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Smart Helmet For Improving Safety In Mining.

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Abstract: The mining industry is inherently hazardous, with workers facing risks such as cave-ins, falling debris, exposure to harmful gases, and machinery accidents. To mitigate these risks, smart helmets have been developed as a safety solution for the mining industry. Smart helmets are high-tech safety helmets equipped with sensors, cameras, GPS tracking, communication systems, and augmented reality technology. These helmets can detect potential safety hazards in the environment and alert workers to take necessary precautions. A wearable helmet is exhibited in this study, for the risks in the mining area. This prototype provides real-time monitoring of harmful gasses, temperature, humidity, and worker's heart-rate.

Keywords: Mining, Helmet, Safety, Sensors, Arduino Nano, LCD Display, Alarm, Tracking, Vital sign monitoring.

I. INTRODUCTION

Smart helmets for safety in mining are becoming increasingly popular as technology advances. These helmets are designed to enhance the safety of miners by providing real-time information about their surroundings, as well as their own vital signs, to prevent accidents and reduce the risk of injury. The demand for coal as the energy resources is always an important and significant part in our life. Sadly, thousands of people have lost their breath in mining accidents, all over the world. The main reason for these accidents is due to the presence of methane and carbon monoxide and other harmful gasses in these mines. These gasses are colourless, odorless and are undetectable by the six sensors of the human. This can cause life taking risk of the accident. Such an accident can be controlled in the prophecy of the explosion process by executing microcontrollers and sensors and to develop a system for the hazardous situations. A steady supervision is important which further recommends some efficient and solid sensing method. To sense the existence of poisonous gas, several techniques can be implemented, using semiconductors is much more effective among the techniques. The advantage of these sensors is, they can be mounted anywhere in the coal mine location.

Apart from this, there are some disadvantages that can be calculated at the time of mining. Safety helmet technology can be the solution for the coal mine workers, whereas a smart safety helmet with updated array of sensors will be presented to sense data and also a wireless system will be available to transmit the data. Safety measures are being implemented through our project and thus it should be thoroughly implemented for creating a safe environment for the people who risk their lives daily. Overall, smart helmets are a promising technology for improving safety in mining, as they can provide miners with valuable information about their surroundings, as well as their own physical condition. As the technology continues to advance, we can expect to see even more sophisticated smart helmets being developed to enhance safety in the mining industry.

Figure 1. Smart Helmet Areas of Interest

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II. LITERATURE REVIEW

1. IoT Based Smart Helmet for Mining Industry Application

Work done: The working principle of the smart helmet was used to outline the flaw of the entire system without a detailed flaw. This research mainly contains Gas Control, Force Detection and Temperature and Humidity Monitoring System, LCD, LED and 9v power supply battery.
Methodology: IoT with GUI system.
Technology: IoT, Temperature and Humidity monitoring sensor.
Gaps: Average delay of 1988 m/s
Future scope: Heartbeat Monitoring System can be added for identifying and notifying about cardiac arrests.

2. IOT Based Smart Helmet for Air Quality Used for the Mining Industry

Work done: A helmet has been created that can distinguish dangerous occasions in the mines. In the advancement of head protectors, they have considered the primary danger that is air quality.
Methodology: Helmet remove sensor, is used to detect the miner using IR sensors. Air quality sensor is used to detect air pollution. Data processing unit is the Arduino Uno microcontroller. Wireless transmission is achieved through the GPRS module with cloud IOT technology. Alerting unit is used to give the alarm sound to miners using a buzzer when any harmful gas is detected and a person is not wearing a helmet.
Technology: IoT, Air Quality Sensors, GSM.
Gaps: The Helmet cost is high.
Future Scope: The framework can be enhanced by adding all the more estimating gadgets to check the excavator's circulatory strain and heart rate. In future, it could likewise be considered if such modules can likewise be utilized for auxiliary administrations, for example, restriction of specialists in respect to each other.

