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IOT Mining Tracking & Worker Safety Helmet

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Abstract: ***Mining plays an essential role in the production of goods, infrastructure and services that improve the well-being of society. But it's also a dangerous industry, especially when it comes to safety and health. Especially when you're working in a complex underground environment. As mines get bigger, issues like stability, oxygen and emergency response get harder to deal with. That's why we're proposing a cutting-edge mining tracking & safety system that puts microcontroller-style circuits in your workers' helmets. The proposed system aims to enhance mining security efficiency by providing:***

- ***Accurate location tracking***
- ***Swift emergency response***
- ***Ensuring the safety***
- ***Well-being of mining industry workers.***

The technology uses integrated circuits in workers' helmets to continuously track their location across the mining site. Each helmet has a panic button that, when pressed, triggers an IOT emergency alert. This allows for a quick response to worker emergencies, improving safety protocols and providing immediate help. Combining location tracking with emergency alerts creates a more secure mining environment that puts worker health and safety first.

Keywords: Safety Helmet, Internet of Things (IoT)

I. INTRODUCTION

Mining plays a pivotal role in shaping the modern world, serving as the backbone of industries that create goods, build essential infrastructure, and offer vital services. The raw materials that are extracted from mines are the basis of many of the products we use every day, such as smartphones and cars. However, the importance of this industry comes at a human cost, as the men and women who work in mines are exposed to a variety of safety and health risks daily. The deeper a mine is, the more dangerous the conditions become, as the lack of oxygen, unstable underground conditions, and the difficulty of evacuation in the event of an emergency increase the risks associated with mining operations.

In light of the risks associated with the mining industry, it is essential to develop novel safety protocols for miners. The objective of this proposal is to identify ways to improve communication and security in mining operations. Underground miners wear a helmet that houses a circuit that provides essential safety features during their work. Mining, particularly in modern times, is still a dangerous activity that releases hazardous gases during its operations and poses serious environmental risks. Safety is a top priority in the mining industry, and each mining business takes various measures to reduce the risk of hazards. IoT integration plays an important role in creating devices that meet the needs of coal miners and ensure their safety and wellbeing.

This innovative approach uses different parameters for collision detection and helmet removal. Collision detection is monitored by detectors such as collision detector, gas detector and Smart Helmet detector. The detector is programmed to take action immediately to prevent a hazardous situation and alert workers via a buzzer. The communication system plays an important role in improving safety. This requires a robust system that includes constant communication between mine workers and a centralized base station.

Wired communication systems are not very effective in underground mining operations. They require a lot of maintenance and can cost a lot of money to install. To overcome these issues, we have developed a wireless data transfer system. It has a combination of a wireless transmitter and a wireless receiver. Not only does it overcome the limitations of the wired system, but it also shows that it is very cost-effective. Miners are wearing specially designed helmets with a built-in Wi-Fi based monitoring system. This system establishes communication with the monitoring Wi-Fi network. The system has ESP32 Arduino based circuitry. It collects and transmits data in real-time, which allows for accurate monitoring of workers' locations. Each helmet circuit is equipped with a panic / emergency button. The button can be used in a variety of emergency situations, including toxic gas inhalations, cave-ins, physical injuries, etc. When the button is activated, an immediate alert is sent, indicating that a crisis has occurred. This quick response mechanism ensures the safety and protection of mining employees by using IoT technology.

This wireless system seeks to address the shortcomings of conventional wired communications in underground mines. Utilizing Wi-Fi and sophisticated circuitry, the system not only facilitates effective communication, but also provides a proactive safety solution.

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Integrating real-time monitoring and instant crisis notifications significantly improves the overall safety procedures in mining operations. This system demonstrates the potential of Internet of Things (IoT) technology to transform workplace safety, offering a practical and dependable solution to the challenges posed by hazardous environments, such as underground mines.

One of the best things about this system is that it integrates with a panic/emergency button that is built into every worker's helmet circuit. When an emergency occurs, such as an inhalation of toxic gas, a cave-in, or a physical injury, workers press this button to alert the control centre. This action immediately triggers an emergency signal which is sent via the IoT web interface to alert the relevant authorities to the emergency. This rapid response mechanism can save lives in critical situations, allowing for immediate and targeted interventions to minimize the risk of injury to the workers.

1) *Enhanced Worker Safety:* The main goal of the project is to improve the safety of the mining workers by putting in place a complete tracking and safety solution. The system will use radio frequency (RF) technology to monitor the movement of the workers inside the mining site to guarantee their safety in an environment that is unstable and dangerous.
2) *Real-time Location Monitoring:* Integrate a microcontroller into the worker helmet for real-time tracking and monitoring of each worker's location across the mining site. The tracking data will be sent via the Internet of Things for centralized monitoring and control.
3) *Emergency Response:* Create an emergency panic button on each worker's helmet. When the panic button is activated, it will send an emergency alert to the IoT web interface right away. This will allow for quick response to various emergencies, such as inhalation of toxic gas, cave-in, physical injury, or any other emergency. This will improve worker safety.
4) *Data Analytics and Reporting:* Analyze the data collected to generate analytical reports on worker movement and safety incidents. Utilize the resulting reports and insights to continually refine mining safety practices and emergency response protocols.

IoT technology has revolutionised a wide range of industries, and the mining industry has been no exception. In 1985, Peter T. Lewis coined the term "Internet of Things" (IoT), ushering in a new era in technology. IoT is essentially the Internet of Things (IoT). IoT devices, from simple sensors to sophisticated machinery, gather data from multiple sources and send it to units that manage, acquire, organize, and analyze that data. One of the first examples of an IoT device was a Coke machine that was modified by Carnegie Mellon University in 1982. This modified machine was able to report its inventory and even update its status, showing whether the newly loaded beverage was cold or not. This initial experiment laid the groundwork for the vast network of connected devices that we see today.

