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A Review on Coal Mine Workers Safety Monitoring and Controlling

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Abstract: Now a day's due to global warming and climate change, there are now difficult conditions in the coal mining industry. In the industry of coal mining, automation is required to cut costs and improve productivity as well as product quality. Mining is necessary for the production of goods, infrastructure, and services that improve people's lives. The need for coal as a source of energy is always high and significant. However, hundreds of people have died in mining accidents around the world, and working on the earth poses a variety of security and health risks. So, in this paper, we suggest a mining tracking and safety system for miners. Using a different sensor, the system can monitor the underground environment and production parameters in real time and intelligently deliver early warnings, improving degree of monitoring production safety and reducing accidents in the coal mine.

Keywords: Coal Mine, Sensing Parameters, Data Transmission Techniques.

I. INTRODUCTION

Coal is an important resource in India, with numerous economic applications. The need for coal as a source of energy is always high and significant[1]. The growing global population is causing unavoidable problems. Mining is one of the most pressing of these challenges[2]. Coal is primarily utilized in the manufacture of thermal power, cement, and steel, as well as a fuel in a variation of other purposes. In a coal mine, there is a considerable possibility of harmful gases being released. As a result, personnel encounter several problems when working at the coal mine. For the security of labourers, technology is improving all the time. Hazards in coal mines are primarily produced by the harsh environment and working conditions. As a result, it is necessary to use a coal mine detecting system. The employing mine checking system's goal is to monitor mine workers' health and the injurious gas level in the coal mine environment region[3].

India is the world's greatest coal producer, but coal mining safe production is still low. Accordingly, calamities are common. Due to global warming and climate change, significant issues arise in the coal mining industry. Therefore, it's critical to keep an eye on and oversee the mine's working environment. The ventilation need of mine employee is controlled, which is dependent on the present climate conditions in the mine field[4]. Workers' safety should always be a top priority in any underground mining operation. Underground mining is a dangerous business in terms of worker safety and health. The deeper the mine, bigger the mine. Due to ventilation issues, underground coal mining poses a greater danger than open pit mining[2].

The internet of things refers to gadgets that communicate with one another over the internet. On a wide scale, Internet of Things applications differ. Smart buildings, smart transportation, smart energy, smart industrial, smart health, and smart city are examples of internet of things applications. All data from sensors is stored in the cloud and can be accessed from there in the internet of things. Data is collected by sensors and actuators and transmitted via the internet. We utilize the cloud to store data, analyse it, acquire information, and visualize it[5].

Sensing Parameters -

1) Gas Sensor -

The sensor has a high sensitivity as well as a fast reaction time. Isobutane, propane, LNG, and cigarette smoke can all be detected by the sensor[5]. Ventilation systems are critical in underground mining for supplying enough oxygen, maintaining non-explosive and non-toxic atmospheres, and running a productive mine. Mine ventilation systems can aid in the removal of high-risk environments. When the mining atmosphere becomes poisonous, primitive means for monitoring it can be traced back. By including a ventilation monitoring system[2].

2) Fire Sensor -

An electronic circuit can be used to create the sensor, which uses a receiver to detect electromagnetic radiation. In underground coal mines, mine fire is one of the most dangerous hazards. From a mine safety standpoint, continuous

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monitoring of underground coal mines for early detection of fires is critical. An electronic circuit can be used to create the sensor, which uses a receiver to detect electromagnetic radiation[6].

3) Temperature Sensor -

A temperature sensor with a calibrated digital signal output is complicated. It ensures high dependability and outstanding long-term stability by employing an innovative digital signal acquisition technique and temperature sensor technology. The calibration coefficients are stored in the OTP memory as programmes, which are then utilised by the sensor's internal signal detection algorithm. Its small size, low power consumption, and signal transmission range of up to 20 metres make it the perfect choice for a variety of applications[7].

4) Vibration Sensor -

It's vital to determine out how much vibration will activate a vibration sensor in the event of a debris flow before installing one. It's also important to think about the likelihood of unintentional sensor activation caused by earthquakes, as well as areas with construction traffic and other vibration sources. Vibration levels can be tracked over time to discover problems before they become problematic. Sensors put on machines are critical for vibration monitoring and analysis[7].

