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Rakshakavach – A Mining Safety Equipment

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***Abstract*: Nowadays, employee safety in the mining industry is a major concern. Mining activity increases throughout time as a result of the increasing demand for raw materials. There are thus more mining workers. The mining safety system need to be configured to provide a workplace free from dangers. There is no early warning system in place to detect the potentially dangerous aspects in mining accidents and give an alarm system. The primary goals of this initiative are to enhance employee working conditions and lower accident rates. This study recommends interconnecting many sensors in order to develop a monitoring system for the security of mining personnel. Also recognize Numerous limitation those caused by temperature, fire, smoke, and harmful gases. Mining activity increases throughout time as a result of the increasing demand for raw materials. There are thus more mining workers. The mining safety system need to be configured to provide a workplace free from dangers. There is no early warning system in place to detect the potentially dangerous aspects in mining accidents and give an alarm system. The primary goals of this initiative are to enhance employee working conditions and lower accident rates. In order to create a monitoring system for the workers' safety in the mining sector, this study suggests connecting several sensors. This may determine the many limits present throughout the working area, such as temperature, fire, smoke, and toxic gas levels. Different types of sensors that are then connected to the Arduino are used for these boundaries. The sensors transfer the data they have collected to the Arduino computer environment. The threshold value determines how the sensor-based alert system operates. As a result, telegram message alerts ground station to take safety precautions and exercise caution. Additionally, if the sensors go beyond a certain level, a buzzer and red light will be activated. The workers can understand that there would be issues with this. This allows for the development of an intelligent monitoring and protection system for mining personnel. Everyone who works in the mining business will benefit greatly from this project.**

***Keywords*: emergency, fire, gas, heartrate, smoke, Spo2 level, temperature, telegram message.**

1. Introduction

Extraction of usable resources from the earth is known as mining. Coal, gold, and iron ore are some examples of materials that are extracted through mining. As time goes on, mining activity grows as a result of the high demand for raw resources. Consequently, there are also more mining workers. The safety of mining workers is a significant issue in the modern age. The mining safety system should be set up such that it can offer a workplace free from hazards. To identify the potentially risky factors in mine accidents and provide an alarm system, there is no early warning system in place. The main promise of this project is that it will improve working conditions for employees and reduce accident rates. In order to create a monitoring system for the workers' safety in the mining industry, this study suggests connecting various sensors. This can identify several boundaries, including temperature, fire, smoke, and hazardous materials. Different types of sensors that are then connected to the Arduino are used for these boundaries. The sensors transfer the data they have collected the Arduino computer environment. The threshold value determines how the sensor-based alert system operates. In order to warn workers to take precautions and be vigilant, the node mCU module raises an alert to telegram. Additionally, if the sensors go above the threshold, a buzzer and red led will be activated. The employees can comprehend that there will be issues with this. This allows for the development of an intelligent surveillance and protection system for mining personnel. Everyone who works in the mining business will benefit greatly from this project.

Due to the rising need for metals and other geological resources, the mining industry has emerged as one of the most important economic sectors in the twenty-first century. Mining is known as the "killing industry" because it poses health risks to miners. Mine security Production levels are still low, and mine accidents frequently cause severe loss of life and property. Since mining is currently one of the most dangerous professions, it is crucial to be aware of the potential risks in advance. It is crucial to monitor the working environment due to the complexity of the mining environment and the variety of operations performed in mines. In mining, a variety of factors, such as temperature, moisture, dangerous vapors, and so on, can have a very negative impact on the professionals. These are the small boundaries that might result in remarkable events when it comes to worker health and safety issues.

The mining sector has the highest occupational death rate of any sector. Methane poisoning, fires, explosions, and rock falls are all frequent causes of occupational fatalities. Consequently, it is crucial to develop a mining safety system.

2. Objectives

- Detection of poisonous gases, fire, smoke.
- Continuous data collection of person’s pulse rate, body temperature, Spo2 level.
- Alerting miners at time of hazards and sending emergency alert to base station.

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- Management of accidental event by real time monitoring.

