Smart Helmet for Tracking Coal Miners

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ABSTRACT

Mining is required for the production of goods, infrastructure, and services that improve the standard of living for people. The society is fortunate to use a wide variety of industrially produced goods. By processing the mined raw resources, they produce these goods. The risk to a mineworker's life is extremely high. For the safety of those who work in mines, there are various issues that must be addressed. The suggested idea is a safety solution for the mining sector that uses a worker helmet-mounted microcontroller-based circuit. A GPS modem is built inside the helmet along with other sensors to track the worker's whereabouts. a GSM modem to communicate the dangerous circumstance and the worker's position. Additionally, each worker helmet circuit includes a panic (emergency) button. A message will be sent to a mobile device and a bell will immediately burst out when this panic switch is touched. Any emergency, such as the intake of hazardous gas or physical injuries, can be treated with this. The presence or absence of a helmet is additionally determined using an IR sensor. If the worker takes off his helmet, the buzzer will go off and a changing message will be sent to both his and the manager's mobile phones. The system therefore assures the security of mining employees.

Keywords: GSM, GPS, DHT22 sensor, IR sensor, MQ7 sensor, MQ2 sensor, Buzzer, Panic switch.

I. INTRODUCTION

Extraction of rich minerals from the earth is known as mining. Due to the need for metals and other resources brought on by the world's fast industrialisation and urbanisation, it is significant in today's society. India is a country with vast natural mineral and precious rock deposits. Some of the mining methods employed in the nation include quarrying, high wall mining, surface mining, and underground mining. In India, there are roughly 11 mines for coal, 13 mines for iron ore, 9 mines for bauxite (aluminium ore), 5 mines for manganese, 5 mines for copper, 3 mines for diamonds and 2 mines for gold.

Due to issues with mine ventilation, risk from hazardous gases, events like rock falls, and head injuries, the mining business has a significant risk of injury. These pose a serious risk to the security of miners. In the mining sector, there are occasionally minor mishaps, but two significant mining accidents that happened in India made people reevaluate the security of miners. The Jharkhand coal mine tragedy, which killed 11 miners and trapped more than 50, and the Chasnala mining catastrophe, which claimed 372 miners' lives. Therefore, a safety device is required to safeguard miners and save them in the event of such occurrences. The ground centre can be informed of environmental changes that could jeopardise the safety of miners using sensors. It is uncomfortable to operate a wired communication system underground due to the maze of tunnels. The expense of installation and upkeep is likewise significant. Also, traditional cable communication cannot be used in situations involving fire, rock falls, or explosions.

A mining helmet could be upgraded by adding technology to improve the safety of the miner. Each miner's helmet is equipped with a sensor circuit that monitors environmental changes, transmits them to a control unit, and then sends messages to mobile devices in response.

The development of this safety helmet took into account exposure to dangerous gases, changes in temperature and humidity, and the addition of a GPS module to track the worker's location when he is in a dangerous situation and send that location to a mobile device and the control unit. The miner is given an extra functionality, the panic button. When Miner wants assistance, he can press that button.

The majority of communication between the mining industry and the ground centre is done via cables and wired networks. When an accident occurs in a mine, the sensors and wires are

typically fatally damaged by the explosion, Consequently, it was impossible to provide information for rescue, search, and detection events. When such events occur, a GSM modem is utilised to communicate over a wireless sensor network.

II. LITERATURE REVIEW

Arpan Karar, Rohan Paul, Sumit kumar Jindal, Abhirup Datta [1] a smart helmet with lots of cutting-edge features that is being proposed for coal miners. The smart helmet would be able to recognise potentially fatal conditions, such as the presence of dangerous gases like Carbon Monoxide, CH4, LPG, and natural gases, with the help of various sensors. An infrared sensor determines whether the miner is wearing a helmet or not. Every sensor has a critical value that, when surpassed, activates the buzzer and illuminates the LEDs to alert the miners and supervisors. The mining authority can easily trace the workers' locations thanks to the GPS module that is installed in their helmets.

ranjal Hazarika [2] suggested a smart safety helmet. This helmet has a carbon monoxide and methane gas sensor. Through an X-Bee wireless module that is linked to the helmet, this sensor detects the gas, and the data is wirelessly communicated to the control centre. The controller in the control room sounds an alert when the concentration of methane or carbon monoxide gas exceeds the critical level, protecting the workers and the facility by averting an impending accident.

N. Gayatri, J. Madhuri, S. Rajasoundaran, Mahamamad Firose Shaik, and Velliangiri S [3] are among the authors. Smart coal mine safety and monitoring system that can recognise many boundaries, such as moisture, temperature, toxic gas level visible all around, and vibrations sent in the operational area. 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. In order to warn workers to take precautions and be vigilant, the mobile phone's GSM module raises an alert. Additionally, if the sensors go above the threshold, a buzzer and red led will be activated. Through this, the workers can understand that there is some problem ahead.

