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Intelligent Mining Technology for an Underground Metal Mine Based on Unmanned Equipment

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ABSTRACT
This article analyzes the current research status and development trend of intelligent technologies for underground metal mines in China, where such technologies are under development for use to develop mineral resources in a safe, efficient, and environmentally friendly manner. We analyze and summarize the research status of underground metal mining technology at home and abroad, including some specific examples of equipment, technology, and applications. We introduce the latest equipment and technologies with independent intellectual property rights 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. Three basic platforms are used for intelligent and unmanned mining: the positioning and navigation platform, information-acquisition and communication platform, and scheduling and control platform. Unmanned equipment was tested in the Fankou Lead-Zinc Mine in China, and industrial tests on the basic platforms of intelligent and unmanned mining were carried out in the mine. The experiment focused on the intelligent scraper, which can achieve autonomous intelligent driving by relying on a wireless communication system, location and navigation system, and data-acquisition system. These industrial experiments indicate that the technology is feasible. The results show that unmanned mining can promote mining technology in China to an intelligent level and can enhance the core competitive ability of China's mining industry.

1. Introduction

With the world's rapid economic development, the demand for mineral resources is increasing. It has been forecast that the depth of more than 33% of the metal mines in China will reach or exceed 1000 m within the next decade. Deep underground mining will become the trend of metal mining in China [1]. To overcome the disadvantages of traditional mining methods, such as excessive resource consumption, poor operating environments, low production efficiency, high safety risks, high production costs, and severe pollution, it is essential to develop an intelligent mining technology for underground metal mines that provides complete safety, environmental protection, and efficiency [2,3]. Some developed countries have done a great deal of work in the field of intelligent mining for underground metal mines over many years, and thus have considerable experience in this field. At the beginning of the 21st century, Canada, Finland, Sweden, and other developed countries made plans for intelligent and unmanned mining. At the Stobie Mine, an underground mine belonging to the International Nickel Company of Canada, Ltd. and a typical example of such an automated mine, mobile devices such as scrapers, rock drills, and underground mining trucks are operated remotely and workers can operate the equipment directly from the central control room on the surface [4]. According to the Canadian government's 2050 long-range plan, Canada intends to transform one of its underground mines in the northern part of the country into an unmanned mine. The plan states that all devices will be controlled from Sudbury via satellite in order to achieve intelligent and unmanned mining. Another intelligent mining program covering 28 topics—including the real-time process control of mining, real-time management of resources, construction of a mine information network, and application of new technology and automatic control—was carried out in Finland. Sweden has developed the Grountecknik 2000 strategic plan

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