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(54) **MONITORING SYSTEM FOR MINING SAFETY.**

(57) Disclosed is a monitoring system for mining safety, which relates to the technical field of coal mining. The monitoring system for mining safety includes a sensor and monitoring device mounting module, a data acquisition and transmission module, a monitoring module, an alarm and early warning module, a data analysis and decision support module, and a remote monitoring and management module. By real-time monitoring and detection of mine safety parameters, potential safety hazards can be found and dealt with in time, so that the safety management level of mines can be improved.

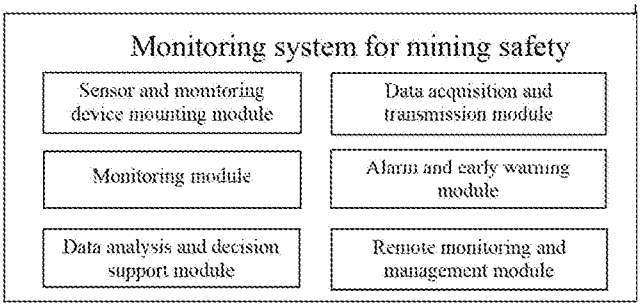

FIG. 1

LU505202

MONITORING SYSTEM FOR MINING SAFETY

TECHNICAL FIELD

The present invention relates to the technical field of coal mining, and in particular relates to a monitoring system for mining safety.

BACKGROUND

In coal mine ventilation and gas management, a coal mine safety monitoring system implements the gas management policy of "pumping first and then mining, determining production by wind, monitoring and controlling" and builds the requirements of "reliable system, ventilation up to standard, management in place and effective monitoring" and its management system. In the aspect of coal mine transportation management, the coal mine safety monitoring system can perform real-time monitoring to grasp the operation safety status of belt conveyors and rail conveyors at any time.

At present, the frequency of mining accidents is also increasing. The mining monitoring system is a comprehensive automation product that integrates computer technology, communication technology, control technology and electronic technology. However, the existing monitoring system has poor flexibility in risk alarm and notification, which makes operators unable to accurately know the accident information, and the existing monitoring system can not identify the actions of workers at work.

SUMMARY

Aiming at the deficiency of the prior art, the present invention provides a monitoring system for mining safety, which solves the problems of poor flexibility of danger notification and inability to identify the actions of workers.

In order to realize the above objective, the present invention employs the following technical solutions. A monitoring system for mining safety includes a sensor and monitoring device mounting module, a data acquisition and transmission module, a monitoring module, an

alarm and early warning module, a data analysis and decision support module, and a remote monitoring and management module; and the sensor and monitoring device mounting module includes a methane sensor, a temperature and humidity sensor, a smoke sensor, a geological deformation detector, a respirator and oxygen sensor, and a video monitoring device, the methane sensor being capable of monitoring methane concentrations in a coal mine roadway, a mining face, a mined-out area, a return air roadway and an electromechanical chamber, the temperature and humidity sensor being capable of monitoring the temperature and humidity in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber, the smoke sensor being capable of monitoring the smoke in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber, the geological deformation detector being capable of determining a surface condition by measuring a relative displacement, a settlement height and an azimuth angle of a monitoring point, the respirator and oxygen sensor being capable of monitoring the oxygen in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber to ensure the safe breathing of miners and avoid the risk of suffocation and poisoning in thick smoke, poisonous gas or oxygen-deficient environments, and the video monitoring device being capable of monitoring images and videos of various areas of a mine in real time to discover and record potential safety hazards and abnormal situations.

Preferably, the data acquisition and transmission module includes a wired transmission unit, a wireless transmission unit, a sensor network unit, a data storage and forwarding unit, and a cloud platform transmission unit, the wired transmission unit being capable of transmitting the collected data to a monitoring center by means of a wired connection mode, the wireless transmission unit being configured to solve the problem of difficult wiring in the mine so that a wireless transmission mode is applied gradually, the sensor network unit being capable of realizing distributed data collection and transmission and being suitable for large-scale mine

monitoring, the data storage and forwarding unit being capable of first storing the collected data in a local device, and then transmitting a same to the monitoring center after communication recovery, and the cloud platform transmission unit being capable of uploading data collected by a sensor and monitoring device to a cloud platform, so that the monitoring center may access and process the data through the cloud.

Preferably, the monitoring module includes a data receiving and storing unit, a data processing and analyzing unit, a real-time monitoring and early warning unit, a data visualization unit, a remote monitoring and management unit, and an action behavior identifying unit, the data receiving and storing unit being capable of receiving the collected data and storing a same in a database or the cloud platform for later analysis and inquiry by connecting to the sensor and monitoring device, the data processing and analyzing unit being capable of processing and analyzing the collected data to extract key information and indexes and performing trend analysis and anomaly detection to determine determine the safety state and risk degree of the mine, the real-time monitoring and early warning unit being capable of monitoring various indexes and parameters in the mine in real time and carrying out real-time early warning and alarm according to preset safety standards and rules, the data visualization unit being capable of visualizing the collected data by means of charts and maps to allow users to intuitively understand the safety status and trend of the mine, the remote monitoring and management unit being capable of realizing remote monitoring and management of a mine safety monitoring system by means of the Internet and remote access technology, and the action behavior identifying unit being capable of recognizing actions of workers in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber.