S Venkatesh Kumar, G Janani, K Devi, M Dharani, and C Kathirvel [4] proposed an IOT-based Smart Helmet and tracking system for coal miners that is designed to detect gases and the temperature of the ground. The emergency button can also be utilised by miners when they are in danger, and this suggested way could also be used as a tracking system for coal miners using the Internet of Things (IoT).

A. Kumar, G. P. Hancke, C. J. Behr, [5] The three primary forms of hazards—air quality, helmet removal, and collision (miners are struck by an object)—were taken into consideration when designing a smart helmet for the mining sector to monitor air quality and detect hazardous events. The first factor is the quantity of dangerous gases, such as CO, SO2, NO2, and particulate matter. The second dangerous incident was categorised as a miner taking off their mining helmet. When the helmet is on the miner's head, it can be detected by an IR sensor. A miner being struck in the head by an object with a force greater than 1000 on the HIC is considered to have experienced the third hazardous event.

III. PROPOSED SYSTEM

The main goal of this project is to develop a prototype for a smart helmet with sensors like the DHT22 sensor for temperature and humidity detection, the MQ2 sensor for smoke detection, and the MQ7 sensor for CO gas detection that will increase safety for coal mine workers.

An IR sensor will be used to monitor helmet removal.

Both the supervisor's and the employee's mobile phones will receive a message, allowing them to decide how to move forward based on the message. The problem and the person's location will both be included in this message.

IV. BLOCK DIAGRAM

Block diagram of proposed system

V. HARDWARE REQUIREMENTS

These are the hardware components which are used in this project. All the components with their usage are mentioned below.

Arduino UNO: It is a microcontroller board based on ATmega328P. It is used for interfacing hardware and software.

NEO-6M GPS: It provides two-dimensional

location i.e., latitude and longitude of a place. GPS receiver with a built-in ceramic antenna, which provides a strong satellite search capability.

SIM900 GSM: It sends the location determined by the GPS to the predefined mobile number through SMS.

Buzzer: It alerts the surroundings whenever sound is detected.

MQ2 Sensor: The MQ-2 is a smoke and combustible gas sensor from Winsen. It can detect flammable gas in a range of 300 - 10000ppm. It's most common use is domestic gas leakage alarms and detectors with a high sensitivity to propane and smoke.

MQ7 Sensor: Sensitive material of MQ-7 gas sensor is SnO2, which with lower conductivity in clean air. It makes detection by method of cycle high and low temperature, and detect CO when low temperature (heated by 1.5V). The sensor's conductivity is morehigher along with the gas concentration rising.

IR Sensor: An infrared sensor (IR sensor) is a radiation-sensitive optoelectronic component with a spectral sensitivity in the infrared wavelength range 780 nm … 50 µm. IR sensors are now widely used in motion detectors, which are used in building services to switch on lamps or in alarm systems to detect unwelcome guests.

DHT22 Sensor: The DHT22 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use but requires careful timing to grab data.

Panic Switch: a button or switch that operates any of various safety devices, for use in an emergency. hit the panic button or press the panic button informal to react to a situation by demanding emergency action.

VI. SOFTWARE REQUIREMENTS
Arduino IDE

It is used for Arduino IDE (Integrated Development Environment) is the software for Arduino. Arduino IDE is an open-source Software which makes it easy to write code and upload it to the board. It is a cross-platform software which is available for every Operating System like Windows, Linux, macOS.

It is used for writing code, compiling the code to check if any errors are there and uploading the codeto the Arduino. Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension ino. The editor has features

for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors.
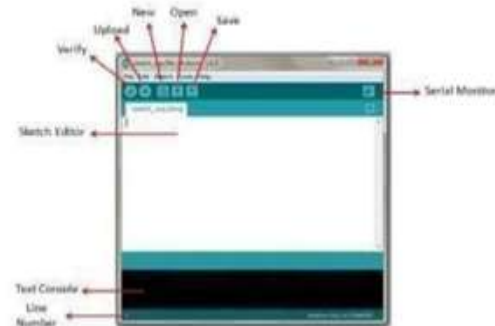
Arduino IDE platform

The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Source code can be uploaded into Arduino UNO by the following procedure

1. Download and install Arduino IDE 2.0.
2. Open Arduino IDE 2.0.
3. With the editor open, at the very left, there is a checkmark and an arrow pointing right.
4. Click on the verify tool (checkmark). After a few seconds, we can see the result of the action in the console.
5. Now the code is compiled, and that it is working. Now, before the code is uploaded to our board, the board which is to be used need to be selected. It can be achieved by navigating to Tools > Port > {Board}. The board(s) that are connected to your computer should appear here, and we need to select it by clicking it. In this case, our board is displayed as COM44(Arduino UNO).
6. After the board selected, click on the upload button and it will start uploading the sketch to the board .