II. TECHNIQUES FOR DATA TRANSMISSION

1) Bluetooth -

The goal of Bluetooth technology is to provide a low-power, low-cost wireless air interface and software control system. Bluetooth technology can be used to replace cable interfaces, allowing for a new method of data transfer for the security and monitoring of coal mine. Transceiver receiver data from the acquisition front-end module via Bluetooth wireless transmission. The Bluetooth module is in charge of receiving MCU commands, sending commands, and receiving data from the acquisition front-end. Bluetooth is considered a reasonable secure wireless technology when used with precautions[8].

2) LoRaWAN -

LoRaWAN is a medium access control (MAC) layer protocol based on the cloud that primarily works as a network layer protocol for handling the interconnection between LPWAN gateways end-node devices as a routing protocol. All devices' data rates, communication frequencies, and electrical energy are governed by LoRaWAN. The network's devices are asynchronous, so they only send the date when they're ready. Multiple gateways receive data packets transmitted by an end-node machine and transport them to a centralised network server. After that, the data is sent to the application server[3].

3) MSP430 -

MSP430 used in different applications such as sensors systems which received analog signals and converts them into digital vales and after processing send these values to the host system. The temperature, humidity, gas, and smoke status of an underground mine all are monitored using an MSP430 controller. The ventilation need for mine employees is also controlled by this system, which is dependent on the current climate conditions in the mine field. This system utilizes low power, cost effective microcontroller MSP430. The MSP430 is designed specifically for ultra-low power applications. Its flexible clocking system, multiple low power modes, instant wakeup and intelligent autonomous peripherals enable true ultra-low power optimization, dramatically extending battery life[4].

4) Zigbee -

Zigbee is utilised for short-range communication between the mine worker's devices and the ground control centre. A low-cost Zigbee-based wireless mine monitoring system that provides early warning intelligence on methane, temperature, and humidity in the mining region. The Zigbee network measures the vibration of the entire human body. It uses less energy and has a lower development cost. It transmits and receives data wirelessly with ease[9]. Its signals may pass through walls and are quite effective in mines. Its capacity to construct mesh structures allows it to communicate over large distances[10].

5) Wireless Sensor Network -

It has high rate and power; the wire network is beneficial in many areas of the coal mine. Wireless sensor networks are better suited for data transfer. It may be tightly implanted and detect the conditions in the mine region, making it suitable for the mine face and improving system performance. Temperature, sound and pressure are examples of physical or environmental conditions that wireless sensor network monitor. Industrial and consumer applications, including as industrial process monitoring and control and machine health monitoring, employ such networks. Wireless

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sensor network nodes self-organize quickly underground in mines and sense the concerned object in an irregular environment[11].

6) Internet of Things -

The Internet of Things is a useful tool for improving coal mine safety supervision. Remote dynamic regulation against coal mines can be supported intelligent coal mine surveillance is something that can be encouraged. Intelligent coal mine monitoring is possible, as is the capacity for early warning and emergency reaction, as well as the supervisory and decision-making level of coal mine supervising authorities, resulting in accidents and losses being minimized and finally, the unattractive situation of safe coal mine manufacture can be improved[12].

METHODOLOGY

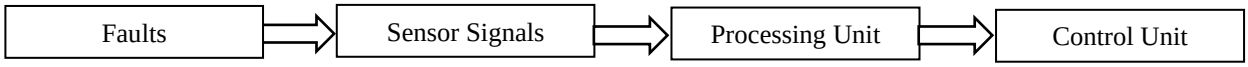

Fig.1 Coal Mine Monitoring and Controlling Process

Different parameters in a coal mine are monitored using various sensor signals, such as gas, fire, temperature, vibration, humidity, and smoke. The coal mine fault blocks show faults that occur in coal mines, while the coal mine sensor blocks demonstrate how to select a suitable signal for detecting purposes. The condition parameters of the coal mine are monitored by a sensor, which sends the current status of the coal mine to the processing unit, which processes it according to the instructions. If a fault occurs in a coal mine, the fault will be automatically control by the control unit.