3. Review of Wearable Device Technology and Its Applications to the Mining Industry

Work done: This paper reviews current trends in wearable device technology, and provides an overview of its prevalent and potential deployments in the mining industry.
Methodology: This review includes the classification of wearable devices with some examples of their utilization in various industrial fields as well as the features of sensors used in wearable devices.
Technology: wearable device technology to mining sites.
Future Scope: Smartwatch, Smart eyewear, Fitness tracker, Smart clothing, Wearable camera, Wearable medical device, etc.

4. Applications of Smart Helmet in Applied Sciences

Work done: In this study, the current status and trends of smart helmet research were systematically reviewed. Five research questions were set to investigate the research status of smart helmets according to the year and application field, as well as the trend of smart helmet development in terms of types of sensors, microcontrollers, and wireless communication technology.
Methodology: In this study, the systematic review was designed using five steps as follows. A search method was designed to identify academic research articles related to the research questions. Selection criteria were set to distinguish between articles related to the research questions and those not related to them. The selected articles were analyzed, and the results were integrated. The results were summarized and reported to provide answers to the research questions.
Technology: The 103 articles obtained from literature selection were classified to separate contents of the articles and facilitate interpretation of the data. This analysis was conducted for each individual publication by considering the RQs.
Gaps: Some sensors, such as cameras and global positioning systems attached to smart helmets have potential elements of privacy invasion. To date, there has been insufficient research on the security and privacy of data collected by smart helmets through sensors.
Future scope: Considering the expandability and functionality of smart helmets, they can be widely used not only for various sporting events but also for military purposes.

5. Smart Helmet Using Zigbee

Work done: Here, they have designed a system, i. e. smart helmet using ZigBee technology for monitoring the hazardous gasses, abnormal temperature conditions and the humidity levels in the air.
Methodology: This project includes various sensors which would detect various risks for workers working in a mine. The project uses ZigBee for long range reliable communication. The project uses an Oximeter for pulse rate detection as well as oxygen level detection. It uses an IR sensor for detecting falling rocks. The device uses Gas sensors for detecting levels of toxic gasses inside the mine.

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Technology: ZigBee boards are used at both ends – Mine worker's helmet as well as Supervising Unit. Alerts at both ends are given using buzzer and LED indications.
Gaps: It requires knowledge of the system for the owner to operate Zigbee compliant devices. It is not as secure as a Wi-Fi system. Replacement cost will be high when any problem occurs in Zigbee compliant home appliances.
Future scope: The helmet can be made light weight by making use of fabricated SMD components in a small size PCB.

III. METHODOLOGY

The proposed system consists of a helmet removal sensor, which is used to detect if the miner is wearing the safety helmet or not; this is achieved through the IR sensors. Air quality sensor, which is used to detect air pollution from coal mines. It is mainly due to emissions of particulate matter and gases including carbon monoxide (CO), Carbon dioxide (CO2).
A mining helmet needs to be modified by adding intelligence to the helmet to improve the safety of the miner. Data processing unit is the Arduino Nano microcontroller, which is used to get all the data from the above all sensors and concludes whether any intimation to the wireless unit or the user wearing it.
Wireless transmission and alerting unit is used to shares the data obtained from the processing unit. Wireless transmission is achieved through GPRS module with cloud IOT technology through this the information regarding the gas situations are uploaded in to a server and the server store the data, the stored data is displayed in a server login channels through this we can see former recorded position of gases level and can decide mine is safe or not and to take different protection styles will be made easy. Alerting unit is used for the alarming situation to miner using buzzer when any harmful gas is detected by the system.
Smart helmets are designed to enhance the safety of miners by furnishing real-time information about their surroundings, as well as their own vital signs, to prevent accidents and reduce the threat of injury. Here are some of the key features of a smart helmet for safety in mining:
GPS and proximity sensors: GPS and proximity sensors help the miner to navigate their way around the mine, while also alerting them to any obstacles or dangers that may be nearby. This can be achieved through the use of Infrared sensors and GSM modules.
Vital sign monitoring: Smart helmets can monitor the miner's vital signs, such temperature, and oxygen levels. This information can be used to detect signs of fatigue, illness, or injury, and alert the miner or their supervisor. Sensors like DHT11 can be used for detecting surrounding temperature and humidity.
Gas level monitoring: To identify the presence of any harmful gases in the surroundings, MQ7 Gas sensor. It can sense harmful gases like methane, butane, propane, CO, etc and trigger a buzzer in the receiver circuit.