The current global population of approximately 7.25 billion people is supplemented by more than 3 billion internet users. By 2017, there were 8.4 billion IoT devices, and by 2030, that number is expected to rise to around 50 billion. This explosion in IoT devices creates a vast network, connecting everything from home appliances to smartphones. IoT devices have outpaced the human population in terms of number, and this trend is only expected to continue. IoT is made up of three basic parts: the Device, the Network, and the Application.

The DNA of IoT is the combination of these three parts in a formulaic way:

Device + Controller + Sensor + Internet = IoT

The driving principle of IoT is the "3As of IoT" – always, anytime, anywhere, with an emphasis on continuous connectivity and accessibility. The Internet of Things (IoT) functions through four fundamental elements:

a) *Sensors:* These devices are essential for gathering environmental information. The information they collect can be as simple as a temperature reading or as complex as a video feed. Sensors are GPS devices, camera systems, microphones, temperature sensors, and more. Sensors can convert physical information into electrical signals. When two sensors are connected, actuators are used to interact based on the information collected.
b) *Connectivity:* Once collected, the data is transferred to the cloud via a wide area network (WAN), Wi-Fi network, satellite network, Bluetooth network, etc. This connectivity allows for a smooth transmission of data for data processing and analysis.
c) *Data Processing:* The acquired data is processed in the cloud by advanced software. This processing may be as simple as verifying temperature data or as complex as identifying objects within the data stream. Cloud-based data processing increases the productivity and effectiveness of Internet of Things (IoT) applications.
d) *User Interface:* The processed data is then made available to users through text or email alerts. This user interface makes sure that the information from IoT data is easy to access and use.

Utilizing the capabilities of IoT, the system provides not only monitoring of workers but also facilitates the communication and exchange of data between the various components of a mining site. By integrating IoT into the system, it is possible to analyze data in real time, enabling proactive decisions and preventive measures to be taken in the face of ever-changing challenges. This system helps the mining industry to keep up with technological progress while ensuring the safety and well-being of its workforce.

This study proposes a comprehensive approach to mining safety through the utilization of Internet of Things (IoT) technology. By concentrating on real-time tracking, immediate response, and wireless communication, the project seeks to significantly improve the safety measures for underground miners. Not only does the implementation of these cutting-edge technologies address existing safety issues, but it also serves as a reference for future mining activities, highlighting the significance of worker health and safety and the preservation of the environment in the mining sector.

The Mining Tracking and Safety System (MTSS) marks the beginning of a new era for mining operations. By incorporating Internet of Things (IoT) capabilities into the material of mining helmets, a comprehensive safety net has been developed to protect workers in hazardous environments. Not only does this system improve the productivity of mining operations, but it also safeguards the lives of those who work tirelessly to mine the resources that power our modern society. As we progress, industries must embrace such cutting-edge solutions to ensure that progress is accompanied by the prosperity of those who are driving it – the hidden heroes beneath the surface of the Earth.

