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Smart Drilling Technology Based on Pilotless Appliances for an Overground Iron Mining Company

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Abstract

This article examines the current state of research and development of intelligent technologies for underground metal mines in China, where such technologies are being developed for use in the development of mineral resources in a safe, efficient, and environmentally friendly manner. We analyse and summarise the state of research in underground metal mining technology in the United States and abroad, including specific examples of equipment, technology, and applications. We introduce the most recent equipment and technologies for unmanned mining, including intelligent and unmanned control technologies for rock-drilling jumbos, down-the-hole (DTH) drills, underground scrapers, underground mining trucks, and underground charging vehicles, all with independent intellectual property rights. For intelligent and unmanned mining, three basic platforms are used: the positioning and navigation platform, the information-acquisition and communication platform, and the scheduling and control platform.

Keywords: Technology • Drilling • Metal • Mines

Introduction

The demand for mineral resources is growing in tandem with the world's rapid economic development. It is predicted that the depth of more than 33% of China's metal mines will reach or exceed 1000 m within the next decade. Deep underground mining will become the metal mining trend in China. To overcome the drawbacks of traditional mining methods, such as excessive resource consumption, poor operating environments, and low production efficiency, high safety risks, high production costs, and severe pollution, intelligent mining technology for underground metal mines that provides complete safety, environmental protection, and efficiency is required [1].

Despite the fact that these developed countries have already invested significant time and money in the study of intelligent mining, only a few related studies have been conducted in China, particularly in the field of intelligent equipment and platforms. China is funding a number of intelligent mining projects in order to rapidly advance its capabilities, including the Key Technology and Software Development for Digital Mining project and the High-Precision Positioning for Underground Unmanned Mining Equipment and Intelligent Unmanned Scraper Model Research project [2].

Mining is one of the world's oldest industries. Mining production techniques have rapidly evolved from artificial, mechanised, and on-site remote-control production to intelligent and fully automated production. Mechanization tools have been developed to move the mining industry forward, single-equipment and independent systems have been automated, and the entire mining production process has been highly automated. Intelligent mining technology, based on mechanised and automated mining, has been rapidly developed by integrating information technology with the industrialization of mining technology. As a result, intelligent processes in mining equipment have been gradually upgraded; unmanned and centralised mining equipment have now entered the stage of practical application, which will significantly advance the automation and information technology used in mining [3].

Rock drilling is a critical process in mining that affects productivity, cost, and efficiency. Different geological conditions necessitate different mining methods, which necessitate different types of rock drilling. For medium-length hole drilling, a hydraulic rock-drilling jumbo is required. An intelligent and unmanned rock-drilling jumbo has been designed to support intelligent mining technology and complete drilling work efficiently. The first basic technologies implemented in the unmanned hydraulic rock-drilling jumbo were remote control and a virtual-reality display, which shows the jumbo's initial unmanned control platform on the surface. The virtual prototype display system is well-integrated, including on-site audio and video signals, to increase the sense of immersion while performing remote-control operations.

Literature Review

Drilling, blasting, loading, and transportation are the four main processes in underground mining. Because a charging vehicle is required for blasting, it is critical to develop an automation operation for a charging vehicle. An underground charging vehicle is a mechanical and electrically integrated product that transports raw materials, mixes explosives, and loads gun-holes. It has a compact structure, a high degree of automation, and a wide range of applications. An intelligent vehicle charging system. The pipe-reeling, pipe-feeding, and charging speeds can all be controlled digitally, and the reeling and feeding speeds are automatically matched to the charging speed and hole diameter. To improve the blasting effect, a fully coupled charge is achieved [4].

A two-dimensional navigation map was constructed using a point and line as the basic geometric representation, and accurate drawing of the underground map and detailed incorporation of navigation information were achieved. This provides a basic map platform for the mining equipment's precise positioning and intelligent navigation. Combining laser positioning data with ultra-wide-band auxiliary positioning data yielded real-time high-precision positioning information. A high-precision laser-positioning base station system, a vehicle machine vision system, and UWB wireless positioning technology comprise the positioning system [5].

Discussion

A ubiquitous underground information-acquisition and control device performs the basic functions. A high-frequency embedded processor and distributed architecture are used to achieve real-time high-precision acquisition

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and rapid reliable transmission of analogue, digital, and video and audio frequency. The architecture can be configured with various underground equipment, a digital mine system, a mining production system, and an environmental monitoring system, and information can be efficiently uploaded. Using Ethernet and other data-transmission methods, a non-differential data-transmission channel is established between the equipment and the communication system. A multilevel composite network architecture based on distributed technology enables seamless roaming and redundant transmission technologies between base stations while the underground vehicle is moving [6,7].

Conclusion

Intelligent mining technologies for underground metal mines are the physical manifestation of China's national policy of modernising traditional industries through cutting-edge technology. Through multidisciplinary and multiple technology integration, intelligent mining technologies integrate applications of high-end technologies based on automation, information technology, digital and artificial intelligence, and many other new technologies. Intelligent mining not only improves the effectiveness of mining equipment and the intelligent monitoring of mining processes, but it also significantly improves mining efficiency, lowering mining costs and increasing mining enterprises' competitiveness. Simultaneously, intelligent mining can reduce the number of field operations as well as the risk of disasters. Furthermore, intelligent mining is an effective way to achieve cleaner production and mine development that is sustainable.

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Conflict of Interest

There are no conflicts of interest by author.

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