Uploading the Code in Arduino IDE

7.   When it is finished, it will notify in console log.

Output in console.

VII. PROCESS

First it checks whether the person is wearing the helmet or not by using the IR sensor, if the person is not wearing the helmet, then the buzzer gets on and a alert message is sent to mobile.

If the person is wearing the helmet, then it checks the condition of all other sensors such as smoke sensor, MQ2 sensor, DHT22 Temperature and humidity sensor, MQ7 sensor, if any of the sensor is detected then it sends the alert message and the location of the worker to the mobile using GSM modem.
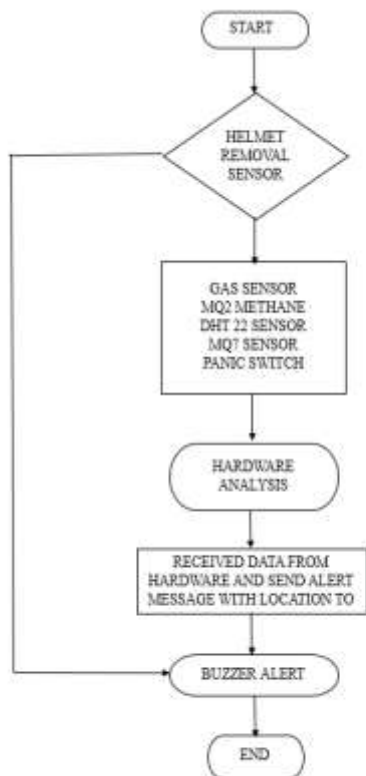
Flow of study

The MQ2 sensor and MQ7 sensor is detected when the smoke, dangerous CO gas level exceeds 300ppm. Then it sends alert message and location of the worker to the mobile.

The DHT22 sensor is detected when the temperature exceeds $35^{o}C$ and humidity above 120 $g.m^{-3}$ then it sends alert message and location of the worker to the mobile.

And it also consists of a panic switch which is a push button switch pressed by the worker when he is in a dangerous condition. On pressing the switch, it sends alert message and location of the worker to the mobile.

VIII. RESULTS
Output 1: Temperature and Humidity Sensor

The project's DHT22 sensor notifies the Arduino Uno when the temperature in the mine rises. By lighting a matchstick and bringing it close to the sensor, this was tested. The sensor detects a rise in temperature, and a GSM modem is used to send the message "Person in high temperature region, help him" to a mobile device.

Detection of temperature and humidity

When the temperature rises beyond a predetermined threshold, as specified in the programme, the message "Alert!! High temperature alert" is displayed on the serial monitor and a message with the worker's position is sent by GSM to mobile.

Numerical Display of temperature and humidity

Numerical Display of temperature and humidity

Hi Temperature alert:
29.30
Person in high temparature help him
http://maps.google.com/maps?saddr=17.411789,78.398663

Temperature alert message with location of worker to mobile

Output 2: Detection of Smoke Sensor

When there is raise in percentage of dangerous gas in mine, MQ2 sensor will help to detect those gases. MQ2 sensor used in this project senses this raise and alerts the arduino. As programmed, it displays a message in serial monitor and buzzer gets activated. Arduino also activates GSM modem to send a message "High smoke is detected" with the location of worker to mobile.
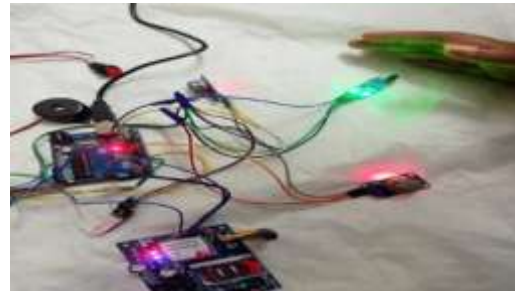
Detection of smoke

Dangerous smoke alert:
0
Person struck in Dangerous smoke
http://maps.google.com/maps?saddr=17.411636,78.398695

Smoke alert message with location of worker to mobile

Output 3: Detection of Helmet Removal

Here, the IR sensor is utilised to determine whether or not the person is wearing a helmet. As designed, a message is shown in the serial monitor when the helmet is not being worn, and the buzzer is immediately activated. Using a GSM modem, it simultaneously transmits to a mobile phone the message "Person is not wearing helmet please put on helmet."

