

Technique and its applications of computer monitoring and control for safety mining production process of coal industry in China

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With the development of modern digital technique, computers have been widely used to monitor and control in retrofitting traditional industries. In Chinese coal industry, some analog monitoring and control systems have been replaced by the modern computer digital systems. According to the development status of Chinese coal industry, this paper presents some technique and its applications of modern digital computer monitoring and control for safety mining production process. The technique has been used in the full digital monitoring and automation control for hoists, coal mining machines, belt transport machines, and whole coal mining production process. With the technique, it has been achieved the better economical and social benefits in safety mining production in China.

Introduction

With the development of modern digital technique, computers have been widely used to monitor and control in retrofitting traditional industries. In Chinese coal industry, some analog monitoring and control systems have been replaced by the modern computer digital systems, such as, full digital monitoring and automation operation control technique and applications for hoists, digital monitoring technique for safety operation of coal mining machines of coal mine, digital monitoring technique for underground belt transport machines of coal mine and digital monitoring technique for production processes of coal mine based on information network.

According to the development status of Chinese coal industry, this paper presents some technique and its applications of modern digital computer monitoring and control for safety mining production process. The technique has been used in the full digital monitoring and automation control for hoists, coal mining machines, belt transport machines, and whole coal mining production process. With the technique, it has been achieved the better economical and social benefits in safety mining production in China.

Full digital monitoring and automation operation control technique and applications for hoists

Development and status of mine hoist in China

Mine hoist is the key equipment of mine production process. The control system with good performance of hoist is the important factor of assuring mine production capability and security.

Early in 50s–60s, mine hoists in China was AC hoist driven by AC machines, such as wound-field asynchronous motors. Since 70s, some DC hoists have been used, driven by G-M (generator-motor). In the early 70s, the DC hoist

fed by thyristor converters was first imported from ASEA Company. Since 80s some mine hoists controlled by digital computer systems have been developed and imported, such as full digital DC hoists fed by converter and AC hoists fed by cycloconverters.

DC hoists driven by DC motors fed by converters have good control performance and widely used in mining engineering area in China. With the development of computer control technique, the computer control system of mine hoist is replacing for the analog control system, and is becoming the important symbol of modern coal mine in China. For AC hoists, the full digital ac-ac cycloconverter control system have been used in mine hoists.

Constitute of full digital control system for mine hoists

The control system of a modern mine hoist can be divided into following subsystems: speed regulating system, position control system, monitoring system, brake control system, loading/unloading system and shaft signal system. The basic constitute of full digital control system for mine hoists is shown in Figure 1.

In DC hoist control system (shown as Figure 1), according to winding signals, PLC unit sends operation instructions. The control system for travel, speed and current implements travel calculation, motor speed control and current regulation. The whole control process is achieved by computer digital units. The applied results are shown that the whole control system of hoist has good control performances and meets the requirements of safety production for coal mine in China. The operation characteristics of a winding cycle for mine hoist is shown in Figure 2.

Intelligent monitoring for mine hoist

According to the operation technology of mine hoist an implement scheme of full digital computer automation

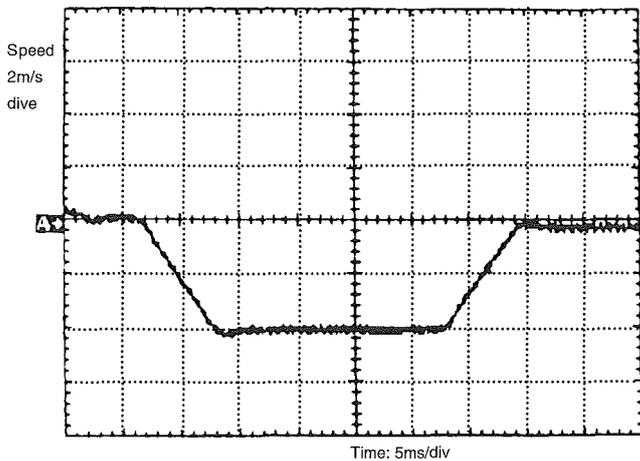


Figure 2. The operational characteristics of a winding cycle for mine hoist

value, i.e. the output signal of speed regulator, and actual current measured value. The following features are achieved, such as, current PI regulation, current pre-control, electromotive force control, logic-commutation and triggering control.

- The monitoring program of system is used in the operation status monitoring of whole hoist system, including speed and position. The speed monitoring includes the monitoring of over-speed, continuous speed, speeds point by point, slip rope, and signals from different speed measurement sources. The position monitoring includes the monitoring of over-winding, synchronous positions, computed positions from pulses of two different encoders.

Digital monitoring technique for safety operation of coal mining machines of coal mine

It is main feature of coal mining machine development of 1990s to monitor online the operation status of the machines and diagnose the faults in operation using computer digital technique. At present, the systems of status monitoring and fault diagnosis in the core of computer are widely used in coal mining machines with electrical traction in China. With the varied signal sensors, such as, voltage, currents, traction force, position, directions, pressure, speed, temperature sensors, etc. With these sensors and monitoring system, the good operation status of coal mining machines can be exactly got and described. Because of using this advanced technique, some satisfactory development and progress are made in safety production of coal mine in China. Some principles and system constitution of digital monitoring technique for safety operation of coal mining machines of coal mine are introduced in this paper.

