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Safety Mining Helmet based on IOT

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ABSTRACT: Among all professions, mining is one of the riskiest. In some nations, there are no social or safety guarantees for underground miners, and they could be left to manage on their own in the event of an injury. Our improved communication technology, which must be used for an intelligent sensing and warning system in order to prevent all of these calamities, has been developed to address this problem. The communication inside the mines is done so using Wireless communication technology. 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. Once the poisonous gas is detected the helmet opening gets closed and the oxygen supply is provided within the helmet for the miners by the opening of solenoid valve of the oxygen cylinder. Panic switch is provided for the safety of the miners and it is used to provide alert signal to the control room during any emergency situations. 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. This paper presents the undertaken design detailing solutions to issues raised in previous research.

KEYWORDS: Node MCU, Safety, Data monitoring, Gas, temperature, and Light Sensors.

HISTORY: The evolution of the smart helmet can be traced back to the early 21st century, when advancements in technology and a growing emphasis on safety spurred innovation in various industries, including construction, manufacturing, and especially transportation. The concept of integrating technology into helmets to enhance safety and functionality gained momentum around the mid-2000s. Initially, these helmets were designed primarily for motorcyclists and cyclists, aiming to address issues like visibility, communication, and impact protection. One of the earliest forms of smart helmets featured built-in Bluetooth communication systems, allowing riders to make hands-free calls and listen to music while on the road. These helmets also incorporated LED lights for increased visibility and safety, particularly at night. As sensor technology and IoT connectivity became more sophisticated, smart helmets evolved to include features such as built-in cameras for recording rides, GPS navigation systems, and even heads-up displays (HUDs) that projected information directly onto the rider's visor. In the industrial sector, smart helmets emerged as a solution to improve worker safety in hazardous environments such as construction sites and factories. These helmets often include sensors to monitor environmental conditions like temperature, humidity, and gas levels, as well as built-in communication systems to facilitate real-time collaboration among workers. In recent years, the application of smart helmet technology has expanded to include other sectors such as sports, military, and emergency services. For example, smart helmets for athletes may feature biometric sensors to track performance metrics like heart rate and exertion levels, while military-grade smart helmets may incorporate advanced optics for enhanced situational awareness and target acquisition. Overall, the history of the smart helmet reflects a convergence of technological innovation and a growing emphasis on safety across various industries, with ongoing advancements continuing to shape the future of helmet design and functionality.

I. INTRODUCTION

In the mining industry, safety has long been a paramount concern, especially in subsurface operations where risks abound. Mining accidents, often fatal, occur with distressing frequency, with collapsing mining slopes being a leading cause. Recognizing the urgent need for enhanced safety measures, a novel approach employing IoT technology is proposed. By outfitting miners' helmets with sensor devices connected to a central monitoring system, potential dangers such as excessive headloads can be promptly detected and relayed to the appropriate authorities. This proactive system not only alerts management to individual miners in distress but also triggers collective responses, fostering a safer working environment. Furthermore, as the mining sector expands to meet the demands of growing economies like Pakistan's, ensuring the well-being of workers becomes increasingly imperative. With the incorporation of microcontroller-based circuits and Wi-Fi tracking systems into safety helmets, real-time monitoring and emergency response capabilities are bolstered. By addressing not only physical hazards but also environmental risks like toxic gas

exposure, this comprehensive approach underscores a commitment to safeguarding the lives and livelihoods of those laboring in the depths of the earth. In an industry where danger lurks at every turn, prioritizing security through innovative technologies is not just a necessity but a moral imperative. Moreover, the significance of safety extends beyond individual miners to the broader economic and environmental landscape. The mining sector's contribution to national economies cannot be overstated, yet its progress must not come at the expense of human lives or ecological integrity. By embracing IoT-driven safety measures, the industry demonstrates a commitment to responsible resource extraction and sustainable development. As new technologies emerge and global demand for raw materials continues to rise, integrating advanced safety protocols becomes not only a moral imperative but also a strategic advantage. Ultimately, by prioritizing the well-being of its workforce and the preservation of the environment, the mining sector can forge a path toward a safer, more sustainable future for all stakeholders involved.

