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COAL MINING SURVILLANCE ROBOT

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ABSTRACT

Coal is one of the most important fossil fuels in the world, it plays an essential role in human production, especially in the field industrial heating, urban gas production, power generation, and many other fields. However, the use of coal, especially the emission of sulfides and nitrogen oxides during coal combustion cause a series of environmental problems. Coal is India's most basic commercial imperativeness resource. And it is the third-largest coal producing country inside the world. Coal contributes over 70% of control time. Each labourer is allotted to satisfy a certain portion inside the mine's functioning and is ready with the fitting framework. various sectors worldwide. However, it is also associated with inherent hazards, including gas leaks, structural instability, and explosive dust. To enhance safety and minimize the risk of accidents, the paper proposes the development of a prototype surveillance robot for coal mine monitoring. The robot utilizes four DC gear motors, a motor driver, an ESP32 webcam, a breadboard, and various sensors, including humidity, MQ2, and temperature sensors to gather real-time data on the mine's environmental conditions. The collected data is transmitted to a central monitoring system via an ESP8266 Wi-Fi module, enabling continuous surveillance and timely detection of potential hazards. This study intends to develop a coal mine safety monitoring system using an RTOS Robot module, enhancing safety monitoring and reducing accidents in coal mines. Coal Mining Surveillance Robot will employ wireless sensor networks comprised of numerous micro sensor nodes characterized by their small size and cost effectiveness. The coal mining safety robot is a novel approach developed to address the inherent hazards of the industry. With a combination of DC gear motors, an ESP32 webcam, and an array of sensors, including humidity and temperature sensors, the robot serves as a monitor of environmental conditions. Real-time data transmission via an ESP8266 Wi-Fi module will ensure swift communication with a central monitoring system, enabling rapid detection of various hazards. Through wireless sensor networks, the proposed system revolutionizes the safety protocols in coal mining, offering a scalable and cost-effective solution to mitigate risks and enhance worker safety.

I.INTRODUCTION

Coal is one of the most important fossil fuels in the world, it plays an essential role in human production, especially in the field industrial heating, urban gas production, power generation, and many other fields. However, the use of coal, especially the emission of sulfides and nitrogen oxides during coal combustion cause a series of environmental problems[13]. Coal is India's most basic commercial imperativeness

resource. And it is the third-largest coalproducing country inside the world. Coal contributes over 70% of control time. Each labourer is allotted to satisfy a certain portion inside the mine's functioning and is ready with the fitting framework. In this division, many masters are losing their lives amid the threats. This chance calculate is happened due to the utilization of existing observing framework and less security measures inside the environment. As of late, a number of ask around works are carried out to progress the watching system and the security measures of the pros inside the underground coal mine[2]. Coal generation frameworks are complex with unsafe and energetic characteristics that consist of characteristic conditions, subordinate generation and operation conditions (e.g., gear, specialized framework and institution, etc.), and a number of dynamic subjects . Agreeing to measurements , a add up to of 20,731 mine mishaps happened in China, with an normal of 1.7 passings per mishap[9]. Coal mines have many dangers that robots could help monitor and prevent accidents. Scientists studied how to build a mining robot using digital twin architecture, math models of sensors, and learning models. The digital twin lets the robot adjust to underground mines. The sensor models calculate exact positions in tight spaces. And the learning models use math to improve the robot's performance. By combining these three things, the researchers built a robot well suited for coal mines. It can travel safely, detect hazards, and avoid harming workers. The framework provides a great start for developing robots for the coal mining industry[10]. Gas accidents are one of the main reasons that affect coal mine safety production. In order to ensure worker’s safety and productivity, it is important to make the coal mine risks known and controllable through certain technical means [12]. An analysis of gas leaks in coal mines between 2006 and 2010 revealed significant dangers for workers in the industry. The frequency of gas burnouts followed an exponential trend, indicating a worsening situation. Ownership, gas levels, and geographical location were key factors influencing safety. Categorization by causes exposed managerial flaws, particularly in coal mining operations. Despite an overall positive trend, spikes in accidents occurred on Mondays and in summer months, especially within coal mines. Gas explosions and outbursts posed serious threats, particularly in underground operations, with incidents slightly increasing [11]. With all the hazardous effects of mining, safety becomes a crucial element to consider. Mine safety has been receiving more attention in the last few decades by researchers, scientists, and practitioners. Due to its immense importance, it can be argued that safety has become the fourth pillar of mining sustainability, being an integral part of the economic, environmental, and social impact studies of new mining projects [15]. Fundamentally, mine safety relates to the maintenance of the health and well-being of all people who work or visit a mining operation. The workers, contractors and visitors who visit the mine sites must be able to return home safely. Mine safety is not just a reactive system of recording safety statistics, it is much more than that. Mine safety includes taking responsibility for the entire operation and efficiently planning the mining operations [14].