Main contents of digital monitoring for coal mining machines of coal mine

The main research contents of digital monitoring for coal mining machines of coal mine are as follows:

- Operation status monitoring and fault diagnosis system
- Fault diagnosis for driving induction motors.

Constitute and applications of monitoring system for coal mining machines

- *Digital monitoring system*—This part is constituted of

several computers fixed on coal mining machines. It has the features of data acquiring, processing, storing, transmitting, and displaying.

- *Operation instruction and protection unit*—The important task of operation status monitoring and fault diagnosis system is to give some operation instructions and have necessary protection features.
- *Fault diagnosis unit*—Generally, The practical values from measurement units are compared with set values. Then through logic judgment, some display and warning signals are given.
- *Signal unit*—With this unit, some monitoring data, display and warning signals are shown.

The typical application of monitoring system for coal mining machines is shown in Figure 3.

Digital monitoring technique for underground belt transport machines of coal mine

Status and development of underground belt transport machines for coal mine

Since 1980s, underground belt transport machines have become the main tools of underground coal transportation for coal mines of high production with high efficiency in China. It plays an important role for the automation and safety operation of belt transport machines in coal mining production. DCS (distributed control system) is used in the integrated control system of belt transport machines, allocated with the industry TV sets and varied protection sensors. Utilizing the optical fibre communication technique, the varied parameters and main part images of the machines can be transmitted to the ground control centre. Thus, the integrated control of the machines can be implemented on the ground. The digital monitoring technique for underground belt transport machines of coal mine has been widely applications in China, and the better economical and social benefits have been achieved.

Main contents of monitoring system of underground belt transport machines in China

Main features and properties of monitoring system of underground belt transport machines are as follows:

- *Conforming to requirements of safety mining production for coal mine*—Monitoring installations of underground belt transport machines should be adapt to the wretched environment of having the dangers of gas and coal dust explosion underground coal mine.
- *Control features*—Monitoring system has the features of control, protection, communication, and signal comprehension. Operation modes have: off-line/manual, on-line/maintenance, programming, half-automation and remote control modes.
- *Network features*—Monitoring system of belt transport machines based on information computer monitoring and control network with TV set picture monitoring parts can be used either in unique belt transport machine, or combined with multiple belt transport machines, controlling several or tens of belt transport machines.

Applications of monitoring system of underground belt transport machines in China

In the monitoring system of underground belt transport machines in China, the computer system on ground control

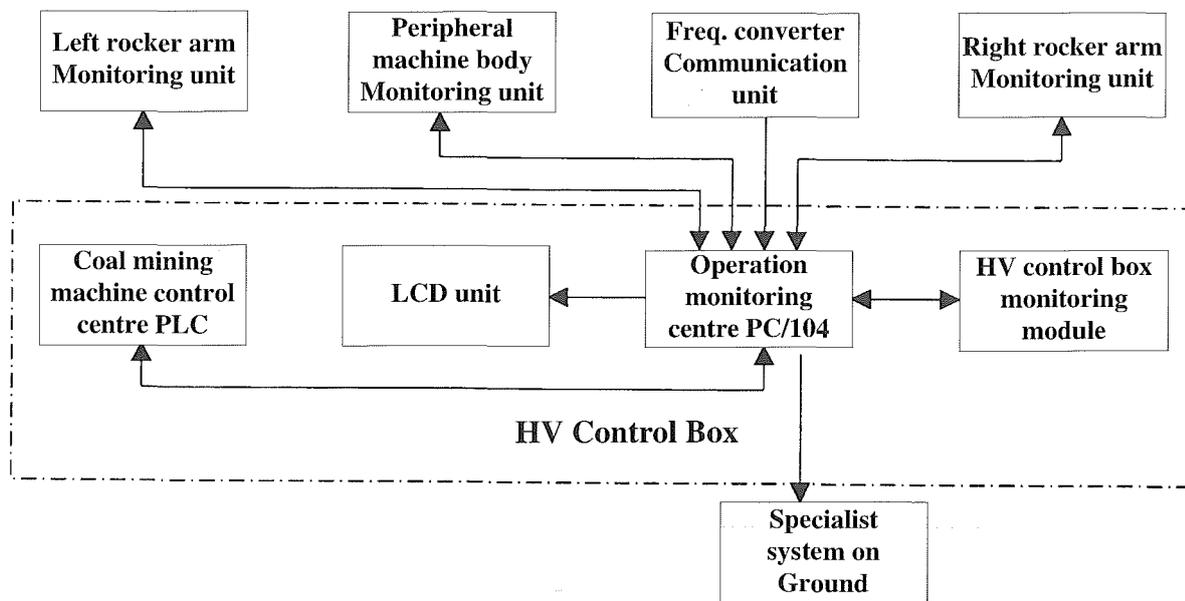


Figure 3. Typical application of monitoring system for coal mining machines fed by electric drive

department shows on real-time operation status of underground belt transport machines, prints various data and tables, connects with the whole mine computer network, and sends the suggestion signal and warning signals.