3. Literature review

The mining industry is a significant contributor to the Indian economy and is a significant sector. While the mining industry's contribution to GDP only amounts to 2.2% to 2.5%, it is between 10% and 11% when compared to the GDP of the overall industrial sector. Even small-scale mining raises the price of producing minerals by 6%. In India, the mining industry offers job opportunities to over 700,000. Mine safety is a comprehensive phrase that refers to the practice of limiting and managing a variety of risks connected to the life cycle of activities related to mining. Implementing known hazard controls and/or lowering mining activity hazards to levels that are ethically, legally, and socially acceptable are all part of mine safety practice. Many miners consider mining ventilation to be a serious safety risk. Poor ventilation in underground mines exposes workers to dangerous gases, heat, and dust, which can lead to poor health, accidents, and even death. Dilution, capture prior to entering the host air stream or isolation are the three main methods for controlling the concentration of methane and other airborne pollutants underground. Explosions in mines are frequently caused by ignited methane gas, which can then start larger explosions of dust. For this reason, a method known as "rock dusting" is used to disperse rock dusts like limestone dust throughout mines to reduce the likelihood of coal dust explosions and to restrict the scope of probable explosions. While the primary goal of mine safety is to reduce hazards to the health and safety of mine employees, actual mining safety procedures may also concentrate on lowering dangers to the mine's machinery, structure, and ore body. Some of the previous projects had only features like to send the distress message [1]. A safety system was incorporated into the jacket which was worn by the miner which continuously monitored the health parameters of the miner and exact location of the miner will be sent in the time of distress [2]. A smart helmet system was which had different gas sensors alerted the miners in time of abnormal level of poisonous gases along with providing protection to the head. All this system not only increases productivity and net yield but also conserves both human and natural resources. The entire system is designed so that it may be operated via Wi-Fi technology at any moment to boost safety and prevent accidents.

A. Survey About Mining Accidents

Disasters and accidents related to mining can be avoided. Tragically, history frequently repeats itself and it appears that the lessons learned from past mishaps and catastrophes are neglected or forgotten**.** Five people were reportedly strangled in February 2022 when a pile of debris fell on residents laboring to reclaim coal from an abandoned open-cast mine in the eastern state of Jharkhand, which was under the jurisdiction of state-run Coal India, according to local authorities. There were 17 people killed and hundreds more people injured in a mining catastrophe in Western Ghana, which drew criticism for the country's industry's inadequate safety rules. Around 300 miles west of Accra, Ghana's capital, near the mining town of Bogoso, there was an explosion on January 20. A gas explosion in a mine might result in someone suffocating if methane gas replaces the oxygen they were inhaling. To assess the circumstances of the accident and identify the cause of death in this case, the methane gas content from cadaveric blood and tissues must be measured.

4. Methodology

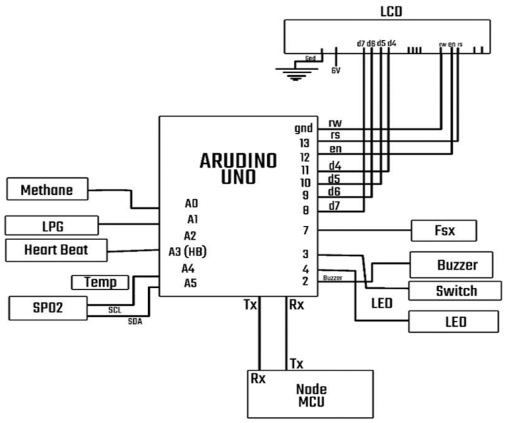

Fig. 1.

In this project Arduino uno microcontroller has been used. This system monitors surrounding environmental parameters such as fire, LPG, Temperature, and methane gases and also monitors the Heartbeat and SPO2 level of the miner and provides an early warning, which will be helpful to all miners present inside the mine to save their life before any casualty occurs.

Here we have used the Arduino Uno Microcontroller and to this microcontroller all the sensors are connected. And then this microcontroller is connected to the LCD and the Node MCU. Then the sensors such as the Methane Sensor lpg sensor, Temperature Sensor, SPO2 sensor, Heartbeat sensor are all connected to the Analogue pins, which means it will give the exact values. Then the fire sensor is connected to the digital pin where it tells yes or no.

Here the Methane, LPG, Heartbeat, Temperature and SPO2 sensors are connected to the analog pins from A0 to A5 respectively. Then the digital pin D7 is connected to the fire sensor. Then the other digital pins are connected to the LCD and then to the buzzer, switch, and LED respectively.

The Methane, LPG and Fire sensor will alert only when they sense the gas or fire and then they send a signal to the base station and will alert the miner with a buzzer. Then the heartbeat, SPO2 and the temperature sensors will be checking the values every second and we can observe the value in the base station and once there is any abnormality only there will be a alert message signal sent to base station and also it alerts the miner.

As we have connected the Heartbeat sensor to the analogue pins it will continuously collect the data and that will be seen on the LCD and there will be a alert message sent to the base station and also the buzzer will buzz and make the miner alert when the heartbeat is less than 70bps and is more than 120bps. And the threshold for the temperature sensor is that it sends a

alert message when the temperature of the human body exceed 37 degree C.

