



Design and Development of Smart Helmet with Enhanced Safety and Tracking Alerts: An Application Coalmines

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ABSTRACT

The main aim of our project is safety. The safety of mine workers is the primary objective of the underground mining industry. To avoid mining accidents every mining industry follows some basic rules and some precautions. The main reason for mining accidents is collapse. The collapsing accidents of coal mining are not always that much danger. Immediate rescuing helped a lot of worker's life. Communication is very important in the mining industry. To provide safety in the coal mining area, a good communication method must be there. Wired communication in underground mining is costly and not so effective in communicating. Wireless communication in underground mining is costless and so effective in communicating with each other's. Avoiding unnecessary risks such as gas sensors and temperature sensors helps us to take necessary steps during coal mining. During hazardous conditions, a buzzer in the mine workers' helmets gives a signal to the workers to avoid such things communication is done between mining people, before doing anything they need to make sure that they are safe. This project intends to create a smart helmet that can identify hazardous events, monitor the surrounding environment, and send information sensor data to a central console for easy tracking. This secures the life of miners in mining industries.

Key Words: Gas Sensor, Temperature Sensor, Vibration Sensor, GPS Module, Arduino UNO, LCD, Buzzer, IoT Module.

1. INTRODUCTION

The mining sector has many facets and involves intricate processes carried out below, in tunnels, etc. This comprises a number of risk variables that have an impact on miners' health. It's possible that miners are unaware of environmental factors like pressure changes, temperature changes, and others. Sometimes big things, such as mining equipment or hard rock, collide with miners, endangering their lives. The miners' exposure to dangerous gases puts them in danger and has an impact on them as well. Miners are unable to contact the outside world in this circumstance. Safety has long been a top priority in the mining sector, particularly in sub-surface mining. Mining accidents happen while minerals or metals are extracted. Each year, mining accidents claimed the lives of thousands of miners, particularly those engaged in hard rock and coal mining. One of the major causes of the majority of these incidents is collapsing mining stops. Most mining stop collapses do not result in fatalities. The injured miners can be helped with immediate first assistance. However, in the shadowy depths of an underground mine, it is difficult to tell when a specific miner is in difficulty. As a result, we require a method to check on each miner's health individually. The safety helmet is one item that every miner wear. Therefore, we may use this helmet to gauge the user's health and assist in relaying that information to the central office outside the mines. This project uses a wireless sensor network to try and accomplish the same thing. In this situation, the smart helmet system turns into a crucial and practical tool to safeguard the miners from severe mishaps. The goal of this project is to create a smart helmet that can detect hazardous events, keep an eye on the environment, and update data from sensors and GPS locations to the central console for simple tracking. This safeguards the miners' lives



in the mining sector. Several systems are being developed for this purpose by using various technologies in different countries. These applications try to address this gap between miners and work centers by monitoring them to get various information. In-depth information regarding smart helmet systems that have been established for the benefit of miner safety and other related requirements is enhanced in this review study. Through the comparison of the developed systems and using the information gathered, a review of the system modules, features, and technologies for giving timely information on mining workers is highlighted. Are worried these dangers are associated with coal Industries. Therefore, worker safety should always be a top priority in all underground mining activities. Underground mining operations can be dangerous for both the health and safety of workers. These dangers result from the various methods used to extract the various minerals. The risk increases with the depth of the mine. These safety concerns are quite important, particularly for the coal industry. Therefore, whether mining for coal or any other minerals, worker safety should always be a top priority. Due to ventilation issues and the possibility of a collapse; underground coal mining entails a higher risk than open pit mining. However, all types of mining have safety risks due to the use of heavy equipment and excavation techniques. As a result of the numerous safety measures, worker education and training programs, and health and safety regulations that are frequently implemented in modern mines, both open-pit and underground mining have seen significant changes and advancements in safety. The principal source of energy in India has always been coal, and this has greatly accelerated the country's industrial development. It is essential to the generation of about 70% of the power. Consequently, coal's significance in the energy sector is crucial. However, the process also creates additional byproducts, which pose a possible risk to the environment and the nearby population. Instead, the current study is a sincere effort to evaluate the seriousness and create a real-time monitoring system of detection using Wireless Technology.