II. MAIN OBJECTIVE OF THE PROJECT

1. **Safety Enhancement:** Smart helmets aim to improve safety for users by integrating features such as impact detection and notification systems, built-in lights for visibility, and communication capabilities to alert others in case of emergencies.
2. **Real-time Monitoring:** These helmets often include sensors to monitor environmental conditions, vital signs, or performance metrics in real-time, providing users with valuable data to optimize their activities and ensure their well-being.
3. **Communication:** Smart helmets enable seamless communication among users, whether it's through built-in intercom systems for motorcyclists, hands-free calling for cyclists, or team communication for workers in industrial settings.
4. **Information Access:** Smart helmets may incorporate heads-up displays (HUDs) or augmented reality (AR) technology to provide users with access to relevant information such as navigation directions, alerts, or visual cues without obstructing their field of view.
5. **Integration with IoT Ecosystem:** These helmets can be integrated into larger IoT ecosystems, allowing for data exchange and interoperability with other smart devices and systems, thereby enhancing overall functionality and connectivity.
6. **Customization and Personalization:** Smart helmets often offer customizable features and settings to cater to individual preferences and needs, providing users with a personalized experience tailored to their specific requirements.
7. **Performance Optimization:** In sports or industrial applications, smart helmets may include features to monitor and analyze performance metrics, offering insights to help users improve their skills, enhance productivity, or prevent injuries. Morse code-based authentication can be combined with other authentication factors, such as passwords or biometric data, to create a multi-factor authentication system that offers even greater security.

III. LITERATURE SURVEY

[1] Motivation for better development of communication infrastructure comes from coal mine accident. At the time of emergency accurate information of the environmental condition should provide with great ease to the rescue team & this can be achieved by proper communication. This paper discusses continuous monitoring of underground coal mine parameter like gases, temperature, humidity & vibration. The various parameter information is sense, collected and stored in microcontroller (ARM 7) using respective sensor. All this information send towards monitoring section. In the monitoring section there is one GUI created. Decision is taken accordingly through which mine worker are informed through buzzer One of the applications of WSN that is Zigbee protocol, IEEE 802.15.4 standard is used for communication. The communication between hardware circuit in coal mine and administrator done through the Zigbee. This system is adaptive & highly beneficial for rescue & protection.

[2] In this paper the research method of Mine Safety Monitoring System based on ZigBee is elaborated, and the hardware design of ZigBee sensor node and system software design are discussed. The self-organizing routing algorithm for ZigBee networks and the gateway design and systems integration are also studied. ZigBee based Mine Safety Monitoring System can achieve a variety of safety factors of production, and underground environment (such as gas, temperature, humidity and other environmental indicators) for monitoring, controlling mine production, and safety management.

[3] A cost effective ZigBee-based wireless mine supervising system is presented in this article. This scheme used intelligent helmets as voice terminal and ultra-low-power nodes of wireless sensor network. The programme adopted ZigBee wireless technology to build wireless sensor networks, realized real-time surveillance with early-warning intelligence on methane, temperature, humidity in mining area, and used speech communication to reduce potential safety problems in coal production.

[4] The underground mines everywhere the planet are adversely tormented by numerous hazards together with gassy explosions, landslides, fireplace hazards, etc. This results in the importance of safety for the mine staff. A stronger communication technology should be used for AN intelligent sensing and warning system. For this, RF technology is chosen for the communication within the mines. The wireless device network is provided for the sensing of adverse operating atmosphere conditions. Combining each these technologies, a brand new good helmet module is developed. The wireless device network consisting of assorted sensors senses mine atmosphere parameters like temperature, pressure, humidity, gases like paraffin, CO, etc. The measured parameters are processed and are used for an early intelligence warning system with the assistance of programmed alarm sounds, if there's any serious deviation from the conventional parameter price vary. The RF technology is additionally used as locating system, that helps in locating the mine-workers. This RF based mostly wireless device network is reliable with straightforward installation and quick sensing and locating system. the look provides 3 modules, specifically helmet module, localizer module, and room module. The helmet module contains of assorted sensors, microcontroller, antennas, encoders, decoders, etc. The helmet module acts as AN intelligent, low power node within the wireless device network. The room module contains antennas, PC, decoder, etc. The sensors won't to measure the variations within the temperature, humidity, pressure, fireplace and take selections for needed actions supported the measured knowledge to make sure the protection of the underground mine staff.