Preferably, the alarm and early warning module includes a real-time alarm unit, a multi-level early warning unit, an early warning rule unit, a parameter setting unit, and an early warning information recording unit, the real-time alarm unit being capable of monitoring various

indexes and parameters in the mine in real time, and the system immediately sending out an alarm upon abnormal conditions or safety risks are found, the multi-level early warning unit being capable of sending out different early warning signals according to different safety risk levels and emergency degrees, the early warning rule unit being capable of setting corresponding early warning rules according to the specific conditions and safety standards of the mine, the parameter setting unit being capable of setting corresponding early warning parameters according to the specific conditions and safety standards of the mine, and the early warning information recording unit being capable of recording and storing early warning information, including triggering time, early warning type and triggering parameters.

Preferably, the data analysis and decision support module includes an early warning rule optimization unit, a risk assessment and prediction unit, and a decision-making unit, the early warning rule optimization unit being capable of optimizing and adjusting an early warning rule according to data analysis results, the risk assessment and prediction unit being capable of evaluating and predicting mine safety risks based on historical data and model algorithm, and the decision-making unit being capable of providing decision support for mine safety to managers.

Preferably, the remote monitoring and management module includes a remote control unit, a remote maintenance unit, and a remote management unit, the remote control unit being capable of operating and adjusting a mine safety system by means of a remote control device, the remote maintenance unit being capable of remotely maintaining the mine safety device, and the remote management unit being capable of remotely managing the mine safety device.

The present invention provides a monitoring system for mining safety and has the following advantageous effects.

1. According to the present invention, by wired or wireless connection of those sensors and monitoring devices to the monitoring system, the collected data can be transmitted to the monitoring center for processing and analysis; and by real-time monitoring and detection of mine

safety parameters, potential safety hazards can be found and dealt with in time, so that the safety management level of mines can be improved.

2. According to the present invention, the monitoring module needs to be equipped qith professional hardware equipment and software system for construction and operation to ensure the accuracy and safety of data; at the same time, the monitoring module also needs to be equipped with professional operators and technical personnel to be responsible for the operation maintenance and fault treatment of the system; by means of the operation of the monitoring module, the safety management level of the mine can be improved, the occurrence of accidents can be prevented, and the life safety and property safety of miners can be guaranteed; and by the arrangement of the action behavior identifying unit, the actions and behaviors of workers can be identified and analyzed to prevent workers from violating rules.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a structural schematic diagram of a monitoring system for mining safety according to the present invention;

FIG. 2 is a schematic diagram of a sensor and monitoring device mounting module of the monitoring system for mining safety according to the present invention;

FIG. 3 is a schematic diagram of a data acquisition and transmission module of the monitoring system for mining safety according to the present invention;

FIG. 4 is a schematic diagram of a monitoring module of the monitoring system for mining safety according to the present invention;

FIG. 5 is a schematic diagram of an alarm and early warning module of the monitoring system for mining safety according to the present invention;

FIG. 6 is a schematic diagram of a data analysis and decision support module of the monitoring system for mining safety according to the present invention; and

FIG. 7 is a schematic diagram of a remote monitoring and management module of the

monitoring system for mining safety according to the present invention.

DETAILED DESCRIPTION

The technical solutions of the examples in the present invention will be described clearly and completely by reference to the accompanying drawings of the examples in the present invention below. Obviously, the examples described are only some, rather than all examples of the present invention. Based on the examples of the present invention, all the other examples obtained by those ordinary skilled in the art without creative efforts fall within the scope of protection of the present invention.

Examples

As shown in FIGS. 1-7, an example of the present invention provides a monitoring system for mining safety, including a sensor and monitoring device mounting module, a data acquisition and transmission module, a monitoring module, an alarm and early warning module, a data analysis and decision support module, and a remote monitoring and management module; and the sensor and monitoring device mounting module includes a methane sensor, a temperature and humidity sensor, a smoke sensor, a geological deformation detector, a respirator and oxygen sensor, and a video monitoring device, the methane sensor being capable of monitoring methane concentrations in a coal mine roadway, a mining face, a mined-out area, a return air roadway and an electromechanical chamber, the temperature and humidity sensor being capable of monitoring the temperature and humidity in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber, the smoke sensor being capable of monitoring the smoke in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber, the geological deformation detector being capable of determining a surface condition by measuring a relative displacement, a settlement height and an azimuth angle of a monitoring point, the respirator and oxygen sensor being capable of monitoring the oxygen in the coal mine roadway, the mining face, the mined-out area,

the return air roadway and the electromechanical chamber to ensure the safe breathing of miners and avoid the risk of suffocation and poisoning in thick smoke, poisonous gas or oxygen-deficient environments, and the video monitoring device being capable of monitoring images and videos of various areas of a mine in real time to discover and record potential safety hazards and abnormal situations.