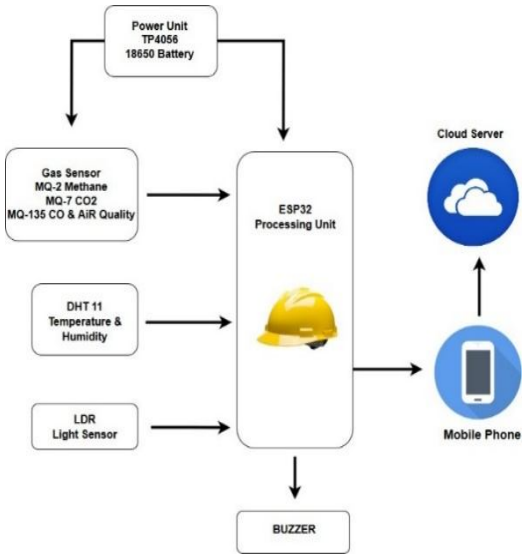


Fig. 1. Hardware and Software Used

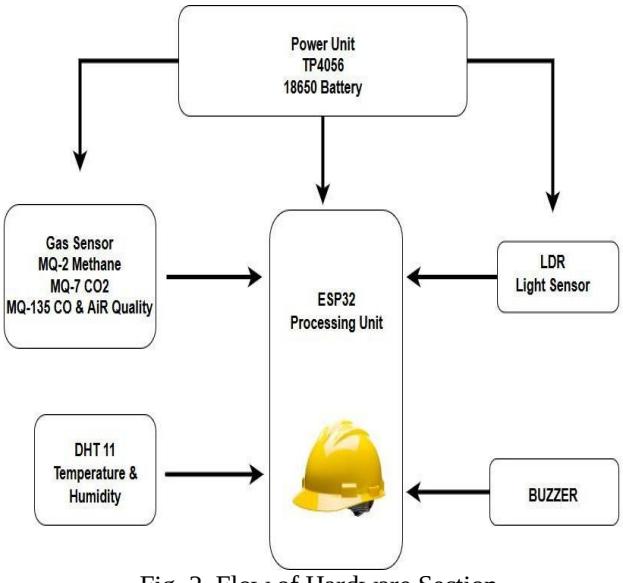


Fig. 2. Flow of Hardware Section

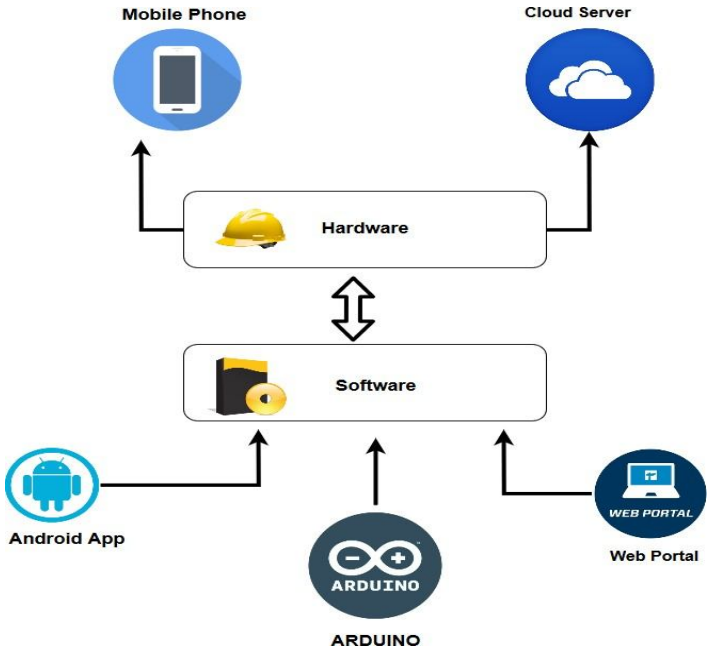


Fig. 3. Flow of Software Section

II. LITERATURE REVIEW

In 2023, AKL Sandaruwan and B Hettige [1] presented a worker safety helmet that works on IoT. The importance of safety in the mining industry cannot be overstated, especially in underground operations where the well-being of mine workers is of paramount importance. All mining operations must adhere to fundamental safety regulations and measures to avoid accidents, and collapses are a major risk. While coal mining collapses are not always particularly dangerous, immediate rescues are essential in saving lives. Communication is a key factor in mining, particularly in underground mines. Worn-out wired communication is costly and inefficient, while wireless communication is cost-effective and effective. Wireless communication allows the industry to transmit essential information immediately, thus improving safety measures—furthermore, the integration of sensors (gas and temperature sensors) aids in proactive risk prevention. Miners wear helmets with buzzers that alert them during hazardous conditions, and priority is given to communication so that all mining personnel can confirm their safety before proceeding, thus creating a safe environment for all involved.

To address these issues, a pioneering project has emerged: the creation of smart helmets, which act as intelligent guardians of miners. These helmets are equipped with various sensors to detect potentially hazardous events and keep an eye on the environment around them. By collecting data from various sensors, the helmets can transmit it to the central console, where it can be exchanged in real-time. This allows for the efficient monitoring of miners and the prompt response to emergencies. By utilizing cutting-edge technology, the project improves safety protocols in the mining industry, thus saving lives and preparing the ground for a safer future.

In 2023, Pankaj Kunekar, Prerana Waghmare, Preyas Videkar, Sangharatna Bombarde, Y. D. Satyamedha, V. Khandagale, Yashovardhan U. Wagh [2] presented a solution and a plan for the problem of Miners Security. The issue of safety in the coal mining sector is a major concern due to the frequent occurrence of accidents. This study highlights the need to implement a wireless network connection to transmit real-time data to alert officials in the event of an accident, thus allowing for rapid responses. Accidents resulting from falling rubble onto workers are a major risk in mining. To address this issue, we have launched an IoT-based helmet project to assist the industry. However, the mining sector is lagging in terms of technological progress. To bridge the gap and introduce cutting-edge IoT solutions, we have developed the concept of ‘SMART HELMETS’. These helmets provide a lifeline to workers working in the depths of the mines, acting as an essential safety measure. By incorporating cutting-edge technology in mining practices, we aim to improve worker safety and transform the mining industry. This prototype is composed of an ESP8266, an accelerometer sensor, a gas sensor, and a buzzer which can be used to detect the various dangers present in the mines.

In 2023, Harshal Ramesh Aher, Rupal Vilas Turkane, Gayatri Dattatray Varpe, Namrata Sunil Waghmare, and V. R. Aware [3] proposed the work "Mine Safety System Using IoT." The implementation of a new, innovative approach to mine safety is essential in order to increase mining profitability, reduce costs, and prioritize worker safety. This system is composed of two components: one to monitor the wellbeing of miners, and the other to monitor various environmental factors. Air pollution in mining areas is largely caused by emissions of Sulphur (SO2) oxide, nitrogen dioxide, and CO2. Smoke sensors are used to monitor the levels of these hazardous gases in the mine, with semiconductor gas sensors measuring their concentration levels. If any of the sensor readings exceed the safety threshold, a buzzer is triggered by the microcontroller, which in turn transmits the information to the Monitoring Section Module. The data collected in the Monitoring Section is then uploaded to a webpage using Internet of Things (IoT) technology. This system provides immediate responses to any potential hazards, significantly improving the safety and wellbeing of miners.

In 2022, Suwama Kama, Tanzila Noushin, and Shawana Tabassum [4] conducted a study on the IoT-based Smart Helmet, which involved automated and multi-parametric monitoring of underground miners' health hazards. Making sure workers are safe in underground mines and on construction sites has always been a top priority, but with the rise of IoT technology, it's become even more important. This study focused on creating and deploying an IoT smart helmet that would revolutionize real-time safety monitoring for miners. This smart helmet was designed with specialized body sensors that could capture all sorts of health data. The sensors worked together to wirelessly send important info to the central control room where it was quickly analyzed. The testing process showed how effective the helmet was, but it also showed how it could revolutionize safety in high-risk environments. The most important part of the solution was its immediate response mechanism. This allowed for quick reactions to potential risks, reducing them in real time. Not only did this solve a long-standing safety issue, but it showed how technology could make a huge difference in workplace safety.

This innovative smart helmet is a game-changer in the field of occupational safety, particularly in sectors such as mining and construction where time-critical responses are essential. Its capacity to address safety issues in real time, at the moment they arise, highlights the immense value of real-time tracking technologies. This innovation, which seamlessly integrates IoT capabilities, is a perfect example of what the future holds for workplace safety practices. Implementing such advanced solutions not only protects the health and safety of workers but also establishes a new benchmark for safety in hazardous work environments. Consequently, this development is likely to make a lasting impact in sectors where safety is a priority, creating environments where workers can perform their duties with greater assurance and security.