Detection of helmet
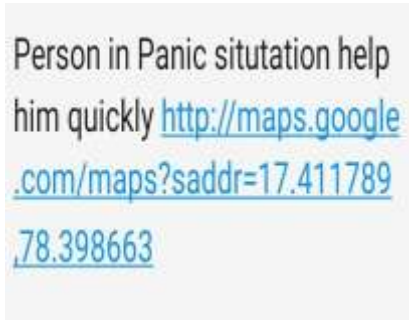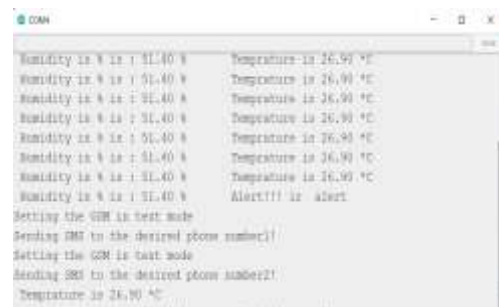

Message when helmet is removed

person is not with helmet:
0
Please put on helmet
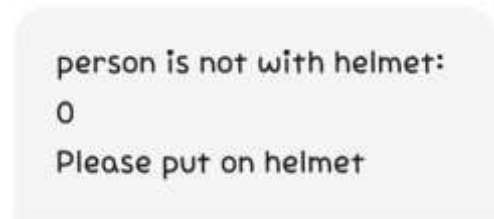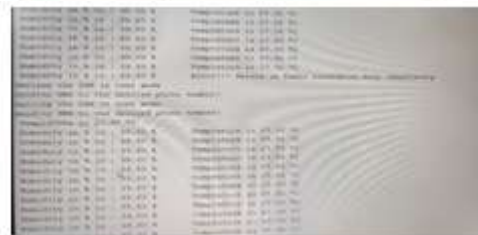
Helmet removal alert message to mobile

Output 4: Output when panic switch is pressed

As intended, the panic switch triggers the

buzzer and displays a message in the serial monitor when it is pressed. Using a GSM modem, it simultaneously communicates the location of the worker and the message "Person is in panic situation help him quickly" to mobile phones.
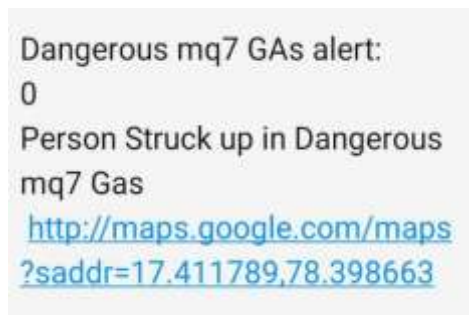
Message when Panic switch pressed

Message to mobile when Panic switch pressed

Output 5: Simulation Result MQ7 Sensor
When there is raise in percentage of Carbon Monoxide gas in mine. MQ7 sensor used in this project senses the raise and alerts the arduino. As programmed, it displays a message in serial monitor and buzzer gets activated. Here, arduino activates GSM modem to send a message to mobile "Person stuck up in dangerous mq7 gas" with the location of worker.

CO gas alert message with location of worker to mobile

IX. CONCLUSION
This project ensures safety for workers who are working under mines. This prototype satisfies all the objectives as stated in objectives section. DHT22 sensor is used to detect temperature and humidity changes. Gas sensors are used to detect the percentage change in their respective gases. Smoke sensor is used to detect increase in percentage change in smoke. IR sensor is used to detect whether the person is wearing helmet or not. If he is not wearing the helmet a message will be sent to his mobile to wear the helmet. A panic switch is embedded in this prototype which can be used by the worker when he is in trouble. GPS and GSM modules are included, when there is any abnormal condition detected by sensors or when panic button is pressed, it immediately initiates the buzzer to blow and we can get an SMS with the exact location through a link, we can reach the location easily. This SMS will be sent to worker mobile who is wearing the helmet and manager mobile who is outside the mine. This project ensures more safety for coal mine. worker. This also helps in escaping from dangerous environment.

REFERENCES
- HyochangAhn, Sang-Burm Rhee, Simulation of a RSSI-Based Indoor Localization System Using Wireless Sensor Network', IEEE, 2010.
- Nisha Dube1, Prof. K.S.Ingle 2 PG Student, Dept. of Ece "Intelligent Mining: A Monitoring and Security system for Coal Mine Workers", International Journal of Advanced research in Electrical Electronics and Instrumentation Engineering (An ISO 3297:2007 Certified Organization) Vol.5,Issue . 1, january 2016.
- Researchgate.net/publication/261427510_Intelligent_coal_mine_monitoring_system_
- based on the Internet of Things.
- Ijisrt.com/wp-content/uploads/2017/04/A-SMART-HELMET-FOR-IMPROVING-SAFETY-IN-MINING-INDUSTRY.
- S. R. Dokar V. M. Kul karno J.S.Wakode "Smart Helmet for coal mines Safety monitoring Alerting" Vol.6,Issue 7,July 2017.
- Ashwini Bonala and D. Ravi kiran Babu, "IoT Based Coal Mine Safety Monitoring and Control Automation", IOSR- JCE, vol. 20, no. 6, pp. 21-2, 2018.