The data acquisition and transmission module includes a wired transmission unit, a wireless transmission unit, a sensor network unit, a data storage and forwarding unit, and a cloud platform transmission unit, the wired transmission unit being capable of transmitting the collected data to a monitoring center by means of a wired connection mode, the wireless transmission unit being configured to solve the problem of difficult wiring in the mine so that a wireless transmission mode is applied gradually, the sensor network unit being capable of realizing distributed data collection and transmission and being suitable for large-scale mine monitoring, the data storage and forwarding unit being capable of first storing the collected data in a local device, and then transmitting a same to the monitoring center after communication recovery, and the cloud platform transmission unit being capable of uploading data collected by a sensor and monitoring device to a cloud platform, so that the monitoring center may access and process the data through the cloud.

The monitoring module includes a data receiving and storing unit, a data processing and analyzing unit, a real-time monitoring and early warning unit, a data visualization unit, a remote monitoring and management unit, and an action behavior identifying unit, the data receiving and storing unit being capable of receiving the collected data and storing a same in a database or the cloud platform for later analysis and inquiry by connecting to the sensor and monitoring device, the data processing and analyzing unit being capable of processing and analyzing the collected data to extract key information and indexes and performing trend analysis and anomaly detection to determine determine the safety state and risk degree of the mine, the real-time monitoring and

early warning unit being capable of monitoring various indexes and parameters in the mine in real time and carrying out real-time early warning and alarm according to preset safety standards and rules, the data visualization unit being capable of visualizing the collected data by means of charts and maps to allow users to intuitively understand the safety status and trend of the mine, the remote monitoring and management unit being capable of realizing remote monitoring and management of a mine safety monitoring system by means of the Internet and remote access technology, and the action behavior identifying unit being capable of recognizing actions of workers in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber.

The alarm and early warning module includes a real-time alarm unit, a multi-level early warning unit, an early warning rule unit, a parameter setting unit, and an early warning information recording unit, the real-time alarm unit being capable of monitoring various indexes and parameters in the mine in real time, and the system immediately sending out an alarm upon abnormal conditions or safety risks are found, the multi-level early warning unit being capable of sending out different early warning signals according to different safety risk levels and emergency degrees, the early warning rule unit being capable of setting corresponding early warning rules according to the specific conditions and safety standards of the mine, the parameter setting unit being capable of setting corresponding early warning parameters according to the specific conditions and safety standards of the mine, and the early warning information recording unit being capable of recording and storing early warning information, including triggering time, early warning type and triggering parameters.

The data analysis and decision support module includes an early warning rule optimization unit, a risk assessment and prediction unit, and a decision-making unit, the early warning rule optimization unit being capable of optimizing and adjusting an early warning rule according to data analysis results, the risk assessment and prediction unit being capable of evaluating and

predicting mine safety risks based on historical data and model algorithm, and the decision-making unit being capable of providing decision support for mine safety to managers.

The remote monitoring and management module includes a remote control unit, a remote maintenance unit, and a remote management unit, the remote control unit being capable of operating and adjusting a mine safety system by means of a remote control device, the remote maintenance unit being capable of remotely maintaining the mine safety device, and the remote management unit being capable of remotely managing the mine safety device.

Although the examples of the present invention have been shown and described, for those ordinary skilled in the art, it can be understood as various changes, modifications, replacements and variations can be made on these examples within the principle and spirit of the present invention. The scope of the present invention is defined by the attached claims and the equivalent thereof.

CLAIMS

1. A monitoring system for mining safety, comprising a sensor and monitoring device mounting module, a data acquisition and transmission module, a monitoring module, an alarm and early warning module, a data analysis and decision support module, and a remote monitoring and management module, wherein the sensor and monitoring device mounting module comprises a methane sensor, a temperature and humidity sensor, a smoke sensor, a geological deformation detector, a respirator and oxygen sensor, and a video monitoring device, the methane sensor being capable of monitoring methane concentrations in a coal mine roadway, a mining face, a mined-out area, a return air roadway and an electromechanical chamber, the temperature and humidity sensor being capable of monitoring the temperature and humidity in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber, the smoke sensor being capable of monitoring the smoke in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber, the geological deformation detector being capable of determining a surface condition by measuring a relative displacement, a settlement height and an azimuth angle of a monitoring point, the respirator and oxygen sensor being capable of monitoring the oxygen in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber to ensure the safe breathing of miners and avoid the risk of suffocation and poisoning in thick smoke, poisonous gas or oxygen-deficient environments, and the video monitoring device being capable of monitoring images and videos of various areas of a mine in real time to discover and record potential safety hazards and abnormal situations.

2. The monitoring system for mining safety according to claim 1, wherein the data acquisition and transmission module comprises a wired transmission unit, a wireless transmission unit, a sensor network unit, a data storage and forwarding unit, and a cloud platform

transmission unit, the wired transmission unit being capable of transmitting the collected data to a monitoring center by means of a wired connection mode, the wireless transmission unit being configured to solve the problem of difficult wiring in the mine so that a wireless transmission mode is applied gradually, the sensor network unit being capable of realizing distributed data collection and transmission and being suitable for large-scale mine monitoring, the data storage and forwarding unit being capable of first storing the collected data in a local device, and then transmitting a same to the monitoring center after communication recovery, and the cloud platform transmission unit being capable of uploading data collected by a sensor and monitoring device to a cloud platform, so that the monitoring center may access and process the data through the cloud.