In 2022, G. Nikhil, T. Shikar, V. Manideep, and G. Radhika [5] conducted a study on developing a Coal Mine Safety System utilizing Wireless Sensor Networks and Arduino technology. The IoT Coal Mine Safety Monitoring and Alerting system solves a critical problem in the inherently hazardous mining industry: worker safety. Mining, particularly in underground settings, presents many risks, and current safety measures often fail, resulting in tragic accidents and the loss of life. This project introduces a revolutionary solution by integrating IoT technology with the help of an Arduino microcontroller. The system uses sensor modules for temperature, smoke, gas, long-range distance, humidity, and more. These sensors collect data and send it to the remote IoT server on a regular basis. If any sensor detects readings that exceed safety limits, it triggers an immediate alert. The system’s rapid response mechanism and real-time data transmission allow for quick interventions and minimize risks to miners’ lives. This project seamlessly integrates IoT capabilities to revolutionize safety protocols in the coal mines. With continuous monitoring and immediate alerts, it provides a strong safety net to protect miners’ well-being.

In 2021, Sowmya Sista Lakshmi, Ayush Dagar, Neeraj Gupta, Manjeet Kaur, and Rashmi Gupta [6] conducted research on the implementation of IoT-based technology in mining tracking and safety helmets. This study focuses on the development and implementation of a smart helmet based on Internet of Things (IoT) technology, which is designed to provide real-time health and safety monitoring of miners working in underground mines or construction sites. The helmet was designed to capture a wide range of health parameters and transmit the data wirelessly. Through rigorous testing, the effectiveness of the helmet was confirmed, demonstrating its potential to transform safety protocols in hazardous environments. The instant response mechanism of the helmet allowed for rapid responses to potential hazards. This innovation addressed long-standing safety issues and highlighted the fundamental importance of technology in improving workplace safety, particularly in industries where time-critical responses are required, such as those in mining and construction.

This smart helmet represents a fundamental shift in occupational safety practices, especially in industries where immediate responses are critical. The ability to respond to safety issues in real time demonstrates the transformative power of real-time monitoring technologies. This innovation seamlessly integrates IoT capabilities, ushering in a new era of workplace safety.

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Not only will it protect workers, but it will also raise the bar for safety in dangerous workplaces. As a result, this innovation is set to make a difference, creating safer work environments where workers can perform their duties with greater assurance and security.

In 2021, Druvanag P, Eaga Chandralekha, Gatla Niharika, Gavini Pranathi, and Nanda Kishore C V [7] conducted an observation focusing on issues about miners' safety. Worker safety is a top priority in the mining industry, especially in emergencies. There are a lot of hazards out there, like gases, minerals, heavy machinery, and more. Coal mines are enclosed, which means there are more risks, like ventilation issues, so safety is really important. But mining is still important for making important goods and services, and India relies heavily on it. But mining also creates some environmental risks. To make sure worker safety is taken care of, they've come up with a system called Mining Tracking and Safety. It uses RF-based technology to track workers in real time, and it's all thanks to microcontroller-based circuits in workers' helmets.

The helmets have RF transmitters and panic buttons that talk to a central microcontroller that's connected to RF receivers. This interacts with tracker RF systems so that data can be sent over the Internet of Things (IoT). By using this technology, miners can communicate more effectively with each other, which means they can respond more quickly to emergencies. Not only does this help with immediate safety concerns, but it also means they can respond faster in crises, which could save lives. Integrating these advanced solutions can help the mining industry improve worker safety protocols, reduce risks, and create a safer environment for everyone involved.

In 2020, Tarek Eldemerdash, Raed Abdulla, Vikneswary Jayapal, Chandrasekharan Nataraj, and Maythem K. Abbas [8] introduced a program designed to enhance miners' safety through the use of security helmets. The mining industry is a fundamental component of any advanced nation and is responsible for the exploitation and exploration of precious subterranean resources such as metals, metals, minerals, coal, diamonds, and more. The Internet of Things plays an essential role in this context, acting as an essential ICT technology. It enables efficient communication through the use of Wireless Sensor Networks using the IEEE 802.14.5 protocol, which powers Low Rate-WAN communication, using particular modulation techniques to facilitate the smooth exchange of data within the mining industry.

The mining industry has been able to gain access to a range of real-time monitoring capabilities through the integration of Industrial Internet of Things (IoT) technologies, as well as wireless sensor networks. This has enabled the monitoring of the movement of essential resources, the safety of personnel, and the optimization of production processes.

In 2020, Punam S. Tajane, Shrutika B. Shelke, Sonal B. Sadgir, and Archana N. Shelke [9] presented a design concept for a Miners Safety Helmet, which comprises two main segments: the Helmet Unit and the Control Unit. Mining continues to be one of the world’s most dangerous occupations, especially in areas where underground miners don’t have access to proper safety protocols and social assistance. Injuries often leave workers without help, resulting in serious social and economic hardship. The mining industry has one of the highest mortality rates in the world, with accidents such as rock falls, fire, explosions, methane poisoning, electrocution, and more being the leading causes of death. Recent research, including one from China, has highlighted the high mortality rate in underground mining and highlighted the need for improved safety protocols.

To tackle these issues, a powerful communication tech has been created to create an advanced sensing and warning system inside mines. RF technology has been chosen for its efficiency, making it easier to communicate in the mines. Safety is a top priority in the mining industry, so it's important to take the necessary steps to avoid accidents. By using cutting-edge communication tech, the industry can raise its safety standards, making sure miners are better prepared to handle the risks of their jobs.