[5] A smart helmet has been developed that is able to detect of hazardous events in the mines industry. In the development of helmet, we have considered the four main types of hazard such as air quality, helmet removal, fire and mercury sensor. The first is the concentration level of the hazardous gases such as CO, SO₂, NO₂, and particulate matter. The second hazardous event was classified as a miner removing the mining helmet off their head.

[6] An intelligent 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 be fatal. LED miner's helmet is the most commonly used helmet because of light weight and low power consumption. However it does not improve the safety of miners apart from providing illumination. Zigbee wireless sensor networks are used to collect sensor data and transmit them. The zig bee 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 zig bee is used for transmission from miner to ground control system in case of hazardous events.

IV. METHODOLOGY

The methodology for developing a smart helmet involves a systematic approach encompassing design, technology integration, testing, and market deployment. Firstly, it's crucial to define the helmet's objectives, whether they be safety enhancement, communication capabilities, or navigation assistance. Next, thorough market research helps identify existing solutions and gaps in the market, guiding the conceptual design phase. This phase involves brainstorming and sketching to visualize the helmet's form factor, integrating feedback from potential users. Secondly, selecting appropriate technologies such as sensors, communication modules, and displays forms the core of the development process. Prototyping allows for iterative refinement, ensuring seamless integration of components while maintaining comfort and safety standards. Safety and user experience testing validate the helmet's performance across various scenarios, from impact resistance to user interface intuitiveness. Finally, successful prototypes transition to manufacturing, supported by marketing efforts to reach target audiences and establish the smart helmet as a reliable and desirable product. Ongoing support and continuous improvement based on user feedback and market trends ensure the smart helmet remains a cutting-edge solution in its field.

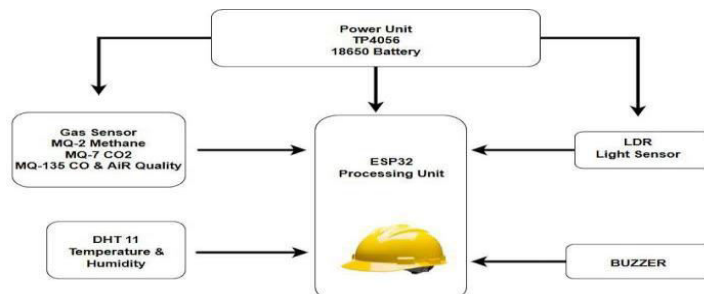


Fig 4.1: System Processing

The image depicts a smart helmet engineered specifically to enhance safety within coal mines. Equipped with a range of sensors including MQ-2 for methane detection, MQ-7 for carbon monoxide levels, and DHT 11 for temperature and humidity monitoring, it serves as a vigilant guardian against potential hazards. The incorporation of an ESP32 microprocessor enables efficient data processing, facilitating timely alarms through a buzzer mechanism upon detecting any perilous conditions. This innovative solution not only offers early warnings but also holds the promise of significantly enhancing safety protocols for coal miners, potentially averting accidents and ensuring a secure working environment.