The idea of this project is to give information about the mishap in the underground mines to the ground team which monitors all the activity, so we chose IoT technology to give the information by the means of web server. We are using Arduino ESP 8266 microcontroller as the heart of the project. Showing the stats alone can't help the ground team to locate the miner in case of any accident. So, we included GPS location in the website which we are displaying so that the help team will have perfect information. About where and when the accident may occur. For this we use GPS module to extract the location of the accident, the GPS data will contain the latitude and longitude values using which we can find the accurate position of the accident place. To run the GPS, we use Arduino ESP 8266 board which has Tensilica L106 32-bit RISC processor. The Arduino is a very user-friendly device which can be easily interfaced with any sensors or modules and is very compact in size. Now we are clear that the Arduino will send the alert the team using the IOT based website by keeping the GPS location on the screen which is obtained from the GPS module.

2. LITERATURE SURVEY

[1] T. Sowmya, G. SrinivasaRao, Ch. Sruthi, I. Tanuja, I. Bhavya, M. Sindhu has proposed Smart Helmet for Mining Workers This project talks about the development of a smart helmet for mining workers, integrating sensors such as gas detectors and environmental monitors to enhance safety. It incorporates communication modules like GSM and Wi-Fi for sending emergency alerts and tracking workers' locations. The Blynk app enables remote real-time data monitoring. The system aims to address the safety challenges faced by mining workers in hazardous environments, providing a comprehensive solution for ensuring their well-being [2] Mrs. A. Dhanalakshmi has proposed A smart helmet for improving safety in mining industry. A smart helmet has been developed which includes various features such as the two-way communication, detection of the hazardous gases, providing



notification in the case of helmet removal, collision (miners are struck by an object, panic switch for emergency situations, continuous monitoring of the environmental conditions such as temperature and pressure in the mining industry and GPS is provided to track the location of the miner. Temperature and Pressure sensors are used for the continuous monitoring of environmental conditions. The information is sent to the control room through wireless network. The layout of the visualization was completed and displayed in the control room with the help of a lab VIEW software.[3] Praveen Kulkarni and Sangam has proposed Smart System for Hazardous Event Detection and Evaluation in Mining Industries A Safety helmet has been developed to assist the miners working in the mining industry. Harmful events tend to occur in the mining industry that can lead to severe injury or death. Zigbee wireless sensor networks are used to collect sensor data and transmit them. The Zigbee based system is cost effective and details are shared with central control unit. This paper presents a study of the mining environment and its hazards and how a Zigbee is used for transmission from miner to ground control system in case of hazardous events.[4] Sabeenian R.S , Kanishka K, Kavi Priya R, Dinesh P.M, Paramasivam M.E , Manjunathan Smart Wearable Gadget For Miners Using IoT proposed this project to know about the mining industry that faces significant safety challenges, including toxic gases, fires, and a lack of rescue systems. The implementation of mine surveillance gadgets, such as smart wearable technology for miners using IoT, can help prevent accidents and save lives.

The smart wearable gadget includes brain activity monitors and sensors for detecting dangerous gases and falls. Effective communication systems are crucial for increasing safety in underground mines. The proposed system has been successfully developed and provides accurate readings, offering potential benefits for improving safety and productivity in the mining industry.[5] Ninni singh, Vinit Kumar Gunjan, Gopal Chaudhary, Rajesh Kaluri, Nancy victor IoT Enabled Helmet To Safeguard The Health Of Mine Workers proposed this method to improvise the creation of real-time surveillance helmet with IoT sensors that provide early warning system in the presence of fire, silicosis dust particles, temperature.[6] Ms. Rakshitha. N, Ms. Vaishnavi. R, Ms. Spurdy. G Mrs. PushapaLatha Mining Worker Safety Helmet Using IoT has proposed this project for intelligent sensing and warning system to improve mining worker safety using IoT technology.