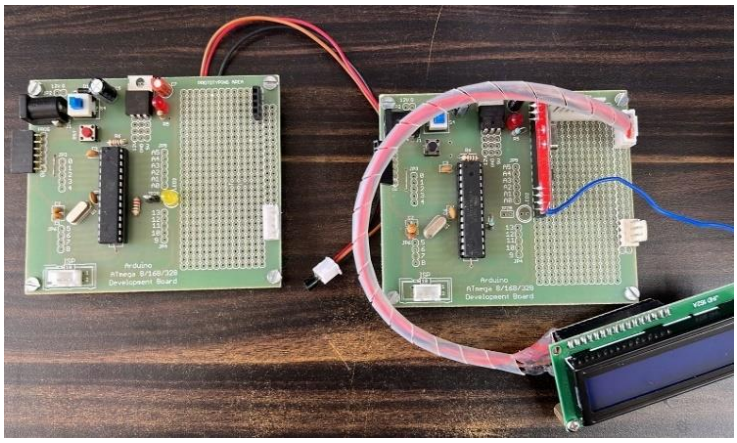

Figure 2. Smart Helmet Implementation

The smart helmet provides a real time monitoring of harmful gases, humidity and miner if he is wearing the helmet or not. The harmful gases like carbon monoxide, LPG, Methane and also temperature are monitored using this system. The use of smart helmets for mining that are equipped with GPS tracking, Gas sensors and temperature sensors has shown promising results in improving the safety and efficiency of mining operations. One study found that the use of smart helmets equipped with GPS tracking technology improved the ability of mining companies to track the location of workers in real-time. This enabled companies to quickly identify the location of workers in the event of an emergency, which could significantly reduce response times and improve the chances of a successful rescue.

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IV. BLOCK DIAGRAM AND FLOWCHART