The whole monitoring system consists of following parts.

- Computer control unit
- Signal, sample, transmitting and processing unit
- Figure display unit
- Control unit
- Signal monitoring unit.

Now, the monitoring system of underground belt transport machines has widely used in coal mine in China. Basically, non-person is on duty for monitoring underground belt transport machines of some coal mine in China.

Monitoring technique and applications of mine production processes based on information network technique

Basic frame of monitoring system for mine production processes

Basic objects of monitoring system for mine production processes are as follows:

- Implementing multi-media computer network under the leadership of mine network administration centre
- Implementing the information acquiring of safety production dispatching, automatic processing of information transmitting, meeting the requirements of coal mine to information quality and quantity and processing speed, and assuring the integrity, accuracy, safety and trustiness of data, to achieve the sharing of information resources
- Integrating to safety production, sale administration, and other type monitoring system
- Supply the support and design reference for leadership administration level with computer analysis, comprehension, and helping design.

Monitoring technique and applications of mine production processes based on information network technique

The safety production is the most important task for coal mine. The safety monitoring is the one of most measures to prevent against accidents in coal mine. It is very necessary to integrate a safety network system with safety information and implement the network administration, to achieve sharing information, implementing modernization dispatching and commanding and monitoring and controlling for safety production.

The advanced monitoring technique of coal mine production processes is adopted to advanced installation technique and management experience and based on modern management. It is built with integrating multi-media computer technique and video-frequency technique, containing the comprehensive managing information system of safety production, picture transmitting, marketing analysis and optimization.

The typical application of coal mine production processes based on information network is shown in Figure 4.

Conclusions

According to the development status of Chinese coal industry, this paper presents some technique and its applications of modern digital computer monitoring and control for safety mining production process. The technique has been used in the full digital monitoring and automation control for hoists, coal mining machines, belt transport machines, and whole coal mining production process. With the technique, it has been achieved the better economical and social benefits in safety mining production in China.

This project supported by the National Science Foundation of China.

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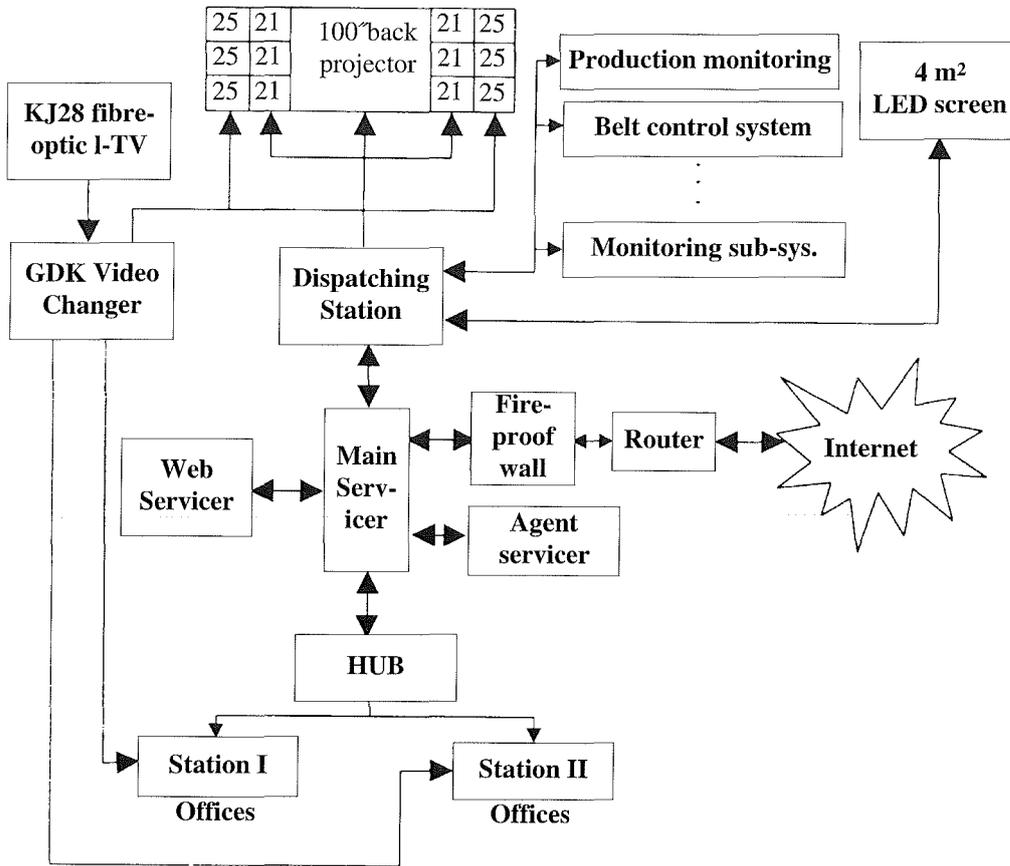


Figure 4 . The monitoring system of high-production and high-benefit coal mines in China