The fire sensor is connected to the digital pin and will be set to 1 and it there is any fire detected it will turn down to 0 and then the alert message is sent to the base station and the miner is alerted. The threshold of the Methane sensor is 150ppm and when it senses more than that value there is a alert message sent. And the threshold of the LPG sensor is150ppm and if the sensor senses more than that it will send the alert message and alert the miner.

If the miners feel any discomfort or anything wrong with their health or the surroundings then can press the switch and then there will be an alert message sent to the base station's separate channel will to allocated to each miner or the rakshakavch he is wearing and then the alert message will be sent to the base station in that channel only so the location of that miner can be found.

5. Proposed Model

System requirements specification is to specify in detail the system components, both hardware and software, which are needed for the system implementation, along with operational requirements, as anticipated from the system.

A. Hardware Requirement

1. Microcontroller Arduino
2. MQ2 and MQ3 gas sensor
3. Spo2 Sensor
4. Power Supply
5. Heart beat sensor
6. Fire sensor
7. Nodemcu
8. Switch, led, buzzer

B. Software's Used

1. Embedded C
2. Arduino IDE

6. Detailed Design

Every module needs to go through a comprehensive design procedure before being put into use. The second part of the project, referred to as the design phase, comprises the precise design of every choice taken in the previous phase. Additionally, it makes implementation simpler, which benefits and saves time. The preliminary design of a system or component is enhanced and developed during the detailed design phase until the design is sufficient to start implementation. It is important to refer to this document, which offers comprehensive details on the system and is commonly utilized by developers throughout installation, while troubleshooting or resolving any issues.

The flowchart for functioning is as depicted in the figure below. When the module is switched on sensor senses the environment for fire, gas and if found it alerts the miners with red led and buzzer along with a telegram message. Health parameters of the miner will be sensed continuously only when abnormal values are recorded it will be informed to base station via a telegram message. When an emergency button is pressed a distress message will be sent along with the location of the miner.

In the beginning of the project, all the sensors try to sense all the environment factors of the mines such as temperature of the mine, based on the threshold value set to the sensors it tries to detect for the presence of obnoxious gases such as methane, lpg, carbon monoxide, high concentration of carbon dioxide etc.

At the same time the persons heartbeat, oxygen saturation level in the blood of the person will also be continuously sensed so that it will be continuously displayed in the lcd. When the fire is detected a warning signal with buzzer as well as led will be turned on. Same goes with fire sensor, The photoelectric turns the radiant intensity signal of the flame into a suitable voltage signal, which is then processed in a single chip microcomputer and transformed into the necessary output. The sensors in the flame detector will detect the radiation that is sent by the flame. So, when the signal goes down which means there is a outbreak of fire, a message will be sent to base station along with the location of the miner. The same procedure follows for mq2 and mq3 sensor. All the sensors are combined together to form a safety system

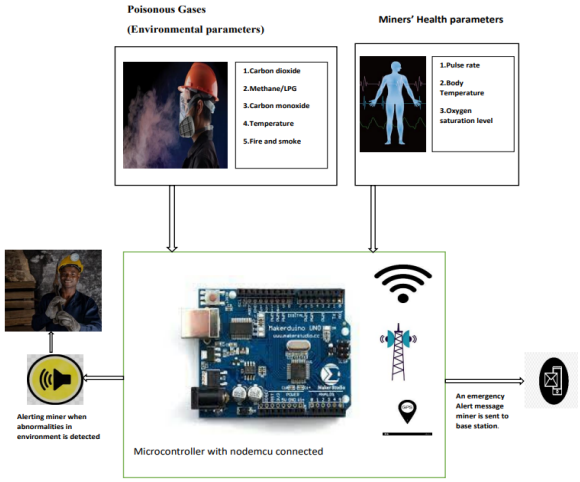

Fig. 2.