The proposed system includes a helmet unit with sensors for detecting gas, temperature, and humidity, as well as an embedded RF transmitter and GPS. The control room unit receives data from the helmet unit and alerts the control room personnel in case of any danger. The system also includes a push button for miners to send an alert message in case of an emergency. The authors suggest that this system can help prevent workplace fatalities in the mining

3. EXISTING SYSTEM

In the existing system safety systems, traditional safety helmets are commonly used without the advanced features of IoT integration. These traditional helmets mainly serve the purpose of head protection but lack the advanced sensing capabilities required to ensure the safety and well-being of miners in hazardous environments. Miners face various risks such as exposure to toxic gases, extreme temperatures, and potential structural instability in underground or remote mining sites. The existing systems typically rely on manual monitoring and communication methods, making it challenging to provide real-time safety alerts or remote tracking of miners' conditions.

4. PROPOSED SYSTEM

The proposed IoT miner safety helmet is a cutting-edge solution designed to enhance the safety and well-being of miners working in challenging and potentially hazardous environments. This system integrates several critical components, including gas sensors, temperature sensors, vibration sensors, and a GPS module. These sensors provide real-time data that can be transmitted wirelessly to a central system for monitoring and analysis. The gas sensor detects the harmful gases in mining. The temperature sensor detects the temperature in the mining area and warns if the saturation temperature is reached. The GPS technology to track the location of workers in real-time, ensuring their safety and enabling quick response in case of emergency. IOT enables the integration of various sensors and technologies to collect and transmit data in real-time. These sensors collect data and transmit it wirelessly to a central system, where it can be analyzed and used to make informed decisions regarding worker safety. Thus, the system ensures mining worker safety using IoT. This proposed system uses IoT for transmission and reception of the data from underground to management system.

