

Key Technologies for Smart Mining of Underground Metal Mines

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Keywords: smart mining; remote control operation; autonomous driving; ore flow; underground metal mines

ABSTRACT

Currently, the global mining industry has entered a new historical phase. With the gradual depletion of surface-level mineral resources and the increasing discovery of deeper reserves, the trend in global mining development is shifting towards the exploration and exploitation of these deeper resources. However, the development of such resources faces multiple challenges, including product pricing dynamics, escalating production costs, ensuring operational safety, and managing the workforce. In response, the inevitable choice for the development of these deeper resources necessitates the advancement towards intelligent, and potentially unmanned, mining technologies, ultimately leading to the establishment of smart mining operations. Centered around the mining production process, a comprehensive set of key technologies specifically tailored for unmanned extraction in underground metal mining is developed. This system spans the entire mining production spectrum, encompassing 'mine planning-mining design-scheduling-single-unit design-blasting operations-stope ore extraction-ore pass ore discharge-locomotive ore transportation-unloading ore lifting-ore hoisting-ore beneficiation-backfilling and tailings transport,' with a primary focus on optimizing the flow of ore as its core concept. This study underscores the crucial importance of 'business flow coordination,' 'data flow integration,' and 'equipment control intelligence,' facilitating the remote, teleoperated, and unmanned oversight of mining production management. The practical implementation and demonstration of these research outcomes within numerous mining enterprises serve as tangible applications, laying the groundwork and furnishing the requisite theoretical foundation and technological underpinnings for the intelligent, resource-efficient, and environmentally sustainable development of deep-seated mineral resources.