3. The monitoring system for mining safety according to claim 1, wherein the monitoring module comprises a data receiving and storing unit, a data processing and analyzing unit, a real-time monitoring and early warning unit, a data visualization unit, a remote monitoring and management unit, and an action behavior identifying unit, the data receiving and storing unit being capable of receiving the collected data and storing a same in a database or the cloud platform for later analysis and inquiry by connecting to the sensor and monitoring device, the data processing and analyzing unit being capable of processing and analyzing the collected data to extract key information and indexes and performing trend analysis and anomaly detection to determine determine the safety state and risk degree of the mine, the real-time monitoring and early warning unit being capable of monitoring various indexes and parameters in the mine in real time and carrying out real-time early warning and alarm according to preset safety standards and rules, the data visualization unit being capable of visualizing the collected data by means of charts and maps to allow users to intuitively understand the safety status and trend of the mine, the remote monitoring and management unit being capable of realizing remote monitoring and management of a mine safety monitoring system by means of the Internet and remote access

technology, and the action behavior identifying unit being capable of recognizing actions of workers in the coal mine roadway, the mining face, the mined-out area, the return air roadway and the electromechanical chamber.

4. The monitoring system for mining safety according to claim 1, wherein the alarm and early warning module comprises a real-time alarm unit, a multi-level early warning unit, an early warning rule unit, a parameter setting unit, and an early warning information recording unit, the real-time alarm unit being capable of monitoring various indexes and parameters in the mine in real time, and the system immediately sending out an alarm upon abnormal conditions or safety risks are found, the multi-level early warning unit being capable of sending out different early warning signals according to different safety risk levels and emergency degrees, the early warning rule unit being capable of setting corresponding early warning rules according to the specific conditions and safety standards of the mine, the parameter setting unit being capable of setting corresponding early warning parameters according to the specific conditions and safety standards of the mine, and the early warning information recording unit being capable of recording and storing early warning information, including triggering time, early warning type and triggering parameters.

5. The monitoring system for mining safety according to claim 1, wherein the data analysis and decision support module comprises an early warning rule optimization unit, a risk assessment and prediction unit, and a decision-making unit, the early warning rule optimization unit being capable of optimizing and adjusting an early warning rule according to data analysis results, the risk assessment and prediction unit being capable of evaluating and predicting mine safety risks based on historical data and model algorithm, and the decision-making unit being capable of providing decision support for mine safety to managers.

6. The monitoring system for mining safety according to claim 1, wherein the remote monitoring and management module comprises a remote control unit, a remote maintenance unit,

and a remote management unit, the remote control unit being capable of operating and adjusting a mine safety system by means of a remote control device, the remote maintenance unit being capable of remotely maintaining the mine safety device, and the remote management unit being capable of remotely managing the mine safety device.

REVENDICATIONS

1. Un système de surveillance pour la sécurité minière, comprenant un module de montage de capteurs et de dispositifs de surveillance, un module d'acquisition et de transmission de données, un module de surveillance, un module d'alarme et d'alerte précoce, un module d'analyse de données et d'aide à la décision, et un module de surveillance et de gestion à distance, dans lequel le module de montage de capteurs et de dispositifs de surveillance comprend un capteur de méthane, un capteur de température et d'humidité, un capteur de fumée, un détecteur de déformation géologique, un capteur de respirateur et d'oxygène, et un dispositif de surveillance vidéo, un respirateur et un capteur d'oxygène, et un dispositif de surveillance vidéo, le capteur de méthane étant capable de surveiller les concentrations de méthane dans une galerie de mine de charbon, un front de taille, une zone d'extraction minière, une galerie de retour d'air et une chambre électromécanique, le capteur de température et d'humidité étant capable de surveiller la température et l'humidité dans la galerie de mine de charbon, le front de taille, la zone d'extraction minière, la galerie de retour d'air et la chambre électromécanique, le capteur de fumée est capable de surveiller la fumée dans la galerie de la mine de charbon, le front de taille, la zone d'extraction, la galerie de retour d'air et la chambre électromécanique, le détecteur de déformation géologique est capable de déterminer un état de surface en mesurant un déplacement relatif, une hauteur de tassement et un angle d'azimut d'un point de surveillance, le respirateur et le capteur d'oxygène sont capables de surveiller l'oxygène dans la galerie de la mine de charbon, le front de taille, la zone d'extraction, la galerie de retour d'air et la chambre électromécanique, le front de taille, la zone minée, la voie de retour d'air et la chambre électromécanique afin de garantir la sécurité respiratoire des mineurs et d'éviter les risques de suffocation et d'empoisonnement en cas de fumée épaisse, de gaz toxique ou d'environnement pauvre en oxygène, et le dispositif de surveillance vidéo est capable de surveiller les images et les vidéos de diverses zones d'une mine en temps réel afin de découvrir et d'enregistrer les risques potentiels pour la sécurité et les situations anormales.