BLOCK DIAGRAM

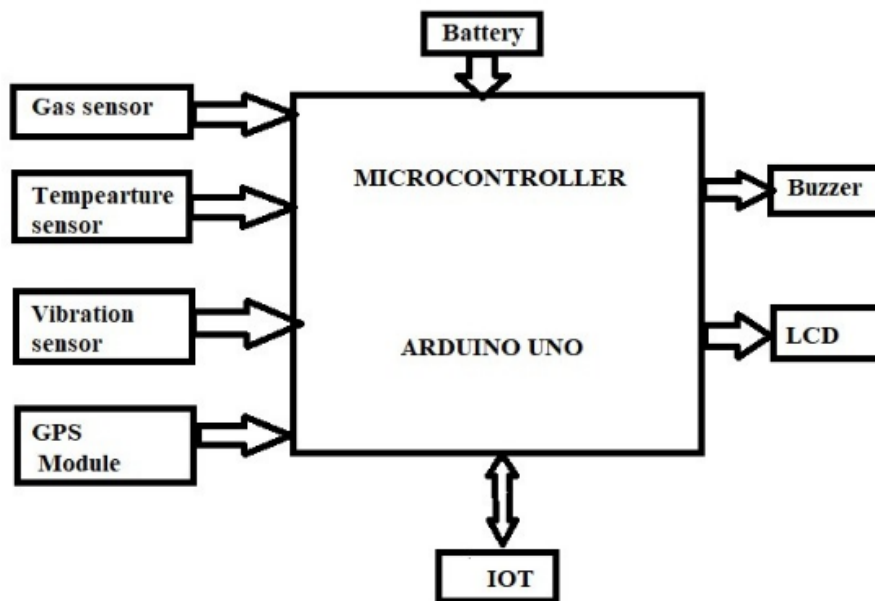


Fig. 1: Block diagram

Flow Chart

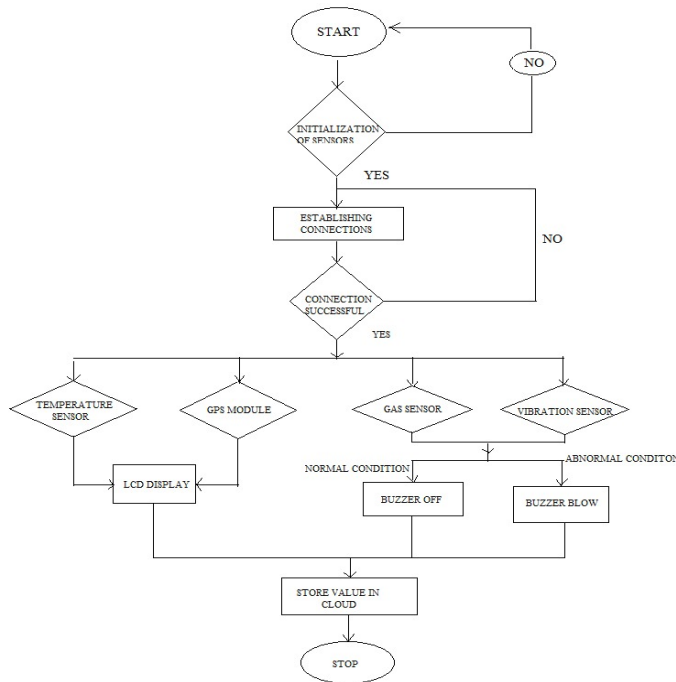


Fig. 2: Flow Chart

SCHEMATIC DIAGRAM

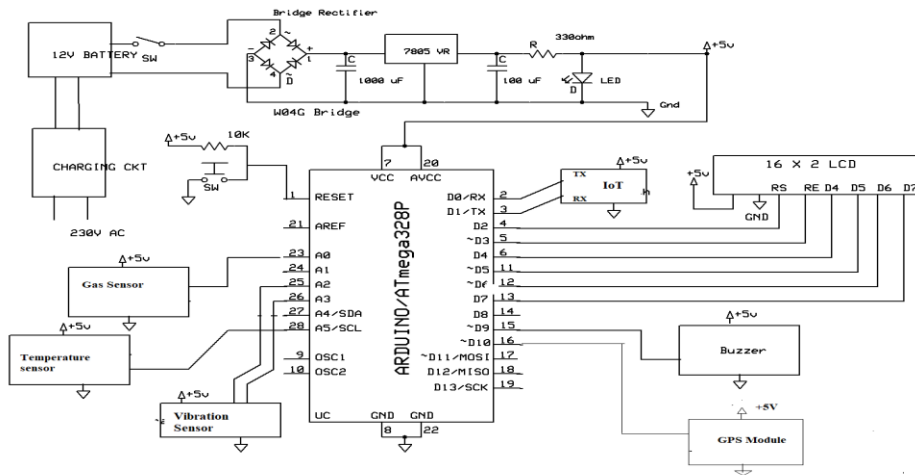


Fig. 3: Schematic Diagram

This is the pin diagram where all the hardware components are connected to the ARDUINO microcontroller having 28 pins. In which 14 GPIO pins as digital pins and 6 GPIO pins. 16MHz crystal oscillator connected internally. Bridge rectifier capacitor with 1000uF Resistor and LED are connected in Regulated power supply which provide the 5v to the Arduino and all input/output modules.

Schematic

- 16*2 LCD Monitor has connected with the Digital pins 2, 3, 4,5,6,7.

- IoT module has connected to Digital Pins D0, D1 internal Transmitter and receiver pins.
- Gas sensors connected to A0, pin of the Arduino micro controller.
- Vibration sensor connected to A2, A3 pins of the Arduino micro controller.
- Temperature sensor connected to A5 pin of the Arduino micro controller.
- GPS module connected to digital pin 10.

WORKING

IoT Mining Tracking and Worker safety Helmet is to utilize various sensors, including gas, temperature, vibration sensors. These sensors are equipped on the helmet of mine workers. The gas sensor detects the presence of dangerous gases alerting miners by giving sound through the buzzer. Temperature sensor monitor the real-time temperature whether it is overheating or extreme cold condition inside the mining industry and display on the LCD. Vibration sensor detects collapses or vibration that occurs in the mine and if any collapse occurs it gives buzzer to alert the miners, to save their lives. The GPS module is used to locate the mine worker position in the mine. These components communicate with each other. Providing real-time data server to provide prompt response to from hazardous events in mine. The collected data is then transmitted through IoT network to a centralized monitoring system and provide correct information regarding the conditions in the mine.

