction of coal and rock dynamic disaster. The unloading coal and rock damage experiment is carried out under the coupling of water-force-heat multiphase, and the three-dimensional infrared radiation field is reconstructed by optimizing the infrared radiation information of denoising and three-dimensional fusion. The temporal and spatial evolution of infrared radiation information of unloading damage of composite coal and rock is revealed by considering the surface damage characteristics, three-dimensional infrared radiation field and simulation software results.

Keywords

Coal-Rock, Damage, Spatio-Temporal Evolution.

1. Introduction

Coal and gas outburst or impact ground pressure are the process of releasing a large amount of energy to the mining roadway in an instant, and the process will destroy the underground production system and lead to a large number of casualties of mine workers. The shallow coal resources in China have been depleted and the mineral resources have gradually entered the deep mining stage. Deep mining is the inevitable trend of coal industry development. With the increasing of mining depth, the problem of impact ground pressure, gas outburst and other coal and rock dynamic disasters is becoming more and more prominent, and accompanied by the trend of multiple disaster coupling. Compared with shallow mining, deep coal and rock dynamic disasters are more severe, more frequent and more complex. Coal mining faces great safety technical challenges.

2. Research methods

In order to meet the urgent demand of underground mine safety production, coal and rock stress is a basic scientific problem and technical problem that must be faced and urgently explored in coal mining. It is very important to carry out stability monitoring during coal and rock mining to ensure the safety of coal mine production.

(1) Study on the optimization of infrared radiation denoising of coal and rock

In view of the influence of coal and rock emissivity and spatial azimuth on infrared radiation results, based on infrared radiation correlation mechanism and single emissivity model, a three-band pseudo-emissivity optimization algorithm of composite coal and rock with universal characteristics in narrow band is constructed to realize infrared radiation monitoring of coal and rock without ore emissivity measurement. Through multi-band optical channel design, the core algorithm of coal and rock finite three-band temperature measurement is derived, and the micro-element angle of coal and rock is classified into the undetermined coefficient of coal and rock finite three-dimensional angle measurement model to ensure the

closure of radiation information and reduce the influence of coal and rock emissivity and spatial azimuth on infrared radiation noise.

(2) Three-dimensional reconstruction of coal-rock infrared radiation image fusion

In view of the fact that the high temperature in the adjacent environment weakens the surface temperature information of the measured coal and rock, the reflection and incident energy enhancement algorithm is derived according to the basic principle of thermal radiation and infrared thermal imaging. It provides the foundation for the next step of image information fusion.

Aiming at the problems of infrared radiation monitoring coal and rock image surface distortion and the fact that the measured coal and rock geometry information can not correspond to infrared temperature information, an image fusion algorithm combining wavelet transform with Contourlet is proposed based on multi-scale analysis theory. The three-dimensional fusion of infrared and visible light is realized. Through image acquisition, feature extraction, feature matching, multi-channel fusion, the infrared image sensor and the composite coal and rock specimen generated by 2 D and 3 visible light sensors are fused with the visible light image through the fusion algorithm to obtain the fusion localization image. The geometric relationship between the plane of coal and rock and the image plane of infrared image is corresponding, and the infrared radiation information of the specimen is reconstructed by three-dimensional reconstruction.

(3) Study on temporal and spatial evolution of infrared radiation in composite coal and rock

In the field, drilling rig is used to core coal and rock mass, and rock cutting machine is used to prepare coal and rock specimens. Using the modified electro-hydraulic servo rock test system, the infrared radiation characteristics and regularity of coal-rock damage under multi-phase coupling of "water-force-heat" under different stress, different water content and different temperature. Infrared thermal imager, high-speed camera and three-dimensional camera were used to collect infrared radiation information, and the strain and surface failure characteristics of coal-rock were monitored synchronously and dynamically.

The collected infrared radiation information is used to denoise the optimization mechanism in "Research content 1", and the infrared radiation field of composite coal and rock is reconstructed by three-dimensional image fusion technology in" Research content 2". Combined with the characteristics of surface failure, stress and strain and three-dimensional infrared radiation field, the damage fracture law of composite coal and rock during load is studied, and the infrared abnormal precursor of composite coal and rock fracture is deeply revealed, and the temporal and spatial evolution law of infrared radiation information of composite coal and rock load is obtained.

The infrared radiation information of three-dimensional reconstruction is transformed into digital model. The three-dimensional reconstruction model is imported into PFC3D simulation software by MATLAB software. Combined with the conclusion of physical simulation experiment, the PFC3D servo loading program under multiphase coupling condition is written. The spatiotemporal evolution of damaged fracture of composite coal and rock is reproduced, and the conclusion of physical experiment is verified by inversion.

3. Conclusion

Based on the theory of damage mechanics and thermal radiation, this paper studies the correlation between infrared radiation response characteristics and coal-rock mechanical characteristics and internal damage, and explores the infrared radiation response mechanism of coal-rock damage process. The optimization model of reflected radiation energy and incident radiation energy is constructed by developing three-wave false emissivity and finite solid angle infrared radiation denoising algorithm to realize the denoising optimization of infrared

radiation information. The three-dimensional reconstruction algorithm of binocular stereo vision is constructed, which combines multi-source data information, stereo fusion infrared image and visible light image, constructs three-dimensional temperature field, and obtains the spatial information of infrared radiation sequence. A uniaxial compression multi-parameter observation of coal and rock mechanics experiment was carried out, and the three-dimensional infrared radiation temperature field was constructed by optimizing the infrared radiation information of denoising and stereoscopic fusion, and the PFC3D particle flow software was used to simulate the evolution process of coal and rock load damage. The relationship between infrared radiation information and stress state of coal and rock is established. The correlation between infrared radiation response characteristics and internal damage of coal and rock is studied.

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