III. CONCLUSION

The methods of coal mine monitoring are discussed in this paper. The design and implementation of a system which can provide security for mine workers and take the appropriate action are required. The study on real time monitoring of poisonous gases and other parameters present in underground mine is analyzed. For providing a sharper and more point-to-point picture of the underground mine, coal mine safety monitoring system is being created. Proper monitoring and communication are possible between the workers and ground staff which can help to take appropriate actions quickly, it will be helpful to all miner's present insides the mine to save their life before any casualty occurs. Using additional sensors all possible safety issues could be monitored. The other important data can be communicated through the system making it feasible where wired communication is a difficult. The control can be managed from the surface itself as the system provides easy access.

REFERENCES

[1] P. Hazarika, "Implementation of smart safety helmet for coal mine workers," 1st IEEE Int. Conf. Power Electron. Intell. Control Energy Syst. ICPEICES 2016, pp. 1–3, 2017, doi: 10.1109/ICPEICES.2016.7853311.

[2] S. Aruna Kumar, K. Hamsika, G. Sandya, V. Purushottam Rao, and P. Sai Kumar, "IoT Mining Tracking &Worker Safety Emergency Alert," Int. J. Mod. Trends Sci. Technol., vol. 6, no. 6, pp. 138–141, 2020, doi: 10.46501/ijmtst060628.

[3] T. Porselvi, C. S. Sai Ganesh, B. Janaki, K. Priyadarshini, and S. Shajitha Begam, "IoT based coal mine safety and health monitoring system using LoRaWAN," 2021 3rd Int. Conf. Signal Process. Commun. ICPSC 2021, no. May, pp. 49–53, 2021, doi: 10.1109/ICSPC51351.2021.9451673.

[4] Y. Zhu, W. Zeng, and L. Xie, "Design of monitoring system for coal mine safety based on MSP430 and nRF905," Proc. - 2011 Int. Conf. Intell. Sci. Inf. Eng. ISIE 2011, vol. 2, no. 7, pp. 98–101, 2011, doi: 10.1109/ISIE.2011.134.

[5] G. Saranya, B. M. Pharkavi, P. Priyanka, and L. Rashika, "Iot Based Coal Mining Safety Monitoring System Using Node Mcu," Mukt Shabd J., vol. IX, no. Vi, pp. 2763–2772, 2020.

[6] L. Muduli, P. K. Jana, and D. P. Mishra, "Wireless sensor network based fire monitoring in underground coal mines: A fuzzy logic approach," Process Saf. Environ. Prot., vol. 113, pp. 435–447, 2018, doi: 10.1016/j.psep.2017.11.003.

[7] N. Sathishkumar, A. M. Manoj, K. Muniraj, M. Naveenkumar, and C. Praveen, "Safety Monitoring System in Coal Mine Using IoT," J. Phys. Conf. Ser., vol. 1916, no. 1, 2021, doi: 10.1088/1742-6596/1916/1/012196.

[8] Y. Wu, G. Feng, and Z. Meng, "The study on coal mine using the Bluetooth wireless transmission," Proc. - 2014 IEEE Work. Electron. Comput. Appl. IWECA 2014, pp. 1016–1018, 2014, doi: 10.1109/IWECA.2014.6845795.

[9] T. Maity, P. S. Das, and M. Mukherjee, "A wireless surveillance and safety system for mine workers based on Zigbee," 2012 1st Int. Conf. Recent Adv. Inf. Technol. RAIT-2012, pp. 148–151, 2012, doi:

DOI 10.17148/IJIREEICE.2022.10x

10.1109/RAIT.2012.6194496.

[10] S. R. Deokar and J. S. Wakode, "Coal Mine Safety Monitoring and Alerting System," pp. 2146–2149, 2017.

[11] Q. F. Wang, S. Zhang, Y. Yang, and L. Tang, "The application of wireless sensor networks in coal mine," ICICS 2009 - Conf. Proc. 7th Int. Conf. Information, Commun. Signal Process., vol. 60774090, no. 60774090, pp. 0–3, 2009, doi: 10.1109/ICICS.2009.5397494.

[12] Y. Zhang, G. Fu, Z. Zhao, Z. Huang, H. Li, and J. Yang, "Discussion on application of IOT technology in coal mine safety supervision," Procedia Eng., vol. 43, pp. 233–237, 2012, doi: 10.1016/j.proeng.2012.08.040.