2. Le système de surveillance de la sécurité minière selon la revendication 1, dans lequel le module d'acquisition et de transmission de données comprend une unité de transmission câblée, une unité de transmission sans fil, une unité de réseau de capteurs, une unité de stockage et de

transmission de données, et une unité de transmission de plate-forme en nuage, l'unité de transmission câblée étant capable de transmettre les données collectées à un centre de surveillance au moyen d'un mode de connexion câblée, l'unité de transmission sans fil étant configurée pour résoudre le problème du câblage difficile dans la mine de sorte qu'un mode de transmission sans fil est appliqué progressivement, l'unité de réseau de capteurs est capable de réaliser une collecte et une transmission de données distribuées et convient à la surveillance de mines à grande échelle, l'unité de stockage et de transmission de données est capable de stocker d'abord les données collectées dans un dispositif local, puis de les transmettre au centre de surveillance après rétablissement de la communication, et l'unité de transmission de plate-forme en nuage est capable de télécharger des données collectées par un capteur et un dispositif de surveillance vers une plate-forme en nuage, de sorte que le centre de surveillance puisse accéder aux données et les traiter par l'intermédiaire de la plate-forme en nuage.

3. Le système de surveillance de la sécurité minière selon la revendication 1, dans lequel le module de surveillance comprend une unité de réception et de stockage des données, une unité de traitement et d'analyse des données, une unité de surveillance en temps réel et d'alerte précoce, une unité de visualisation des données, une unité de surveillance et de gestion à distance, et une unité d'identification du comportement d'action, l'unité de réception et de stockage des données est capable de recevoir les données collectées et de les stocker dans une base de données ou une plateforme en nuage en vue d'une analyse et d'une consultation ultérieures en se connectant au capteur et au dispositif de surveillance ; l'unité de traitement et d'analyse des données est capable de traiter et d'analyser les données collectées pour en extraire des informations et des indices clés et d'effectuer une analyse des tendances et une détection des anomalies afin de déterminer l'état de sécurité et le degré de risque de la mine, l'unité de surveillance en temps réel et d'alerte rapide est capable de surveiller divers indices et paramètres dans la mine en temps réel et d'effectuer une alerte rapide en temps réel conformément aux normes et règles de sécurité prédéfinies, l'unité de visualisation des données est capable de visualiser les données collectées au moyen de graphiques et de cartes pour permettre aux utilisateurs de comprendre intuitivement l'état et les tendances de la mine en matière de sécurité, l'unité de surveillance et de gestion à distance est capable de réaliser la surveillance et la gestion à distance d'un système de surveillance de la sécurité minière au moyen d'Internet et de la technologie d'accès à distance, et l'unité

d'identification du comportement des actions est capable de reconnaître les actions des travailleurs dans la chaussée de la mine de charbon, le front de taille, la zone minée, la chaussée de l'air de retour et la chambre électromécanique.

4. Le système de surveillance de la sécurité minière selon la revendication 1, dans lequel le module d'alarme et d'alerte précoce comprend une unité d'alarme en temps réel, une unité d'alerte précoce à plusieurs niveaux, une unité de règles d'alerte précoce, une unité de réglage des paramètres et une unité d'enregistrement des informations d'alerte précoce, l'unité d'alarme en temps réel étant capable de surveiller divers indices et paramètres dans la mine en temps réel, et le système envoyant immédiatement une alarme lorsque des conditions anormales ou des risques de sécurité sont détectés, l'unité d'alerte précoce à plusieurs niveaux étant capable d'envoyer différents signaux d'alerte précoce en fonction de différents niveaux de risque de sécurité et de degrés d'urgence, l'unité de règles d'alerte précoce est capable de définir les règles d'alerte précoce correspondantes en fonction des conditions spécifiques et des normes de sécurité de la mine, l'unité de paramétrage est capable de définir les paramètres d'alerte précoce correspondants en fonction des conditions spécifiques et des normes de sécurité de la mine, et l'unité d'enregistrement des informations d'alerte précoce est capable d'enregistrer et de stocker les informations d'alerte précoce, y compris l'heure de déclenchement, le type d'alerte précoce et les paramètres de déclenchement.

5. Le système de surveillance de la sécurité minière selon la revendication 1, dans lequel le module d'analyse des données et d'aide à la décision comprend une unité d'optimisation des règles d'alerte précoce, une unité d'évaluation et de prédiction des risques et une unité de prise de décision, l'unité d'optimisation des règles d'alerte précoce étant capable d'optimiser et d'ajuster une règle d'alerte précoce en fonction des résultats de l'analyse des données, l'unité d'évaluation et de prédiction des risques étant capable d'évaluer et de prédire les risques liés à la sécurité minière sur la base de données historiques et d'un algorithme de modèle, et l'unité de prise de décision étant capable de fournir aux gestionnaires une aide à la décision en matière de sécurité minière.

6. Le système de surveillance de la sécurité minière selon la revendication 1, dans lequel le module de surveillance et de gestion à distance comprend une unité de commande à distance, une unité de maintenance à distance et une unité de gestion à distance, l'unité de commande à

distance étant capable de faire fonctionner et de régler un système de sécurité minière au moyen d'un dispositif de commande à distance, l'unité de maintenance à distance étant capable de maintenir à distance le dispositif de sécurité minière, et l'unité de gestion à distance étant capable de gérer à distance le dispositif de sécurité minière.