7. Result and Discussion

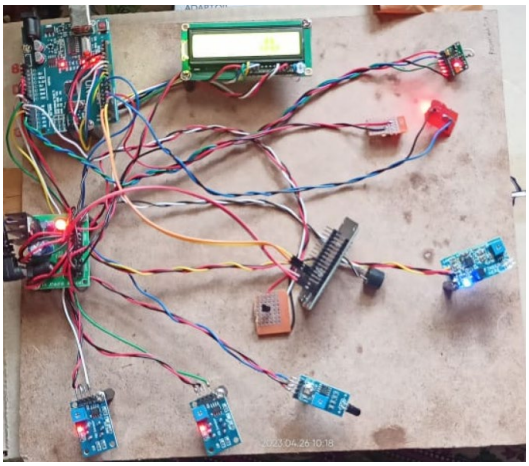

Fig. 3. Hardware of the project

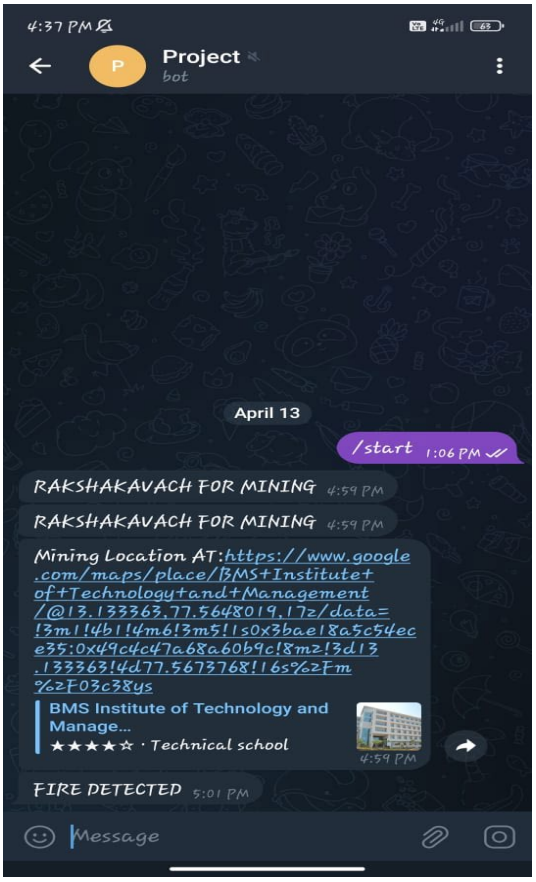

Fig. 4. Alert message received

A smoke sensor, heartbeat sensor, fire sensor, mq2 and mq3 gas sensor, temperature sensor and spo2 sensor are used in the proposed system to monitor the smoke in the mine area and the health characteristics of mine employees, such as heartbeat and respiration rate. Fig. 3 shows the suggested system's hardware implementation. The sensor receives the threshold value or limit value. The micro-controller's output is what determines whether to turn the buzzer ON or OFF. The panic button can be used to send a distress signal to the mining authorities in an emergency. As soon as the miner clicks the panic button, a message is sent to the authorities within five seconds, assisting them in getting to the miner as quickly as possible and saving the miner's life. The buzzer is turned on and the individual is deemed abnormal when the results from the breathing sensor fall above or below the threshold limit. The heartbeat sensor's threshold range is similarly set between 60 and 100. The buzzer is switched on and the individual is deemed abnormal when the results of the heartbeat sensor are above or below the threshold range. When smoke or fire is detected, a message is transmitted to the telegram of the relevant authorities. It was reported that smoke was detected. The temperature of the mine will be assessed often. LCD is used to display it. Every 2 minutes the loop of detection of sensor goes on and the data collected will be displayed in the lcd.

8. Future Scope

The mine's communication range may be increased. Data transport, threat identification, and threat removal may all be fully automated. Where cable connection is problematic, this technique may be used to transmit other crucial data, making it possible. Since the technology allows for simple access, the control may be managed from the surface itself. To enhance monitoring of the miners' safety, additional sensors, such as gas detectors and vibration sensors, can be included in the set. Gas detectors can identify potentially hazardous gas leaks, which may subsequently be reported to the Centre. The use of radar sensors to follow the miners' movements can reduce the possibility of false distress alerts. Individual motes' batteries may be tested, and users may be asked to replace them with new or spare batteries as needed. Following the implementation of the proposed technique, a comparison study with other current research on smart/intelligent headgear and jackets may be conducted.

9. Conclusion

In the deployment of the coal mine safety system, smoke sensors, respiration sensors, heartbeat sensors, and ambient conditions are employed. In the case of an accident, a sophisticated alarm system will let mineworkers know when to evacuate the mining area, protecting them. This system continually monitors the mine using Arduino and other sensors and alerts the employee and the designated person from the ground station. The environment and health of the mineworkers are routinely updated on the IoT website. It is efficient and economical to use the mining worker's medical data to further anticipate medical outcomes using artificial intelligence. In this suggested strategy, a continuous coal mineshaft security and observing framework has been planned, incorporating different sensors to screen different air boundaries, and a threshold is set to all the sensors. If the sensors exceed the threshold, the drive and signal will be on, and a message will be sent from the portable through the ESP32 module. By that time, the employees will be ready and able to follow instructions to safeguard their lives. The creation of a remote management-based mine safety system is a way to increase security while also advancing the mining sector. This study attempts to use portable organizations while automating the mobility of the mining module and yield refresh.

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