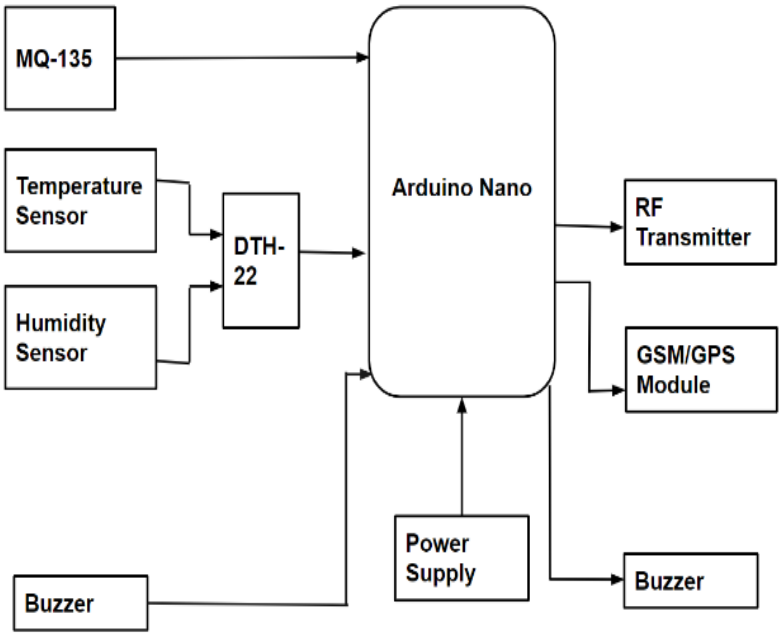

Figure 3. Transmitting Section

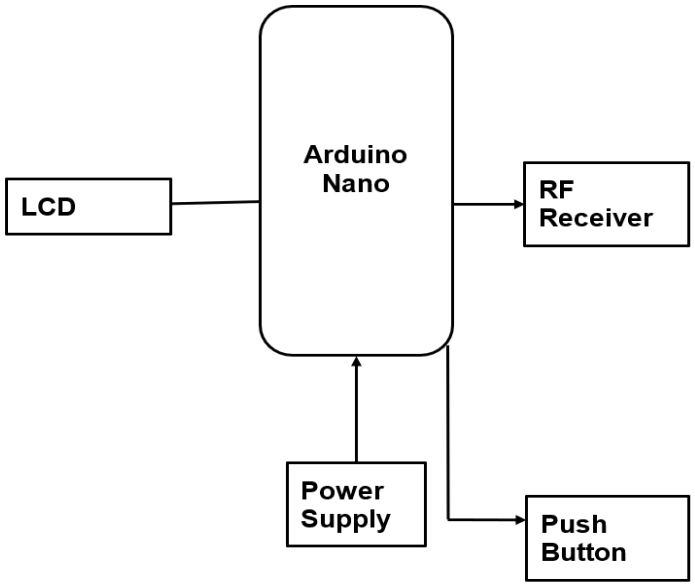

Figure 4. Receiving Section

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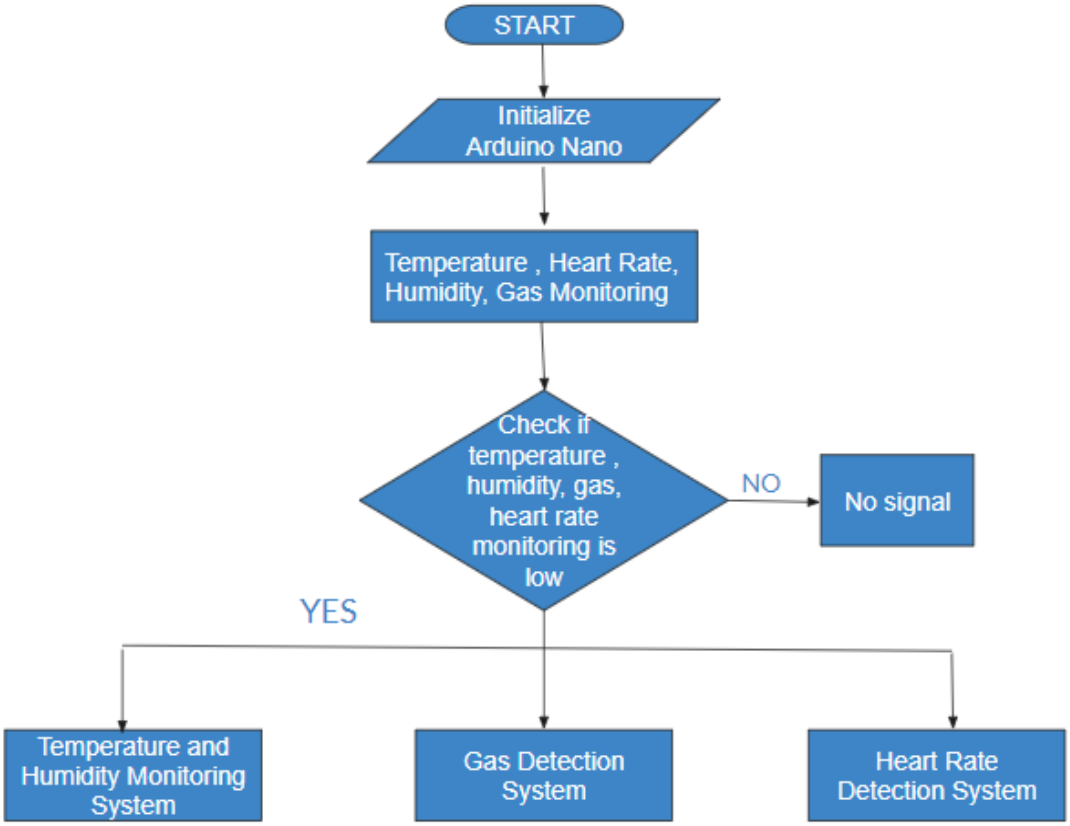

Figure 5. Flowchart

V. SYSTEM SPECIFICATIONS

1. **Arduino Nano ATMEGA328P-PU :**32 kb of programmable FLASH

- 1 kb of EEPROM
- 2 kb SRAM
- Data retention for 20 years at 85^0 Celsius and 100 years at 25^0 Celsius
- Operating voltage: 1.8 to 5.5V
- Operating temperature range: 40-80^0 Celsius

