

## Smart Mines Safety System

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**Abstract:** Safety is the biggest concern for all mining workers in the modern world. A risk-free working environment is guaranteed by the mining safety system. Reducing mining accidents is the project's primary goal. Safety is the biggest concern for all mining workers in the modern world. A risk-free working environment is guaranteed by the mining safety system. Improving working conditions and lowering mining accidents are the project's primary goals. Numerous sensors are utilized in mine safety systems for a variety of purposes, and the Arduino Uno is employed to increase dependability. This system is used in the mining business, and all of the sensors are regarded as a single unit. The sensors monitor a number of characteristics from the working space, including temperature and humidity levels, light intensity, the amount of toxic gases in the air, and flame trace. The readings from these sensors are transmitted to the Arduino for additional processing, and an alarm message is transmitted to the mining control room if the values were over the threshold. The buzzer is intended to enhance working conditions and notify employees who are inside the mining operating area in the event of an emergency.

**Keywords:** safety, monitoring, mining, Wireless sensor network

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### I. Introduction

Underground mining operations involving human work are extremely dangerous, and the hazards rise as one gets farther away from the earth. The many methods that miners employ to extract various minerals are the cause of mining operations that are conducted in a dangerous manner [1]. Miners run the danger of dying when they clash with large things like hard rock and mining equipment. The miners are also impacted by the intake of dangerous gasses that put them in risk. Miners are unable to contact the outside world in this scenario [2]. While maintaining safety must be the top priority, the mine of the future must operate more efficiently to save expenses, emissions, and boost output [3].

Since the near-surface coal seams are rapidly depleting, underground mining activities are extending towards the earth's deeper horizons in an attempt to obtain the deep-seated coal resources. The environmental conditions of the mines at deeper depths worsen due to insufficient ventilation and the creation of a lot of heat, humidity, poisonous and explosive gasses, and dust [4].

Underground mining accounts for 95% of output because of the complex storage conditions of coal deposits. Given the complexity of the coal mine's geology and the severity of natural disasters, there are a number of hidden risks. Therefore, early warning system research is essential for coal mine safety. A reliable safety early warning mechanism and management decision information channel for coal mines and underground wells is the coal mine safety early warning and monitoring system, which provides dynamic information of environmental and personnel safety parameters for disaster warning, production command, management decision making, and even accident rescue.[6] For a very long time, the coal mining sector has been essential to the generation of energy worldwide and has fueled economic expansion. However, there are inherent hazards to the security and well-being of miners involved in the mining of this priceless resource. The grave risks posed by fires, hazardous gas leaks, and accidents highlight the pressing need for sophisticated safety monitoring and alerting systems in coal mines.[7]

The research that is being presented focuses on a solution for the safety of mining workers. The article describes one wearable that uses ambient intelligence, a technology made possible by technological advancements, to ensure people's safety and security. An inventive wearable helmet with smart technology sensors senses a potentially dangerous workplace, gathers data from it, and sends out alerts and warning signals. It will help lower the rate of early mortality as well as severe worker illness (black lung disease) and unpredictable accidents.[9]

## **II. Literature Review**

This section discusses in detail the intelligent system that uses an emergency alert system to identify dangerous working conditions. Ventilation systems provide ample amounts of oxygen, are non-explosive, and ensure a safe atmosphere for underground mining. The mine ventilation system reduces the hazardous working conditions that miners face. The integrated ventilation monitoring system intelligently modifies the airflow based on private real-time data. The creation of an intelligent real-time tracking, monitoring, and communication system becomes important when the monitoring agent discovers unanticipated changes during monitoring.[9].

The survey gathered varied facts, including one death every third day in India's most dangerous job, mining. According to the International Labour Organization (ILO), mining employs only 1% of the global labor force but accounts for 8% of fatal accidents. China has the largest mining industry, generating up to three billion tons of coal annually.[2].

This smart technology built in PPE may offer workers with safety alerts, remind them of certain safety practices, and even allow an injured worker to immediately contact for aid. The system presented in this paper works by making a miner's personal protective equipment (PPE) "smart" with embedded sensors on all of their PPE, which includes: safety glasses, hard hats, miners' clothing, and also by wearing smart technology gadgets like smartphones and smartwatches that can monitor and inform mine personnel of potential safety hazards.[3].

Coal mining activities produce a variety of dangerous and combustible gases, including hydrogen sulfide (H<sub>2</sub>S), carbon dioxide (CO<sub>2</sub>), sulfur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), and methane (CH<sub>4</sub>). Other important risks connected with underground coal mining are mine fires and explosions, which are mostly produced by spontaneous coal combustion and the ignition of firedamp (methane-air combination) and coal dust, respectively.[4]

Miners face a variety of hazards, including gas explosions, roof collapses, mine haulage, sudden intrusions, mine floods, spontaneous combustion, and insufficient escape routes. No exact solution exists that can foresee these hazards and stop them before they happen. [8] These miners are susceptible to abrupt temperature changes, oxygen deprivation, dangerous gasses (carbon dioxide, sulfur dioxide (SO<sub>2</sub>), ammonia (NH<sub>3</sub>), and methane), fluctuating humidity, and other unanticipated and unfavorable risks when working beneath underpasses. Numerous solutions have been created, however they are unable to adequately address China's coal mine production safety monitoring issue. They cannot be adequately monitored and supervised since the majority of these systems only have one function and the follow-up processing function after data collection is imperfect. This makes them unsuitable for centralized coal mine monitoring and production supervision, much alone meeting the needs of customized production operations across many mining locations.[5]

It is a useful tool for compensating for the shortcomings of the present subterranean monitoring system and is appropriate for tough situations. Wireless sensor network technology is applied to coal mines through the use of sensor nodes in the coal mine safety early warning system. The simulation trend is created by gathering environmental parameters of underground coal mines in order to locate personnel, comprehend the current state of the underground, and promptly prevent disasters from reducing casualties.[6]

However, by installing cost-effective wireless communication devices in key positions around the mine, this process may be greatly facilitated. The suggested system employs low-power sensors that are particularly effective in detecting the worker's pulse, respiration rate, and any dangerous gasses that may be discharged into the environment. Hazardous gas levels are regularly monitored and transmitted in real time to avoid dangerous circumstances that might jeopardize the safety of mining workers. Notably, using their sensory talents, humans struggle to identify these gasses. The typical communication method for monitoring systems is burying communication cables below, which can be difficult in some areas, such as coal working faces. [8]

## **III. Conclusion**

Safety in mining is still a top priority because of the dangerous working conditions under which miners work, such as exposure to poisonous gases, extreme temperatures, and the possibility of accidents. The incorporation of contemporary safety technologies like wireless sensor networks, real-time monitoring systems, and intelligent wearable devices has greatly enhanced the capacity to sense and react to potential hazards. The suggested mining safety system, with Arduino Uno and other environmental sensors, is a safe and dependable solution for the monitoring of underground conditions and the provision of timely warnings to avoid catastrophes.

By constantly monitoring parameters like gas concentration, temperature, humidity, and presence of a flame, the system guarantees a safer place to work, minimizing the chances of deaths and long-term medical conditions such as black lung disease. The use of low-cost wireless communication and sensing technology increases the potential for more efficient mining without compromising on worker safety.

Even with the improvement in alert and monitoring systems, it is essential to have more in-depth studies aimed at designing more effective solutions that can anticipate and avoid accidents. Future advancements could involve more sophisticated AI predictive analysis, automated control of ventilation, and better communication

systems in mines. With continuous technological development, the mining sector is able to progress towards a more secure and sustainable future.

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