5. HARDWARE IMPLEMENTATION

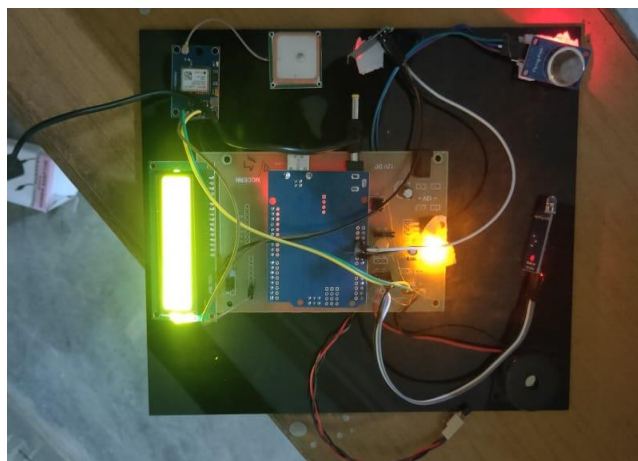


FIG. 4: MOTHERBOARD



FIG. 5: Output in LCD

When the gas and vibrations are detected, it displays yes and if not displays no in LCD, and temperature will be displayed in LCD.

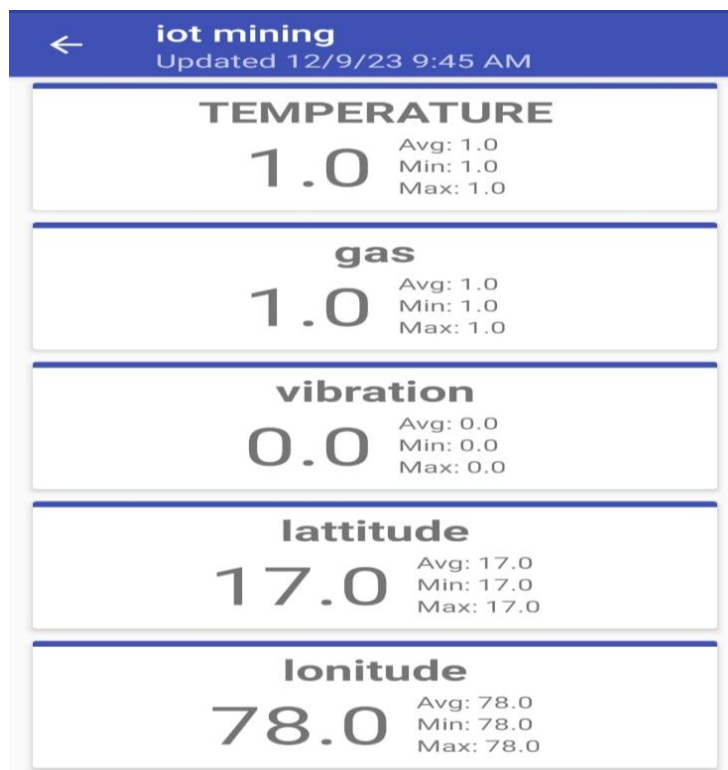


FIG. 6: Output Image

When any changes are detected by the sensors. It displays the data stored in the online app(pocket IoT) as shown in Fig.6



6.CONCLUSION

Implementing IOT mining tracking worker safety helmets represent a significant stride towards enhancing safety and efficiency in mining operations. Real-time monitoring through IOT devices ensures accurate tracking of personnel, promoting quicker response to emergencies. Integrating safety features into helmets, such as temperature sensor and communication capabilities, not only safeguards workers but also streamlines communication within the mining environment. The convergence of IOT technology with mining practices not only prioritizes worker safety but also contributes to the overall optimization of mining operations.