In 2019, D. Hema [10] conducted a comprehensive observational study specifically centered on the safety concerns related to miners. The consequences of an accident involving a construction worker who does not wear a helmet are extremely serious and can lead to life-altering injuries. In these cases, the availability of emergency medical services quickly can make a significant difference in saving lives. This is why the development of the smart helmet is of paramount importance, as it can help to mitigate the devastating consequences of such accidents. The primary goal of the Smart Helmet is to ensure the safety and well-being of construction workers in their work environments by incorporating advanced features that detect potential hazards from either the workers themselves or their environment. The safety attributes included in the helmet include the detection of alcohol, the tracking of the worker's location, the monitoring of the presence of dangerous gases, the monitoring of oxygen levels, the detection of falls, and the use of an SOS feature to immediately identify an accident. Every worker is required to wear a smart helmet before beginning any work on the construction sites.

This is a proactive way to make sure that workers are wearing the necessary safety gear to reduce the risk of head injuries. The smart helmet is designed to detect various dangers that could affect worker safety. If there is an accident, the prototype will automatically trigger an alert. This alert will immediately relay important information to management about the worker’s current location.

This system immediately notifies the management so that they can quickly respond to the situation and provide medical assistance or other necessary interventions. Not only does the incorporation of advanced safety features guarantee the immediate health and safety of construction workers, but it also provides a proactive approach to accident prevention.

In 2018, Rohith Revindran, Hansini Vijayaraghavan, and Mei-Yuan Huang [12] conducted a study on the implementation of Smart Helmets for Safety in the Mining Industry. The mining industry is one of the most important sectors of the global economy. Unfortunately, it is also one of the most dangerous. Miners are constantly facing life-threatening scenarios. This highlights the need for improved safety measures. This project aims to introduce cutting-edge technology to help distressed miners and provide immediate assistance in times of distress. The solution is to augment the miner's helmet with a Wireless Sensor Mote (WSM) and essential sensors. This will create a network of connected wireless sensors. The WSN is a monitoring system that ensures the health and safety of all the working miners.

The routing protocol designed for this project works on DVR, figuring out the best way to go based on the quickest hop. It's really strong, so it can handle failures without needing to synchronize nodes. It's proactive, so you don't have to wait around for help in case of an emergency. If the force sensor on your helmet detects a load that's over a certain limit, the mote inside your helmet tries to send a distress message to your Room Manager through the route you've chosen. When the Room Manager gets the distress signal, it triggers a coordinated response. Medical teams from the central office can be sent to help the distressed miners. Neighboring miners are also notified, so they can help out if they can. In cases where your mote doesn't have a route to your Room Manager, there's a systematic failure recovery process that makes sure the distress communication system is reliable. Rigorous testing has shown that this project can help improve the safety and well-being of miners in the industry.

In 2017, Jagadeesh R and Dr R. Nagaraja [15] researched an IoT-based Smart Helmet for detecting unsafe events in the mining industry, enhancing safety protocols and minimizing risks. A new smart helmet model designed specifically for the mining industry has been developed to detect and respond to dangerous events in the mining environment. This innovative prototype has several key features that enable it to detect various dangerous situations.

- It can detect the air quality. This is extremely important in mining environments, where the presence of hazardous gases such as carbon monoxide can be a huge risk to workers' health. The helmet uses sensors to measure saturation levels of these dangerous gases, giving real-time information on the air quality level.
- The smart helmet has an IR (Infrared) sensor, which allows it to detect when a miner removes their helmet. While this may seem like a harmless action, it can be dangerous for the miner's safety.
- The helmet has a pressure sensor that detects when an object hits the wearer's head. This is especially important in situations where objects fall or collide with a miner, as it can alert them to potential dangers right away.

The most important feature of this smart helmet is its automatic alert generation. In case of a dangerous accident, the system immediately sends an automated alert email to authorized personnel. The email provides important information about the miner's situation. Automating this alert process means that response mechanisms are triggered quickly, allowing for immediate action in the event of an emergency. Integrating real-time detection with immediate notification and rapid response improves overall safety procedures in the mining industry and significantly reduces the risks miners face during their work. This cutting-edge smart helmet model is not only a game-changer for safety in the mining industry but also sets a standard for proactive safety solutions at hazardous workplaces. Combining sensors for air quality with IR technology to detect helmet removal and pressure sensors to detect impact, the system provides miners with a comprehensive safety net. The automated alert system further improves the efficiency of the whole safety process, ensuring miners are protected quickly and efficiently.

In 2016, rof. K.S. Ingle and Nisha Dube [16] released a publication titled "Intelligent Mining: A Monitoring and Security System for Coal Mine Workers" in the International Journal of Advanced Research, which introduces a pioneering approach to enhance the safety of coal mine workers. The main goal of this study is to put in place a top-notch monitoring and security system that uses wireless sensor networks. This system is designed to detect and reduce dangerous environmental factors in coal mines, like temperature changes, humidity, and the concentration of gases. Wireless sensor networks are an advanced technology that can be used to monitor different environmental conditions in real-time. By using sensors placed inside the mines, the system can keep an eye on temperature, humidity, gas levels, and more. All this data is then analyzed in real time so that workers can quickly respond to any issues or dangerous conditions. Plus, the helmet-mounted camera is a cool addition to the system - it takes pictures of the worker's environment and sends them to the main control room for detailed analysis.

The importance of this system is clear when we consider that it has the potential to significantly reduce the number of accidents in coal mines.

The system provides real-time information on the environment, allowing mine operators and workers to make decisions quickly. Rapid response to hazardous situations is essential for preventing accidents and protecting the health and safety of miners. According to the authors of the paper, "Not only does our proposed monitoring & security system have the potential to minimize accidents, but it also demonstrates the potential of cutting-edge technology to improve worker safety standards in the coal industry." By utilizing wireless sensor networks as well as the integration of a helmet-mounted camera, our system provides a complete safety net. Real-time monitoring & rapid response mechanisms are essential tools for preventing accidents and safeguarding the safety and health of miners. This research marks a significant step forward in the ongoing effort to improve safety protocols in the coal industry, demonstrating the transformational power of technology to protect lives and promote a safe work environment.