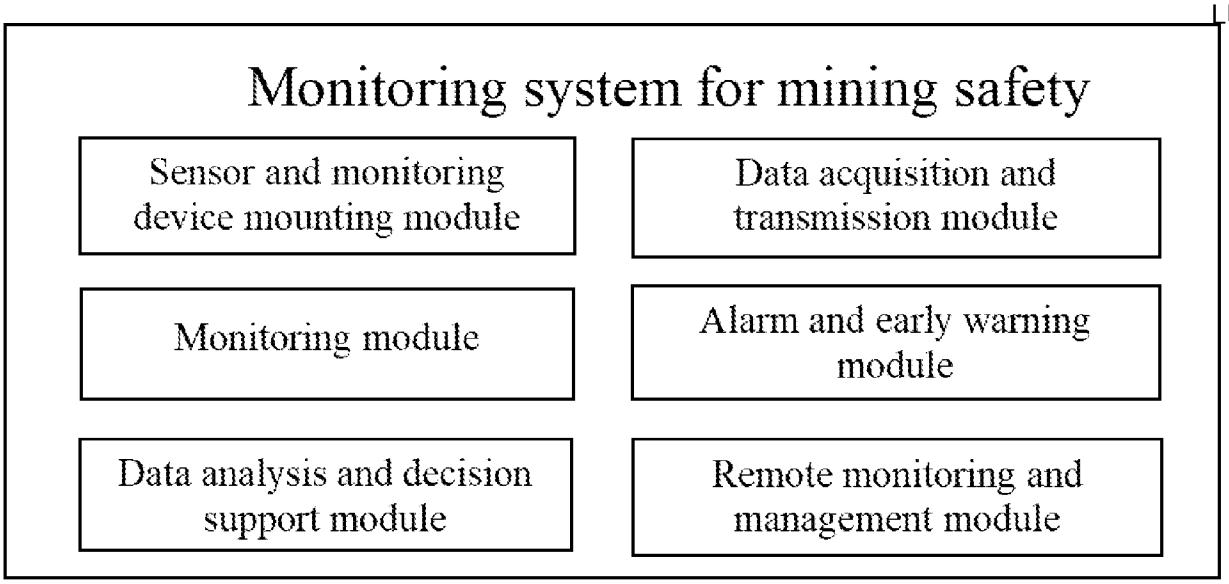
Monitoring system for mining safety
Sensor and monitoring device mounting module
Data acquisition and transmission module
Monitoring module
Alarm and early warning module
Data analysis and decision support module
Remote monitoring and management module

FIG. 1

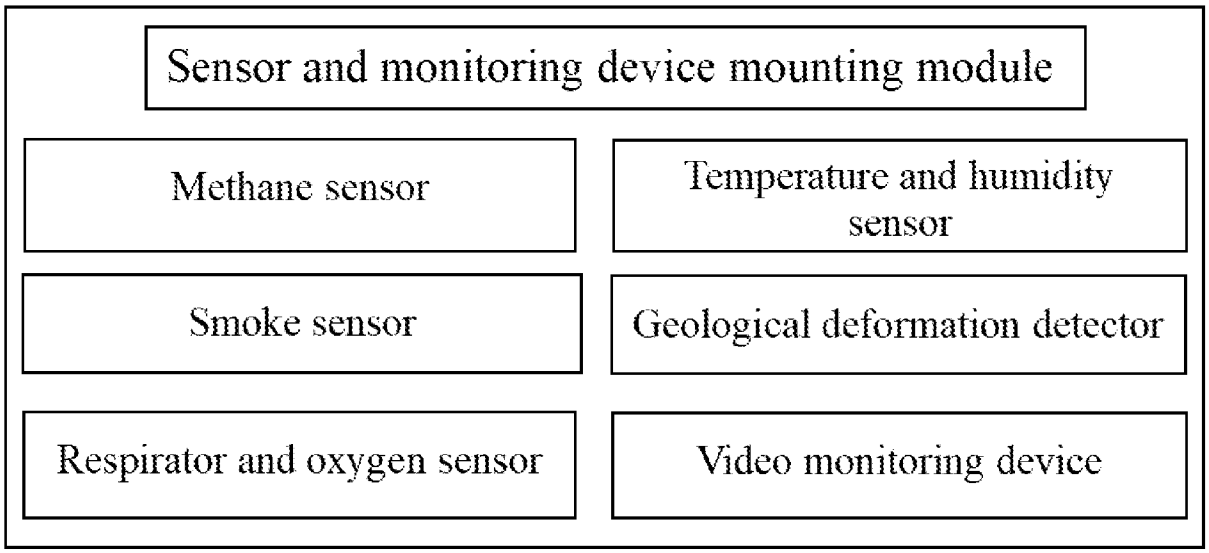
Sensor and monitoring device mounting module
Methane sensor
Temperature and humidity sensor
Smoke sensor
Geological deformation detector
Respirator and oxygen sensor
Video monitoring device