REFERENCES

- [1] T. Sowmya, G. SrinivasaRao, Ch. Sruthi, I. Tanuja, I. Bhavya, M. Sindhu Priya, Smart Helmet for Mining Workers, Journal of Engineering Sciences, ISSN:0377-9254, Vol-14, Issue 04, 2023.
- [2] Ninni singh, Vinit Kumar Gunjan, Gopal Chaudhary, Rajesh Kaluri, Nancy victor "IoT Enabled Helmet to Safeguard the Health Of Mine Worker, Computer Communication, Vol-193, 1 September 2022.
- [3] Sabeenian R.S, Kanishka K, Kavi Priya R, Dinesh P.M, Paramasivam M.E, Manjunathan, Smart Wearable Gadget for Miners Using IOT, E3S Web Conf, International Conference on Newer Engineering Concept and Technology (ICONNECT) <https://doi.org/10.1051/e3sconf/202339904014>, e-ISSN: 2267-1242, Vol-399, 12 July 2023.
- [4] Ms. Rakshitha. N, Ms. Vaishnavi. R, Ms. Spurty. G, Mrs. PushapaLatha. Mining Worker Safety Helmet Using, IoT International Research Journal of Modernization in Engineering Technology and Science e-ISSN: 2582-5208, Vol-06, issue 06, June 2022.
- [5] Kumaravel A, Ajith K, Sravani K, Lakshmi Sreenivasa Reddy L IoT Mining Tracking and Worker Safety Helmet International Journal of Advanced Research in Computer and Communication Engineering, DOI: 10.17148/IJARCC.2021.10579, Vol-10, Issue 05, May 2021.
- [6] N. Renuka, Patlolla Saisree, Sambari Chandhana, MD. Salman, Bakkani Deepak, IoT Based Underground Worker Safety System, Ijreset Journal For Research in Applied Science and Engineering Technology, DOI: https://doi.org/10.22214/ijra_set.2022.47521, ISSN:2321-9653, Vol-10, Issue XI, November 2022.
- [7] Punam S. Tajane, Shrutika B. Shelke, Sonal B. Sadgir, Archana N. Shelke IoT Mining Tracking & Worker Safety Helmet, International Research Journal of Engineering and Technology (IRJET) e-ISSN:2395-0056, Vol-07, Issue-04, April 2020.
- [8] Sahil Kamble, Yash Watkar, Vaibhav Chaple, Sneha Motghare, Sushita Taiwade Development of Smart Helmet for Mining workers using Internet of Things, International Research Journal TIJER, www.tijer.org, ISSN 2349-9249, Vol-10, Issue 3, March 2023.
- [9] Sowmya Sista Lakshmi, Ayush Dagar, Neeraj Gupta, Manjeet Kaur, and Rashmi Gupta, A Technical Review on IoT Based Mining Tracking and Safety Helmet, International Journal of Innovative Research in Computer Science & Technology (IJIRCST) ISSN: 2347-5552, <https://doi.org/10.21276/ijircst.2021.9.4.11>, Vol-9, Issue 4, July 2021.
- [10] B.Yakub, Epuri Deepthi, Vivek Jain, S. Vikram Singh, R. Ravinder Singh, Iot Mining Tracking and Worker Safety Helmet, International Journal of Research in Advent Technology, Special Issue, NCRCEST 2019 E- ISSN: 2321-9637 Available online at www.ijrat.org 225.



- [11] Aruna Kumari, K Hamsika, G Sandya, V Purushottam Rao, P Sai Kumar², IoT Mining Tracking & Worker Safety Emergency Alert, Available online at: <http://www.ijmtst.com/> International Journal for Modern Trends in Science and Technology ISSN: 2455-3778: Vol-06, Issue 06, June 2020.
- [12] Revindran, R., Vijayaraghavan, H., & Huang, M.-Y. Smart Helmets for Safety in Mining Industry. International Conference on Advances in Computing, Communications and Informatics (ICACCI). doi:10.1109/icacci.2018.8554698,2018.
- [13] Sowmya Sista Lakshmi, Ayush Dagar, Neeraj Gupta, Manjeet Kaur, Rashmi Gupta. A Technical Review on IoT Based Mining Tracking and Safety Helmet International Journal of Innovative Research in Computer Science & Technology (IJRCST) ISSN: 2347-5552, <https://doi.org/10.21276/ijrcst.2021.9.4.11>, Vol-9, Issue 4, July 2021 .
- [14] Ranjan, A., Zhao, Y., Sahu, H. B., & Misra, P. Opportunities and Challenges in Health Sensing for Extreme Industrial Environment Perspectives from Underground Mines. IEEE Access, 1–1. doi: 10.1109/access.2019.2941436, Vol-07, 2019.