In 2016, C. J. Behr, A. Kumar, and G. P. Hancke [18] conducted research on a smart helmet designed to monitor air quality and detect hazardous events within the mining industry. The smart helmet was designed to detect potential hazards in the mining sector. During the development process, we carefully considered three main types of hazards: compromised air, helmet removal and collisions (involving miners being hit by objects). The system is designed to monitor air quality by detecting hazardous gases such as carbon monoxide (CO), SO2, nitrous oxide (NO2), particulate matter and other pollutants, thus keeping the concentration levels within acceptable limits. As for the risk of miner helmet removal, our first attempt with an internally developed IR sensor was unsuccessful. Consequently, an external IR sensor was incorporated into the helmet, which accurately determines whether the miner is securely wearing the helmet, thus providing optimal safety conditions.

In 2013, Warsha M. Choudhari [20] introduced a proposal for a Coal Mine Security System, aiming to enhance safety and security measures within coal mining operations. The coal mine security system is a key part of mining operations, keeping an eye on important things like gas, CO, temperature, and stop-switch info from the main production equipment. It helps to predict potential safety risks, so you can avoid disasters like gas and dust explosions. This system is more advanced than before, with smart digital sensors inside its control computer, which makes data acquisition more accurate. Plus, it has a powerful MATLAB platform to manage the data, so you can get a better understanding of how the mine is running. And if something goes wrong, the system has the expert system module to come up with solutions. This software plays a vital role in managing and monitoring the entire mining environment. It acts as a central point for processing and analysing the vast amount of data gathered by the system's sensors and equipment. One of its key features is the ability to transmit real-time information to your main control computer's monitoring program via RS232 communication.

This data transmission enables several critical operations, such as real-time displaying, storing, querying and printing of critical parameters related to your mine's environment conditions and the operation status of different electromechanical equipment. Offering this comprehensive approach to monitoring means that not only will you be able to identify potential risks quickly, but also have a full picture of the mine's condition, which will help you make better decisions and significantly enhance safety measures for both miners and equipment. Combining hardware and software to create a powerful and intelligent monitoring solution. Its accuracy, efficiency and proactive problem-solving capabilities help to strengthen the safety protocols in the mining industry and protect both the environment and the miners.

III. PROPOSED WORK

The proposed study introduces a cutting-edge solution for protecting underground workers through an Internet of Things (IoT) smart helmet. The helmet is equipped with various sensors to monitor important parameters such as gas levels, temperature, and humidity which are essential for miners' safety. The transmitter segment of the smart helmet is controlled by the microcontroller and collects information from components like helmet remover detector, collision detector, and gas sensor. In case of a dangerous situation, the helmet immediately triggers alerts using an application that is deployed across different parts of the mine. The alerts are placed strategically to cover different areas of the mine. When a dangerous situation occurs, the sensors built into the helmet (Helmet remover detector, Gas detector, and Collision detector) immediately detect and send out the relevant parameters. This is an essential safety tool as it provides real time monitoring and timely alerts. This significantly reduces risks and improves the safety protocols for underground workers working underground.

The project is structured in three distinct stages: from hardware design to software design and from there to testing, tuning and debugging. Hardware design is a critical step in the process, as it is used to evaluate the suitability of a transducer and its compatibility with the circuit scheme. During this stage, the selection of transducer is a rigorous process, with attention paid to experimental attributes such as accuracy, precision and measurement factors, as well as its performance under various conditions. The transducer is carefully evaluated to ensure that it is compatible with the project's requirements.

Hardware design serves as a basis, allowing the selected transducer to fit into the circuit framework, and the software design then takes advantage of this compatibility to ensure the project's success. The project is then thoroughly tested, tuning and debugging to refine its performance and address any issues. This thorough approach to hardware and software design ensures a strong foundation and optimal performance, ensuring the successful implementation of the project.

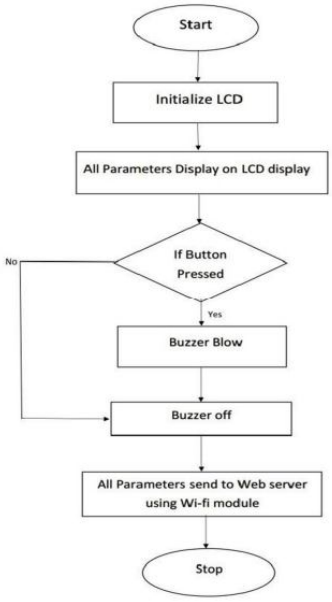


Fig. 4. Flowchart

The software design stage in this study closely follows the project's operational flow. The software is divided into two main groups: sequence and interface. To achieve the predefined objectives of the project, these components need to work together seamlessly. Once hardware and software are integrated, there is a critical phase of testing, adjustment and troubleshooting, during which careful attention is paid to every detail. Even small design flaws can be time consuming to rectify, and often require going back to previous stages for validation. This is why testing and adjustment is essential for the success of the project. The integration between hardware and software is a critical juncture, as it requires a detailed assessment of the system's function and performance. Every component's interaction needs to be carefully examined to ensure smooth operation. Rigorous testing becomes a crucial part of the design process as it ensures that not only does the software follow the study's operating flow but also performs flawlessly to meet the approved goals of the project.

The expected outcomes of the proposed work are outlined below:

1) *Reduced Risks of Mining Incidents:* The objective of the project is to reduce the incidence of mining incidents and fatalities through real-time monitoring and emergency response. The system's capacity to rapidly respond to emergency situations and provide location information can avert or reduce hazardous occurrences.
2) *Enhanced Safety Culture:* Mining companies can promote a safe and responsible workplace culture through the implementation of this cutting-edge safety system. Miners will be assured that their health and safety is a priority, which can result in improved job satisfaction and productivity.
3) *Emergency Alerts:* The IOT web interface displays an emergency signal when a worker presses the panic/emergency button on their helmet. This alerts supervisors and authorities to any critical situations, allowing them to take prompt action to reduce risks and provide assistance.
4) *Compliance and Reporting:* The system is capable of producing comprehensive reports on the movement of workers, emergency occurrences, and safety requirements. The reports can be utilised for regulatory compliance and safety audits, as well as incident investigations, thereby increasing transparency and accountability in the mining sector.