II.LITERATURE SURVEY

Wei Chen, Xuzhou Wang, "Coal Mine Safety Intelligent Monitoring Based on Wireless Sensor Network",DOI 10.1109/JSEN.2020.3046287, IEEE Sensors Journal ,2021.

Wireless Sensor Network (WSN) explores the use of the latest WSN technology in coal mine safety intelligent wireless monitoring, especially the three key technologies that need to solve the WSN wireless communication, transmission routing protocol and positioning algorithm for underground safety monitoring. The application of wireless sensor network in coal mine safety intelligent monitoring system is proposed, this paper discusses the principle and advantages of wireless sensor network and the design basis of wireless sensor network in intelligent monitoring system of coal mine safety. Based on the current situation and existing problems of the low level of intelligence of coal mine safety monitoring system, the design scheme and monitoring mechanism of coal mine safety intelligent monitoring system are proposed, and the feasibility of wireless sensor network in the application of coal mine safety intelligent monitoring system is discussed. Finally, the gateway proposed in this research was tested by laboratory simulation, and the results showed that the gateway designed in this research had good reliability andstability, and proposed a new solution for the design of coal mine safety monitoring system. Wireless sensors are widely used in industrial automation detection and monitoring because of their advantages such as low power consumption, small size and free from space restrictions. The network formed by the combination of wireless sensors as terminal nodes and computer control platform is widely used in many industries. This paper first introduces the characteristics of wireless sensor network and its application, then analyzes the current situation and requirements of coal mine safety monitoring system, and finally analyzes the development and design implementation of wireless sensor network in coal mine safety monitoring system. Coal output ranks among the top in the world, and the coal mine safety monitoring technology is still relatively backward, which has a great impact on the personal safety of coal mine operators [1, 2]. Developed countries adopt mechatronic integration technology and automatic control technology to develop an all-mine integrated automatic monitoring system for mine safety production, which realizes the monitoring of key environmental parameters such as coal mine production equipment, safeguard infrastructure equipment and mine gas [3, 4]. The monitoring system of developed countries was introduced in the last century, but for many reasons, this kind ofsystem cannot adapt to the safety monitoring of coal mineproduction in China. While introducing technology, technicianshave developed a safety monitoring system that adapts to thecurrent situation of coal mining production in China. Dozens ofsystems have been developed, but it cannot well solve thesafety monitoring of coal mine production in China [5]. Most ofthese systems have a single function, and the follow-upprocessing function after data collection is not perfect, so theycannot be effectively monitored and supervised, which is notgood for the centralized monitoring of coal mines and thesupervision of the entire production, let alone satisfying thepersonalized production operations in multiple mining areas

[6].China is rich in coal resources, the mining environment iscomplex, current coal demand continues high temperature, soChina's coal mining safety production is facing a big problem.With the development of computer technology, the maturity ofnetwork technology and the rapid progress of microelectronictechnology, the coal mining industry is advancing towardsmodern production and information management, and it ispossible to establish a perfect wireless sensor network coalmine monitoring system [7]. The mine safety monitoringsystem is intelligent and networked, and the computer systemplatform is used as the main control center to establish userinteraction window in the form of graphical interface. Theestablishment of a mine safety monitoring system withmodularized software and strong expansibility is urgentlyneeded in the safety production of coal mines in China, whichcan effectively prevent various gas explosion accidents. Theindustrial control system adopts the MFC provided byMicrosoft as the development environment on the computer platform, adopts the database and sensor technology to collect data, and USES the computer communication protocol to control the transmission of information [8, 9]. Wireless sensor USES sensor technology, computer communication USES information transmission technology, master control system USES computer application technology. The combination of various technologies constitutes the key technology of coal mine safety monitoring. Coal mine safety monitoring system and sensor node are similar [10, 11] and are composed of three modules :(1) the central control system includes the main control computer, computer peripheral equipment and main control application program; (2) Communication module includes data transmission device and connection cable; (3) Sensor terminal nodes and devices [12]. The working process of the coal mine safety monitoring: monitoring of coal mine gas, wind and other key environmental parameters indexes exceed the cordon of the mine production in the process of the state of the infrastructure is in the normal range, with center control system to analyze the collected data, and provide reference for directing the production department [13, 14], early warning on the poor state, to achieve the effect of nip in the bud. The safety monitoring system deploys various automatic alarm devices and power switches in the mine, which can effectively respond to emergencies, reduce and prevent disasters as far as possible, and escort for safe production [15]. Coal mine safety monitoring system and sensor nodes, is mainly to set the device in coal mine safety monitoring system of the safe operation range value, when it is beyond the scope of value in the process of running, will appear on the map to the voice of the alarm processing and graphics display [16], the supervisors will from sound and color icon is accurately determine where the equipment failure, in order to timely and effectively control, security checks, reduce the incidence rate of the equipment failure. Of course, in the process of equipment management purview division, power and responsibility, promote effective management, when the center of the management system to boot, there is a specific power and responsibility division, as each head after login the system, can the scope of its jurisdiction to supervise all the way, do their job, once appear problem [18] 3, also won't management confusion, can be