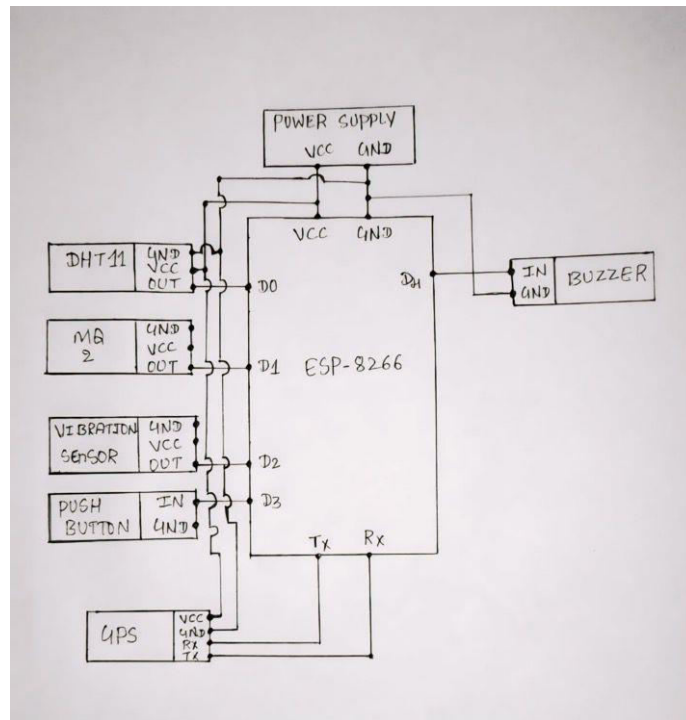


Fig 4.2: System Architecture

V. EXISTING SYSTEM

The existing safety helmet system in the mining industry relies heavily on basic protective gear that primarily shields miners from physical injuries such as falling objects and collisions. While effective in reducing immediate physical harm, these traditional helmets lack the technological advancements needed to address the complex and dynamic hazards present in modern mining environments. They do not offer real-time monitoring of critical environmental conditions like toxic gas levels, temperature, and humidity, which are essential for preventing accidents and health issues. Without these capabilities, miners remain at risk of exposure to hazardous conditions that could be mitigated with timely alerts.

VI. PROPOSED SYSTEM

The proposed safety mining helmet system aims to revolutionize miner safety by integrating advanced technological features to address the deficiencies of traditional helmets. This smart helmet will incorporate real-time environmental monitoring capabilities, including sensors to detect toxic gas levels, temperature, and humidity. These sensors will provide continuous, live data, enabling miners and safety teams to identify and respond to hazardous conditions promptly, significantly reducing the risk of accidents and health issues.

VII. APPLICATIONS

- Underground Mining: Protect from falling rocks, low ceilings, and debris. Built-in lights help in dark tunnels.
- Surface Mining: Shield workers from falling objects, machinery accidents, and harsh weather or chemicals.
- Blasting Operations: Provide protection from flying debris and shock waves during explosions.

- Rescue Operations: Communication systems and lights make them essential for rescue teams in dangerous conditions.
- Maintenance and Inspection: Protect workers from head injuries during equipment maintenance and inspections.

VIII. ADVANTAGES

- Head Protection: They shield the head from falling debris, low ceilings, and impacts, reducing serious injury risks.
- Built-in Lighting: Many helmets have built-in lights for hands-free illumination, essential in dark mines for better visibility and safety.
- Communication Systems: Some helmets include communication systems, allowing miners to stay in touch with each other and the surface for better coordination and emergency response.
- Durability: Made from tough materials, these helmets withstand harsh conditions like high temperatures, moisture, and chemicals, ensuring lasting protection.
- Comfort and Fit: Ergonomic designs with adjustable fittings and padding distribute weight evenly, providing comfort during long shifts and reducing fatigue and accidents.
- Safety Standards Compliance: Helmets meet specific safety standards and regulations, guaranteeing reliable protection.
- Integration with Other Safety Gear: They can be combined with other protective equipment like face shields, ear protection, and respiratory devices for complete safety.
- Reflective Strips: Reflective strips increase visibility in low-light conditions, helping to prevent accidents.

IX. CONCLUSION

safety mining helmets are indispensable tools in the mining industry, providing essential protection to miners in hazardous environments. These helmets offer a range of advantages, including protection from impacts, enhanced visibility, comfort, and compliance with safety standards. Their applications span across various tasks and roles within mining operations, from underground mining to surface mining, drilling and blasting, maintenance and repair, and emergency response. They safeguard against head injuries from falling debris, impacts, and harsh environmental conditions, while built-in features like lights and communication systems enhance visibility and coordination. By meeting rigorous safety standards and integrating with other protective gear, these helmets ensure comprehensive safety and comfort, significantly reducing the risk of accidents and injuries in the mining industry.

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