

Safety Risk Identification and Prevention Strategies of Intelligent Mining in Coal Mines

Jiahui Zhang¹, Jun Zhang^{2,3}, Jiang Ma^{1,*}, Yushuo You⁴, Jingqi Wang¹ and Xuguang Wei¹

¹School of Science, North China University of Science and Technology, Tangshan 063000, China

²Educational and Scientific Institute of Computer Sciences and Information Technologies, National Technical University "Kharkiv Polytechnic Institute", 61002, Kharkiv, Ukraine

³Tangshan Institute of Measurement Test, Tangshan Administration for Market Regulation, Tangshan 063000, China

⁴School of Mechanical and Electrical Engineering, Central South University, Changsha 410000, China

* Corresponding author

Abstract

A set of intelligent isolation drive and safety guarantee system based on dynamic multi-view is constructed to realize accurate reconstruction of coal mine space. In the coal mine operation area, multiple point cloud cameras are deployed, and advanced human body recognition technology is used to carry out accurate three-dimensional reconstruction of operators according to the location of each camera, and the specific location information corresponding to the three-dimensional model is returned in real time. Once a person is detected in a predefined danger area, the system immediately alerts and provides accurate positioning support for downhole smart equipment to assist in its operations. The application of this system can greatly improve the efficiency of coal mine operation safety control and protect the life safety of coal miners in an all-round way.

Keywords

Three-dimensional model; point cloud cameras; human body recognition technology; coal mine operation safety.

1. INTRODUCTION

This paper focuses on the field of coal mine safety, and deeply carries out the research and development and optimization of two core safety monitoring systems: intelligent isolated driving system and dynamic multi-view human space reconstruction safety system. In the complex working environment of coal mine, the intelligent isolated driving system uses high-precision sensors and real-time image processing cutting-edge technology to carry out all-round, uninterrupted real-time monitoring and accurate tracking of personnel in the underground working area. With the help of special explosion-proof high-resolution cameras in coal mines and a well-laid sensor network, the system collects data of operators and the surrounding environment, and then the high-stability central processing unit calculates and gives feedback in real time, effectively avoiding the collision between underground transportation equipment and operators, and opens up a safe action space for operators. In

In addition, the system is equipped with a simple and intuitive operating interface, so that staff can quickly obtain critical information and improve the efficiency of emergency response. The dynamic multi-view human space reconstruction security system aims at complex scenes such as coal mine roadway and mining face, and rationally deploys multiple point cloud cameras at different positions to collect personnel dynamic data in real time from multiple angles. Through the use of advanced computer vision technology and deeply optimized deep learning algorithm, the collected data is deeply analyzed, which can accurately restore the real-time position of personnel in the three-dimensional space of the coal mine, and significantly enhance the safety protection ability of coal miners. The system uses a unique triangulation method combined with deep learning algorithms to quickly identify key features of the human body, accurately build a three-dimensional model, accurately predict the human body posture, and timely insight into the abnormal behavior of personnel, providing strong support for security early warning.

2. MAJOR TECHNOLOGY

By training the YOLOv8 model to improve its performance in specific scenarios and integrating it into our security system^[1]. The ultimate goal of the research is to improve the safety of the working environment and increase production efficiency through technological innovation. Multiple high-resolution cameras capture the environment and human body dynamics from different angles, ensuring that there are no blind spots in all directions, achieving multi-view images, and then data processing and analysis through integrated computer vision technology and deep learning algorithms. This 3D modeling technology allows the system to fully understand the specific position and volume of the human body in space, greatly improving the dimension and accuracy of monitoring^[2].