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timely and effective to solve the problem. Therefore, the application of coal mine safety monitoring system in the management process of coal mine can get twice the result with half the effort. Although the existing coal mine safety monitoring system has reached the basic level of availability, it also has deficiencies and some problems, mainly including the following aspects [20, 21].1) wired network is not only costly, but also difficult to install and operate. 2) The function is limited to the detection and control of environmental parameters, and the attendance and physical condition of underground operators cannot be obtained; 3) It can only measure the environmental parameters of the fixed place, and there is a measurement blind area; 4) The sensor position is relatively fixed [22, 23], and the parameters of target position movement cannot be measured by gun; 5) The communication protocol is not perfect, and the interfaces of various manufacturers cannot be well compatible. In this paper, real-time monitoring, perception andcollection of data and information of downhole operation areaare carried out through wireless sensor network, and the dataand information are processed, transmitted to sink node throughwireless channel, and then sent to ground monitoring centerthrough optical fiber backbone network. It integrated thetelemetry and control technology, sensor technology,embedded computing technology, distributed informationprocessing technology and wireless communication technology,and make full use of the Ad Hoc network characteristic ofdynamic self-organizing, jump, the communication andperception nodes can be mobile, small volume, without layinglines, simple operation, easy maintenance, low cost,networking is the solution of the coal mine comprehensive,unattended real-time monitoring and intelligent early warningsystem is a feasible method, also can make the optimization ofcoal mine safety production plan, scientific and reasonableproduction management and accident prevention.

III.EXISTING SYSTEM

Coal is India's most basic commercial imperativeness resource. And it is the third-largest coal producing country inside the world. Coal contributes over 70% of control time. Each labourer is allotted to satisfy a certain portion inside the mine's functioning and is ready with the fitting framework. In this division, many masters are losing their lives amid the threats. This chance calculate is happened due to the utilization of existing observing framework and less security measures inside the environment. As of late, a number of ask around works are carried out to progress the watching system and the security measures of the pros inside the underground coal mine. Coal generation frameworks are complex with unsafe and energetic characteristics that consist of characteristic conditions, subordinate generation and operation conditions (e.g., gear, specialized framework and institution, etc.), and a number of dynamic subjects. Agreeing to measurements, a add up to of 20,731 mine mishaps happened in China, with an normal of 1.7 passings per mishap

1.It says we need a better way to keep mines safe and lists the problems in making this type of system work in coal mines. The new system wants to use wireless sensors and data tech to make safety better and help with decision making. It also talks about how the

system works and how it shows data in real time, tracks the environment, and helps manage how things work. It adds that we must keep safety and money making in coal mines separate and need to watch over both to stop accidents. In all, the work helps make safety systems better and shows how tech can help make coal mines safer

2.A comprehensive study on the development and implementation of an advanced safety monitoring system for coal mines using Internet of Things technology. The system requirements, proposed methodology, and system implementation, with a special focus on using sensors such as gas, MEMS, and LDR to detect and prevent hazardous events, are outlined. The authors also provide a detailed review of the literature, citing related research work and the importance of advanced mechanisms in improving production safety and reducing coal mine accident rates. The study was prepared by experienced experts in the field and provides valuable insight into the potential impact of advanced technologies on the safety and wellbeing of miners in challenging mining environments