FIG. 2

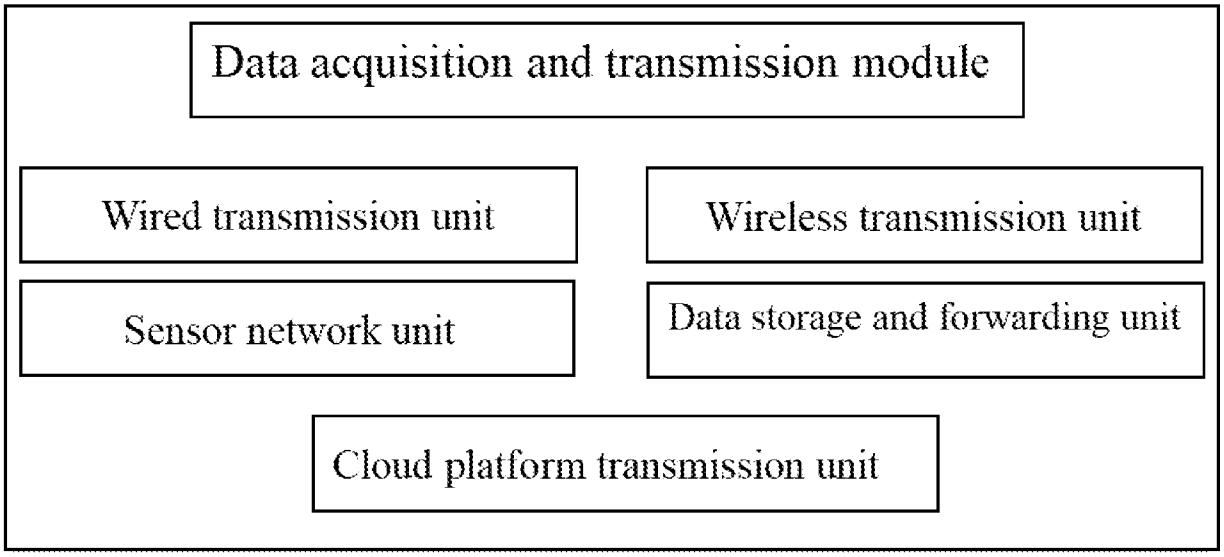
Data acquisition and transmission module
Wired transmission unit
Wireless transmission unit
Sensor network unit
Data storage and forwarding unit
Cloud platform transmission unit

FIG. 3

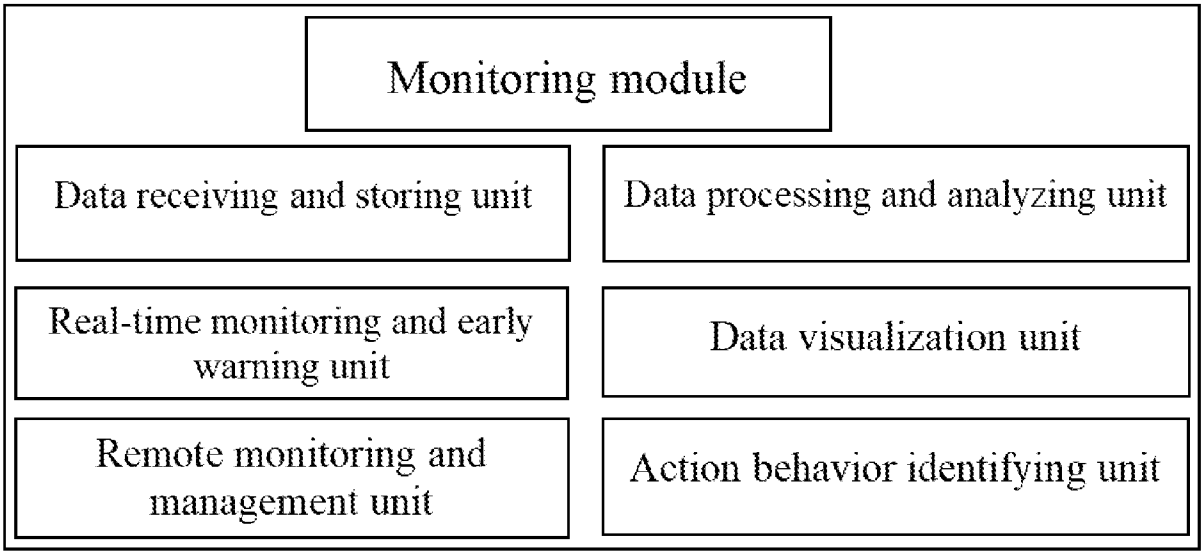
Monitoring module
Data receiving and storing unit
Data processing and analyzing unit
Real-time monitoring and early warning unit
Data visualization unit
Remote monitoring and management unit
Action behavior identifying unit