2. MQ135 Methane Gas Sensor - General Specifications:

- Good sensitivity to combustible gases in wide range
- High sensitivity to Natural Gas
- Low cost and long life
- Simple driver circuit

3. MQ135 Methane Gas Sensor - Technical Specifications:

- Long and stable life

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- Operating Voltage - +5V
- Detect or Measure Propane, Butane, NH_3, NOx, Alcohol, Benzene, Smoke, CO2, etc.
- Analog output voltage - 0V-5V
- Digital output voltage - 0V-5V
- Preheat duration is of 20 seconds

4. LM2596 Module:

- Module Nature - Non-isolated step-down module
- Input voltage range - 7V to 35V
- Output voltage range - 1.25V to 30V
- Load Regulation - ±0.5%
- Voltage regulation rate - ±2.5%
- Operating temperature range - -40℃ to +85℃

5. LCD:

- Operating Voltage - 4.7V to 5.3V
- Current Consumption - 1mA
- Consists of 2 rows and each row can print 16 characters
- Each character build by a 5’8 pixel box
- Can work on both 8-bit and 4-bit mode

6. GSM:

- Operating Frequency - GSM 850MHz ,EGSM 900MHz, DCS 1800MHz
- Operating Voltage Rating - 3.2V - 4.8V
- Output Pin Voltage - 5V dc
- Output Pin Current - 25mA
- Communication Code - UART interface, configured for full-duplex asynchronous mode
- Baud Rate : Supports Auto Bauding and 9.6kb/s used.

7. Humidity and Temperature Sensor – DHT22:

- Operating Voltage - 3.5V to 5.5V
- Operating current - 0.3mA (measuring) 60uA (standby)
- Output - Serial data
- Temperature Range - 0°C to 50°C
- Humidity Range - 20% to 90%
- Accuracy - ±1°C and ±1%

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VI. CONCLUSION

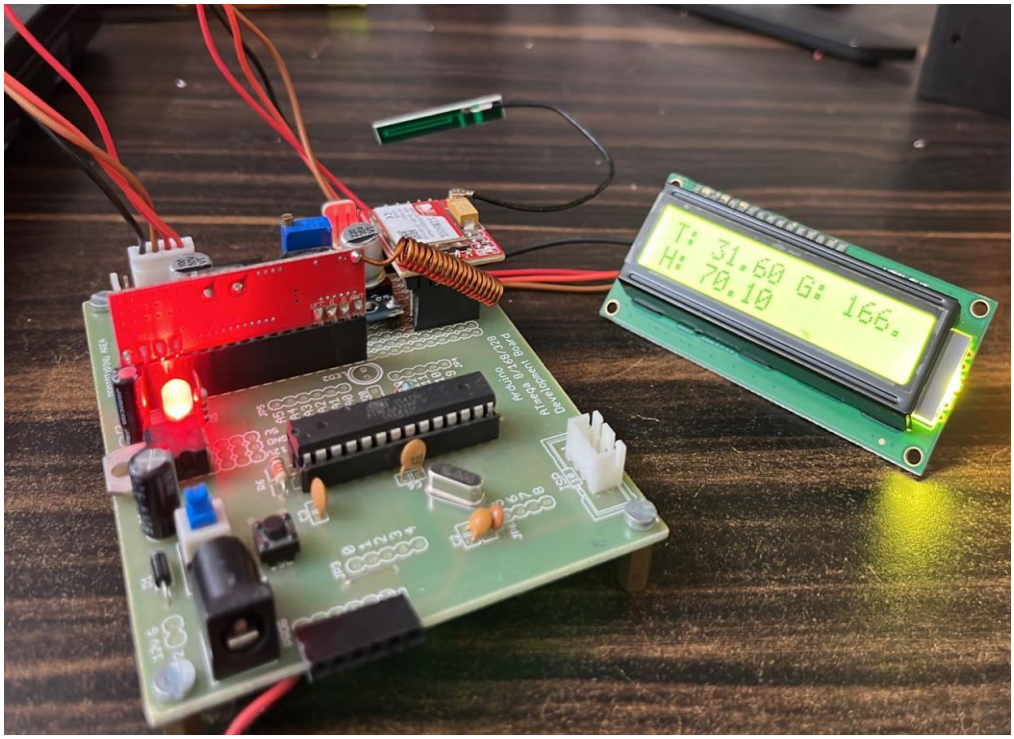

Figure. Receiver Section

Figure. Transmitter Section

In conclusion, smart helmets have proven to be a crucial tool for enhancing safety in mining operations. These