IV.PROPOSED SYSTEM

1. Coal mines have many dangers that robots could help monitor and prevent accidents. Scientists studied how to build a mining robot using digital twin architecture, math models of sensors, and learning models. The digital twin lets the robot adjust to underground mines. The sensor models calculate exact positions in tight spaces. And the learning models use math to improve the robot's performance. By combining these three things, the researchers built a robot well suited for coal mines. It can travel safely, detect hazards, and avoid harming workers. The framework provides a great start for developing robots for the coal mining industry

2. Gas accidents are one of the main reasons that affect coal mine safety production. In order to ensure worker's safety and productivity, it is important to make the coal mine risks known and controllable through certain technical means. An analysis of gas leaks in coal mines between 2006 and 2010 revealed significant dangers for workers in the industry. The frequency of gas burnouts followed an exponential trend, indicating a worsening situation. Ownership, gas levels, and geographical location were key factors influencing safety. Categorization by causes exposed managerial flaws, particularly in coal mining operations. Despite an overall positive trend, spikes in accidents occurred on Mondays and in summer months, especially within coal mines. Gas explosions and outbursts posed serious threats, particularly in underground operations, with incidents slightly increasing

3 .With all the hazardous effects of mining, safety becomes a crucial element to consider. Mine safety has been receiving more attention in the last few decades by researchers, scientists, and practitioners. Due to its immense importance, it can be argued that safety has become the fourth pillar of mining sustainability, being an integral part of the economic, environmental, and social impact studies of new mining projects. Fundamentally, mine safety relates to the maintenance of the health and well-being of all people who work or visit a mining operation. The workers, contractors and visitors who visit the mine sites must be able to return home safely. Mine safety is not just a reactive system of recording safety statistics it is much more than that. Mine safety includes taking responsibility for the entire operation

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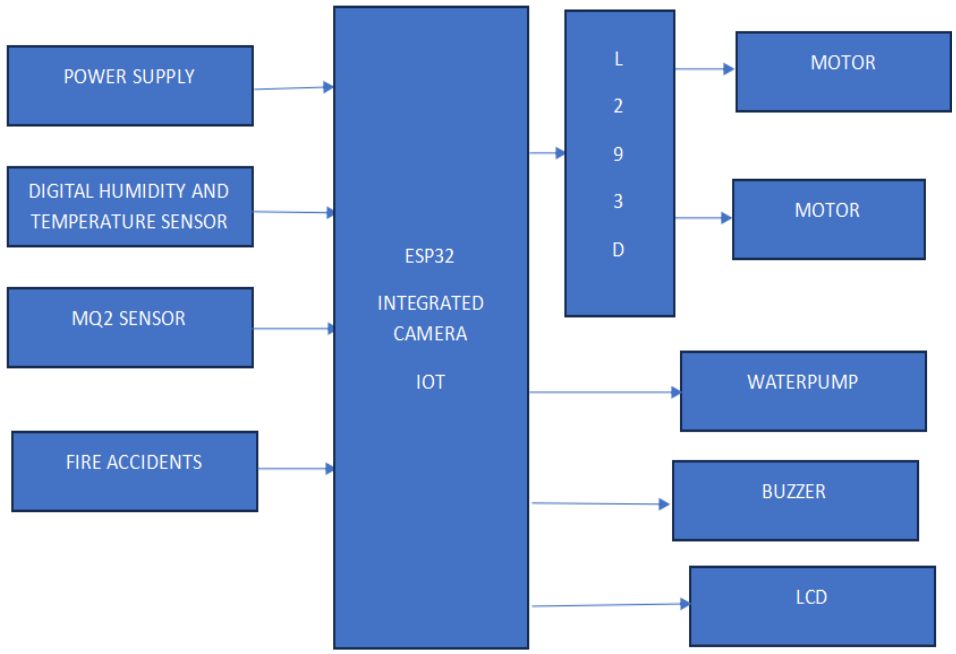
Block diagram



V.CONCLUSION

The successful implementation of the coal mining surveillance robot paves the way for further advancements in coal mine safety technology. By addressing the identified challenges and refining the robot's capabilities through enhanced sensor accuracy, advanced autonomous navigation, sophisticated data analysis, robust communication protocols, and real-time response systems, coal mining operations can significantly improve safety measures and reduce the risk of accidents. The utilization of surveillance robots has the potential to revolutionize coal mine safety practices by providing continuous monitoring, early hazard detection, and proactive intervention, ultimately contributing to a safer and more secure environment for workers in the coal mining industry.

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