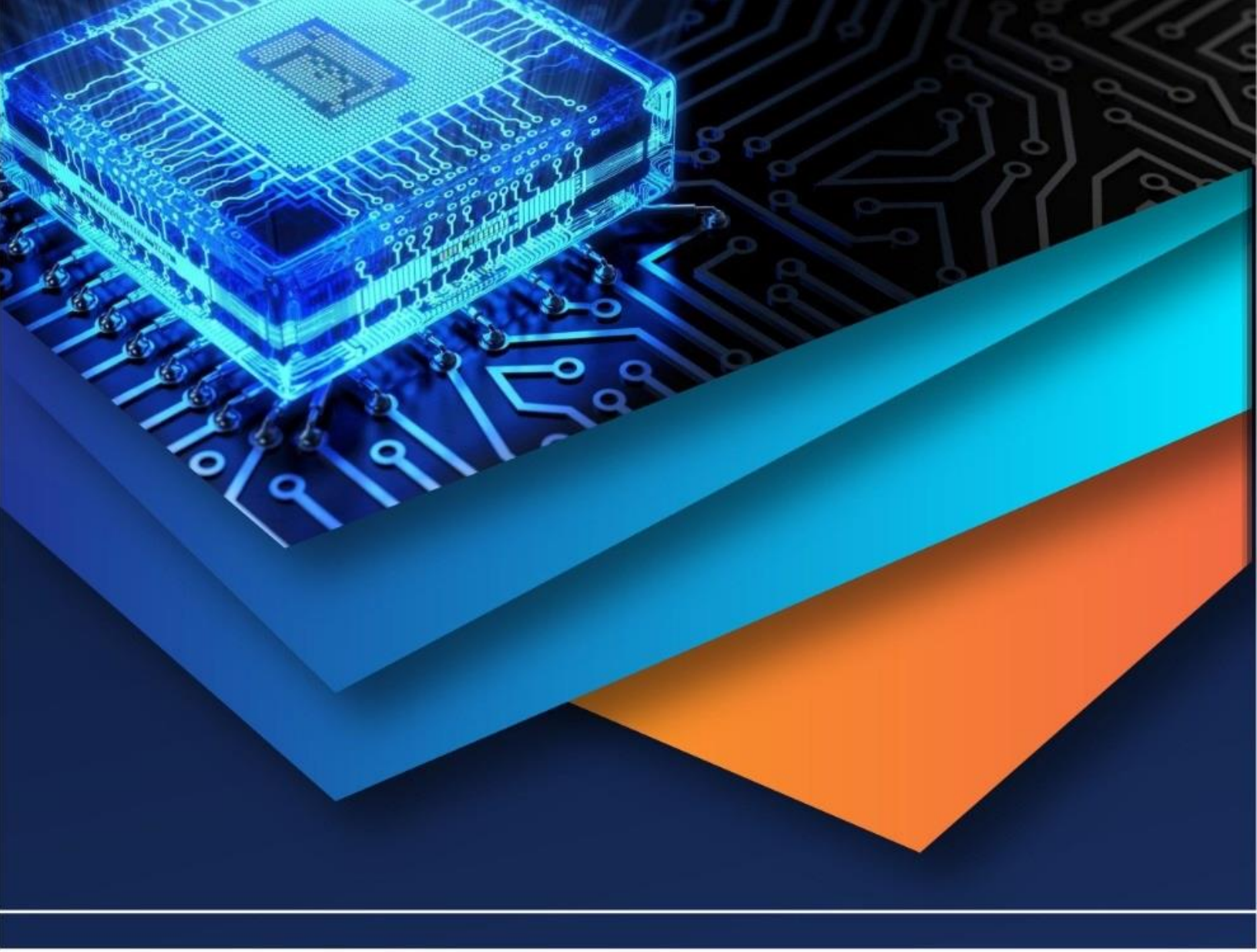
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IV. CONCLUSION

The implementation of IoT technology in safety helmets is a major development in the field of workplace safety. By incorporating IoT technology into the helmets, real-time environmental monitoring and immediate response to potential hazards are achieved. This advancement not only improves worker safety in mining settings, but also establishes a new benchmark for proactive safety practices. The success of this project demonstrates the potential of technology to create safer workplaces, reduce accidents, and protect industrial workers. It is a significant step towards a future in which occupational safety is supported by cutting-edge technology, providing a safe and secure environment for workers.