3. FEASIBILITY ANALYSIS

3.1. The feasibility of market demand

In the coal mine production process, the unloading process is complicated and the working environment is harsh^[3]. The underground space is narrow, the light is dim, the coal dust is diffuse, and the workers need to work with large and complex unloading machinery and equipment, which makes the traditional unloading operation face high safety risks. On the one hand, the special unloading equipment of coal mine is huge in volume and complex in structure, and there are many blind areas in the operation process. Once workers are in these blind areas, it is difficult for equipment operators to detect, and it is easy to cause collisions. On the other hand, long-term and high-intensity underground operations can easily lead to worker fatigue, which can lead to operational errors, such as misjudging the unloading process and mistakenly pressing the equipment button, which may lead to abnormal operation of the equipment, posing a serious threat to the life safety of surrounding workers. In addition, coal mine underground humidity is high, coal dust erosion is strong, mechanical equipment in such an environment for a long time, parts are easy to wear and aging, frequent failures. Once the equipment fails suddenly, in the narrow and densely populated unloading area, it is difficult for workers to escape in time, which is likely to cause serious personal injury. At the same time, due to the noisy scene environment, warning signs are easy to be ignored, and workers may stray into the dangerous area of equipment operation under the tense and busy operation state, with disastrous consequences. In view of this, it is of great significance to deeply study and vigorously develop the intelligent isolated vehicle system for ensuring the safety of coal mine unloading operation^[4]. Using advanced sensor technology, intelligent image recognition technology and automatic control technology, the system can accurately perceive the location information of personnel and equipment in the working area, plan a safe and efficient unloading route through intelligent algorithms, achieve effective isolation of personnel and unloading equipment, and

greatly reduce the chance of direct contact between human and machine^[5]. In this way, it can fundamentally reduce the probability of all kinds of safety accidents, build a solid safety line for coal mine unloading operations, and effectively promote the level of coal mine safety production to a new height^[5].

3.2. Economic feasibility

Cost control: In the design and implementation of intelligent isolated vehicle system, hardware cost control is a key factor, which is directly related to the economic feasibility and return on investment of the project. Through reasonable selection and procurement strategy, the hardware cost can be effectively controlled and the cost benefit can be maximized while meeting the system performance requirements. **Market prospect:** Intelligent security monitoring system, with its efficient data processing capabilities, accurate monitoring technology and advanced analysis algorithms, has a very broad application prospect in the industrial field. With the rapid development of industrial automation and intelligent manufacturing, there is an increasing demand for intelligent monitoring systems that can improve production efficiency, ensure operational safety, and reduce operating costs.

4. CONCLUSION

The working environment of coal mine is dangerous and complex, so it is of great significance to develop intelligent isolated driving system. Relying on advanced technology architecture, the system can efficiently and accurately isolate coal mine operators from mechanical operations. The underground space of coal mine is narrow, the equipment is numerous and the operation condition is complex. Under the traditional operation mode, the personnel and the machinery are in close contact, and the slight carelessness, such as equipment failure, operation error and other sudden conditions, will easily lead to safety accidents. The application of intelligent isolated driving system can significantly reduce such risks and effectively protect the life safety of coal mine workers. The system uses high-precision mining sensors and advanced image recognition technology to monitor and track the movement of personnel in the downhole working area in real time and in all directions. In key links such as coal mining and transportation, the system knows the location and movement trajectory of personnel, and immediately issues an early warning once it detects an anomaly, ensuring the orderly progress of the operation process and greatly reducing the work interruption caused by safety accidents. This efficient operation mode not only improves the overall operation efficiency, but also effectively promotes the improvement of coal mine production efficiency. Compared with traditional monitoring methods, this intelligent isolated driving system has achieved a qualitative leap. Coal mine environment is bad, coal dust flying, heavy moisture, the traditional monitoring is easily affected by these factors, the monitoring effect is not satisfactory. With strong anti-interference ability, the system breaks through the traditional technical bottleneck, can accurately capture personnel dynamics, real-time perception of underground ventilation changes, gas concentration fluctuations and other complex environmental information, and conduct in-depth analysis. It has built a solid technical defense line for coal mine safety production, and promoted the coal mine industry to move steadily in the direction of safety and efficiency.

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