FIG. 4

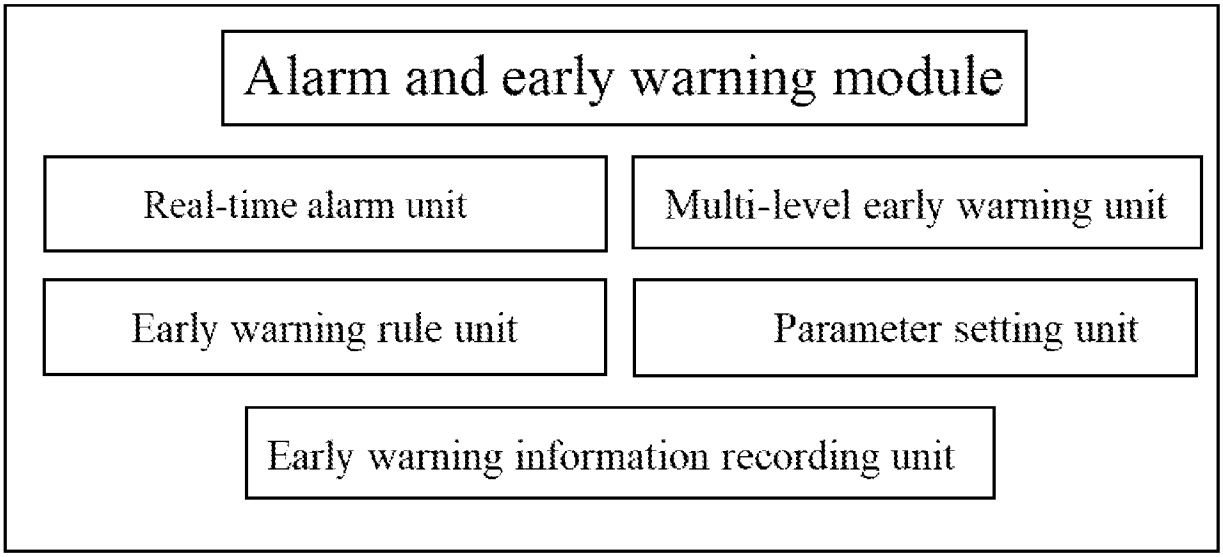
Alarm and early warning module
Real-time alarm unit
Multi-level early warning unit
Early warning rule unit
Parameter setting unit
Early warning information recording unit

FIG. 5

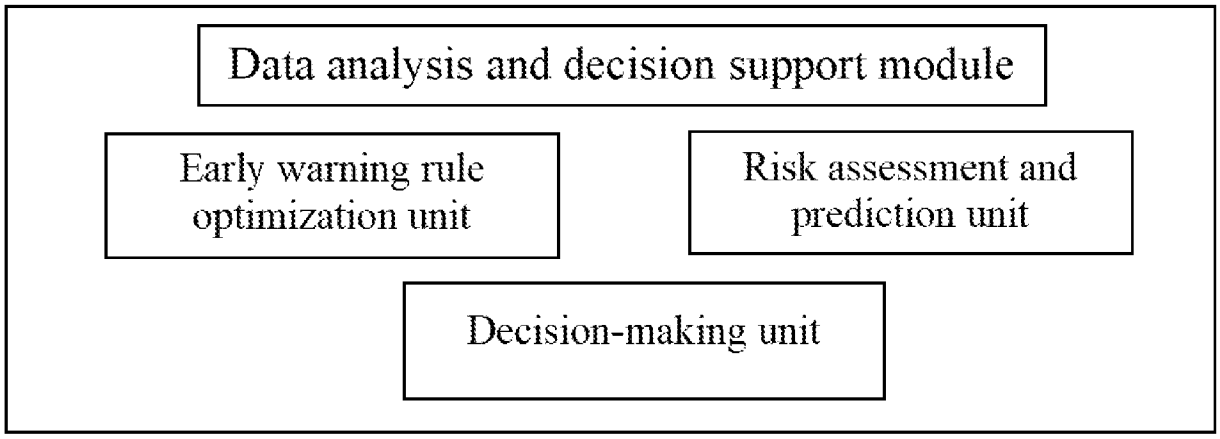
Data analysis and decision support module
Early warning rule optimization unit
Risk assessment and prediction unit
Decision-making unit

FIG. 6

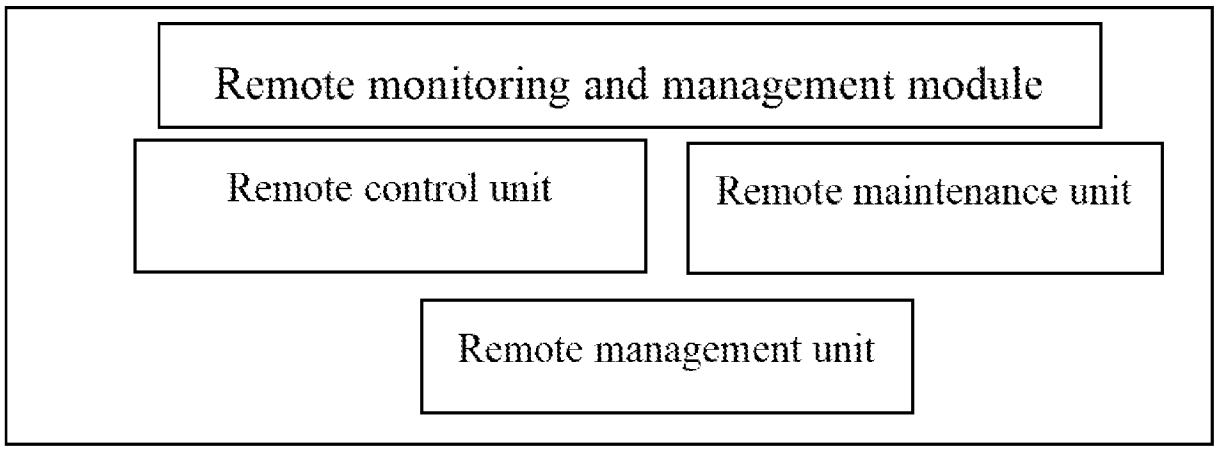
Remote monitoring and management module
Remote control unit
Remote maintenance unit
Remote management unit

FIG. 7