Research and Application of Information Perception Technology for Mine Safety Helmet

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Abstract. Based on wireless sensor network technology in the Internet of Things, this paper studies and designs a mine environment perception system that is used in coal mines. The sense layer adopts the wireless sensor network based on WIFI technology, takes the miner safety helmet as the carrier, integrates the function module with STM32F107 controller as the core, and becomes the mobile node of the underground wireless sensing network, and realizes the monitoring of the miner's work environment information and the underground personnel positioning. Through the test, the intelligent mobile terminal can actively perceive the surrounding environment of the underground personnel, realize the real-time monitoring and intelligent warning of the gas concentration, carbon monoxide concentration and temperature in the surrounding area of the miners, and can provide the positioning information for the ground-based biter, which is an important supplement to the safety monitoring of coal mine in China.

1. Introduction
With the rapid development of coal mine safety monitoring technology, the situation of coal mine safety production in China has greatly improved. However, there are still many shortcomings in the safety monitoring of coal mine in china, how to improve the level of coal mine safety production is the focus of attention of all coal mining enterprises, the solution lies in the need not only to establish a sound scientific management system, but also in the coal mine production technology and equipment has made great progress. At the beginning of the 21st century, some large state-owned coal mines implemented a comprehensive automation system for coal mines with cable industry Ethernet as the core of the communication network, and the use of this system has improved the safety and safety level of coal mine safety to a certain extent.

On the basis of the current comprehensive automation construction of coal mines, the core of the construction of the Internet of Things in coal mines is mainly around the "three perceptions", that is: (1) to perceive the safety environment around the underground personnel, to achieve active security. (2) To perceive the risk of major disasters in mines, to achieve the forecast and early warning of all kinds of disaster accidents, and (3) to perceive the healthy state of the work of major equipment in mines and to achieve predictable maintenance [1-3]. The intelligent terminal designed in this paper is the first specific realization of the perception of the internet of things in coal mines.
2. Overall programme architecture
At present, all kinds of environmental parameters related to safe production should be transmitted to the ground dispatch room, the ground dispatch room for data preservation and processing, when an abnormal situation is detected, the dispatcher only through the broadcast system or other means to notify the underground operators. Because of this passive perception of the way, coupled with the delay of information communication mechanism, it makes it difficult for miners to understand their surrounding information in a timely manner, may make the miners themselves in danger without knowing, thus missing the best chance of escape, resulting in casualties.

The coal mine underground safety helmet monitoring system designed in this paper is composed of three parts: data acquisition layer (terminal node), data transmission layer and monitoring and analysis layer, as shown in Figure 1 [4]. The data acquisition layer takes the miner safety helmet as the carrier, integrates the environmental information acquisition module, audio and video module, wireless communication module, personnel positioning module and sound and light alarm module with THE STM32F107 controller as the core, and realizes the functions of mineworker's operation environment information monitoring, underground personnel positioning, real-time voice communication, sound and light alarm. The data transmission layer realizes the data transfer between the data acquisition layer and the intelligent monitoring and analysis layer by means of wireless transmission to wired transmission [5]. The monitoring and analysis layer is responsible for collecting the data information collected by the terminal node, and has the functions of implementing storage, display query, report printing, data analysis and gas warning.

![System overall architecture diagram.](image)

The purpose of this paper is to monitor the working environment of miners, collect information such as working environment, location, audio and other information of miners through the terminal...
node, and pre-process the collected data, and then transmit the collected data information to the router node through the WiFi network, and complete the conversion from wireless data transmission to wired data transmission on the router node. The final router node transmits the data information over Ethernet to the ground dispatch center.

3. Hardware circuit design
The mobile terminal chooses ST Company's STM32F103ZET6 as the core processor, uses WiFi communication protocol to realize two-way communication, selects Atheros AR9271 as wireless network card, and UDA1341TS as voice processing chip [6-7]. To realize the real-time positioning of WiFi-based personnel, the ground dispatch center can obtain the position information of the mobile terminal in the coal mine through the personnel positioning system, and the gas concentration, carbon monoxide concentration and temperature signal collected by the sensor module are fed into the processor, and then transmitted to the ground dispatch center via WiFi to realize the monitoring of the surrounding environment of the mine personnel. When the gas concentration of the collected mine working surface is greater than 1%, the buzzer will alarm, and the collected gas concentration, temperature, battery power, signal strength and time information will be collected using the LCD screen to display. The hardware circuit block diagram for the mobile terminal is shown in Figure 2.

![Figure 2. Hardware circuit block diagram of mobile terminal.](image)

4. Software design and implementation of mobile terminals
The mobile endpoint designed in this paper is developed on ARM embedded hardware platform, taking into account the frequent switching between multiple tasks and other factors, it is necessary to port the Linux operating system, so that Linux can run on the hardware platform of the endpoint. Each module in the endpoint needs to be tailored to the needs of the development of embedded underlying drivers and upper-level applications. The overall structure of the endpoint software is shown in Figure 3.

![Figure 3. Terminal Software Structure.](image)
4.1. **Terminal program run process**

The system workflow is shown in Figure 4, and the system start-up is divided into cold start and hot start. The first power-up of the device is called cold start, the process of terminal standby wake-up processing task is called hot start, wake-up mode mainly external alarm wake-up and timer wake-up two kinds, after the task processing is completed, the terminal automatically enters standby state.

![System workflow diagram](image)

**Figure 4.** System workflow diagram.

4.2. **Video acquisition process**

The system uses V4L drive architecture to design video information acquisition program, which is divided into the following steps: opening the device, setting the properties, establishing memory mapping, video data acquisition, video data processing, shutting down the equipment and so on. The video capture program process is shown in Figure 5.

![Video capture program process](image)

**Figure 5.** System workflow diagram.

In this paper, the development of the monitoring software mainly includes the design of the system login interface, the monitoring main interface, the data report interface, the over-limit alarm interface, the gas early warning interface and other functional modules. Monitoring software is responsible for real-time access to the helmet system from the data, real-time display monitoring information, storage of various types of data.
5. Summary
As a concrete embodiment of personnel perception thought in the internet of things of coal mine, intelligent mobile terminal realizes the monitoring of the working environment of miners, realizes the communication between underground staff and ground dispatch room, and locates the position of underground personnel. Realizing the beneficial change of miners' ability to change from passive to active perception of their surroundings is conducive to improving the safety production level of coal mines, and is an important supplement to the safety monitoring of coal mines in China. The test shows that the system has achieved the expected goal well, and its popularization and application will have important engineering value for the safe production of coal mines and the safety of miners' safety.

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