REFERENCES

[1] K. L. Sandaruwan and B. Hettige, "A Comparative Study on Smart Helmet Systems for Mining Tracking and Worker Safety in the Mining Industry: A Review," presented at the KDU FOC Student Symposium, General Sir John Kotelawala Defence University, Rathmalana, Sri Lanka, 28 February 2023.
[2] P. Kunekar et al., "IoT based Smart Security Helmet for Miner's Safety," 2023 5th Biennial International Conference on Nascent Technologies in Engineering (ICNTE), Navi Mumbai, India, 2023, pp. 1-5, doi: 10.1109/ICNTE56631.2023.10146728.
[3] A. H. Ramesh, R. V. Turkane, G. D. Varpe, N. S. Waghmare, and V. R. Aware, "A Review on Mine Safety System Using IoT," Innovative Journal for Opportunities and Development in Science & Technology, vol. 3, no. 2, March 2023, Paper ID: IJ2023V3I2-4A-E, ISSN 2582-6026, http://www.ijodst.com/.
[4] S. Kama, T. Noushin and S. Tabassum, "IoT based Smart Helmet for Automated and Multi-parametric Monitoring of Underground Miners' Health Hazards," 2022 IEEE 15th Dallas Circuit and System Conference (DCAS), Dallas, TX, USA, 2022, pp. 1-2, doi: 10.1109/DCAS53974.2022.9845621.
[5] G. Nikhil, T. Shikar, V. Manideep, and G. Radhika, "Coal Mine Safety System Using Wireless Sensor Networks and Arduino," International Journal of Innovative Research in Technology, vol. 9, no. 1, June 2022.
[6] S. S. Lakshmi, A. Dagar, N. Gupta, M. Kaur, and R. Gupta, "A Technical Review on IoT Based Mining Tracking and Safety Helmet," International Journal of Innovative Research in Computer Science & Technology (IJIRCST), vol. 9, issue 4, pp. 44-47, July 2021. [Online]. Available: https://doi.org/10.21276/ijircst.2021.9.4.11
[7] Druvanag P, Eaga Chandralekha, Gatla Niharika, Gavini Pranathi, and Nanda Kishore, "IOT Mining Tracking & Worker Safety Helmet," International Journal for Research in Applied Science & Engineering Technology (IJRASET), vol. 9, issue 5, May 2021. [Online]. Available: www.ijraset.com
[8] T. Eldemerdash, R. Abdulla, V. Jayapal, C. Nataraj, and M. K. Abbas, "IoT Based Smart Helmet for Mining Industry Application," International Journal of Advanced Science and Technology, vol. 29, no. 1, pp. 373-387, 2020. ISSN: 2005-4238.
[9] P. S. Tajane, S. B. Shelke, S. B. Sadgir, and A. N. Shelke, "IoT Mining Tracking & Worker Safety Helmet," International Research Journal of Engineering and Technology (IRJET), vol. 07, no. 04, pp. 5587, Apr 2020. e-ISSN: 2395-0056, p-ISSN: 2395-0072. [Online]. Available: www.irjet.net
[10] Hema, D. (2019). Smart Helmet for Industrial Workforce - A Review Paper. International Journal for Research in Applied Science and Engineering Technology.
[11] Jesudoss, A., Vybhavi, R. and Anusha, B., 2019, April. Design of smart helmet for accident avoidance. In 2019 International Conference on Communication and Signal Processing (ICCSP) (pp. 0774-0778). IEEE.
[12] R. Revindran, H. Vijayaraghavan and M. -Y. Huang, "Smart Helmets for Safety in Mining Industry," 2018 International Conference on Advances in Computing, Communications and Informatics (ICACCI), Bangalore, India, 2018, pp. 217-221, doi: 10.1109/ICACCI.2018.8554698.
[13] Jeong, M., Lee, H., Bae, M., Shin, D.B., Lim, S.H. and Lee, K.B., 2018, October. Development and application of the smart helmet for disaster and safety. In 2018 International Conference on Information and Communication Technology Convergence (ICTC) (pp. 1084-1089). IEEE.
[14] Ghulam E Mustafa Abro, Shoaib Ahmed Shaikh, "PROTOTYPING IOT BASED SMART WEARABLE JACKET DESIGN FOR SECURING THE LIFE OF COAL MINERS"2018 International Conference on Computing, Electronics & Communications Engineering (iCCECE)
[15] Jagadeesh R and R. Nagaraja, "IoT based Smart Helmet for unsafe event detection for mining industry," International Research Journal of Engineering and Technology (IRJET), vol. 04, no. 01, pp. 1487, Jan 2017. e-ISSN: 2395-0056, p-ISSN: 2395-0072. [Online]. Available: www.irjet.net
[16] Prof. K.S.Ingle 1, Nisha Dube 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.
[17] Gaidhane, Mahendra Dhame and Prof. Rizwana Qureshi "SMART HELMET FOR COAL MINERS USING ZIGBEE TECHNOLOGY" Imperial Journal of Interdisciplinary Research (IJIR) Vol-2, Issue-6, 2016 ISSN: 2454-1362
[18] C. J. Behr, A. Kumar and G. P. Hancke, "A smart helmet for air quality and hazardous event detection for the mining industry," 2016 IEEE International Conference on Industrial Technology (ICIT), Taipei, Taiwan, 2016, pp. 2026-2031, doi: 10.1109/ICIT.2016.7475079.
[19] Yongping Wu, Guo Feng, Zhang Meng,"THE STUDY ON COAL MINE USING THE BLUETOOTH WIRELESS TRANSMISSION" 2014 IEEE Workshop on Electronics, Computer and Applications.
[20] Warsha M.Choudhari Professor, Datta Meghe, "Coal Mine Security System " International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868 Foundation of Computer Science FCS, New York, USA Volume 4– No.10, December 2013.
[21] Jiya Tian, Juan Zhu, "POSITIONING SYSTEM FOR MINERS BASED ON RFID" 2011 International Conference on Multimedia Technology
[22] CHENG Qiang, SUN Ji-ping, ZHANG Zhe, ZHANG Fan "ZIGBEE BASED INTELLIGENT HELMET FOR COAL MINERS" World Congress on Computer Scienceand Information Engineering 2009
[23] Ghaith Bader Al-Suwaidi, Mohamed Jamal Zemerly, "LOCATING FRIENDS AND FAMILY USING MOBILE PHONES WITH GLOBAL POSITIONING SYSTEM (GPS)," IEEE/ACS International Conference on Computer Systems and Applications, 2009.
[24] D. Kock and J. W. Oberholzer, THE DEVELOPMENT AND APPLICATION OF ELECTRONIC TECHNOLOGY TO INCREASE HEALTH, SAFETY, and productivity inthe South African coal mining industry," IEEE Trans. on Industry Applications, vol. 33, no 1997.



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