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technologically advanced helmets offer a range of features and benefits that significantly reduce the risk of accidents and promote a safer working environment. Firstly, smart helmets are equipped with sensors and detectors that can monitor various environmental parameters such as temperature, gas levels, humidity, and air quality. This real-time data enables miners to detect potential hazards, such as toxic gases or poor ventilation, and take immediate preventive measures. By alerting miners to dangerous conditions, smart helmets can help prevent accidents and minimize health risks.

VII. FUTURE SCOPE

While smart helmets have already made significant advancements in enhancing safety in mining, there are several areas of future work that can further improve their effectiveness. Here are some potential areas of focus:
1. Enhance the helmet's sensor capabilities to detect a wider range of hazards specific to mining environments. This could include the detection of specific gases, particulate matter, radiation levels, and seismic activity.
2. Integration with advanced analytics and machine learning algorithms can enable real-time analysis of sensor data and prompt alerts for potential dangers. Implement comprehensive data analytics systems to collect and analyze data from smart helmets. This can provide valuable insights into safety trends, identify areas for improvement, and support decision-making processes for safety protocols and equipment optimization.
3. These analytics can also help in conducting post-incident analysis and understanding the root causes of accidents for continuous safety improvements.
Develop more efficient power management systems to extend the battery life of smart helmets. Longer battery life ensures uninterrupted usage during long shifts, reducing the need for frequent recharging or battery replacements.

REFERENCES

[1] "Design and Implementation of a Smart Helmet System for Underground Miner's Safety", a paper by Arnob Barua, M.J Alam, Ahmed Raihan, Rocky Chakma, Springer Nature Singapore, International Conference on Communication, Computing and Electronics Systems.
[2] "Iot Based Smart Helmet for Mining Industry Application", a paper by Tarek Eldemerdash, Raed Abdulla, Vikneswary Jayapal, Chandrasekharan Nataraj, Maythem K. Abbas, International Journal of Advanced Science and Technology Vol. 29
[3] "Smart Helmet Using Zigbee", a paper by Bhagat Sagar Sanjay, Kakde Abhijeet Dilip, Tagad Ajay Balasaheb, Singh KinnuKumar Chandrabhushan, Prof. N. P. Saware, Department of Computer Engineering, Jaywantrao Sawant College of Engineering, Pune, India, International Journal Of Innovative Research In Technology, Volume 6
[4] "Design and Simulation of Smart Helmet for Coal Miners using Zigbee Technology", a paper by Hem Chandra Joshi and Satyajit Das, Department of Electronics and Communication, Amrapali Institute of Technology and Sciences, Haldwani, (Uttarakhand), India, International Journal on Emerging Technologies
[5] "Review of Wearable Device Technology and Its Applications to the Mining Industry", a study paper by Mokhinabonu Mardonova and Yosoon Choi *ID Department of Energy Resources Engineering, Pukyong National University, Busan 608-737, Korea
[6] "IOT Based Smart Helmet for Air Quality Used for the Mining Industry", a paper by P.Roja, D.Srihari, Department of ECE, SVCET, Chittoor , AndhraPradesh, India, International Journal of Scientific Research in Science, Engineering and Technology IJSRSET
[7] Mishra, A., Malhotra, S., & Singh, H. P. (2018, February). Real Time Monitoring &Analyzation Of Hazardous Parameters In Underground Coal Mines Using Intelligent Helmet System. In 2018 4th International Conference on Computational Intelligence & Communication Technology (CICT) (pp. 1-5). IEEE.
[8] Revindran, R., Vijayaraghavan, H., & Huang, M. Y. (2018, September). Smart helmets for safety in mining industry. In 2018 International Conference on Advances in Computing, Communications and Informatics (ICACCI) (pp. 217-221). IEEE.

