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Enhancing Safety in Coal Mines with Advanced Safety Helmets

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Abstract: Coal mining, which is essential for global energy production, poses significant safety challenges for miners working in hazardous environments. This project explores the development and integration of advanced safety helmets designed specifically for coal miners, using Atmega 328p and NodeMCU controllers. These innovative helmets offer comprehensive safety features, including hazardous gas detection, fall detection, health monitoring and real-time connectivity. The system includes sensors to detect gases such as carbon monoxide, monitor vital signs such as heart rate and blood oxygen levels, and track the miner's location using GPS. The helmets provide instant alerts and data transmission via a mobile app, enabling quick responses to emergency situations.

Keywords: Senors, Nodemcu, Gps, Arduino, Server.

I. INTRODUCTION

Coal mining has long been vital to the world's energy production. However, the success of the industry comes with a responsibility to ensure the safety and well-being of the miners who work in the harsh and challenging conditions below the earth's surface. In response to the dangers they face on a daily basis, a pioneering solution has emerged: the development and integration of advanced safety helmets designed specifically for coal miners.

Our project embarks on a comprehensive exploration of protective helmets equipped with advanced technologies designed to protect and improve the lives of miners. We will explore current safety issues in coal mining, the unique challenges miners face and how innovative hard hats powered by Atmega 328p and NodeMCU controllers can change their safety standards. the development of advanced safety helmets for miners, powered by Atmega 328p and NodeMCU controllers, represents a giant leap forward in miner safety. These helmets are not just protective equipment, but intelligent companions that save lives and are designed to meet the unique challenges faced by coal miners. With integrated gas detection, fall detection, health monitoring and real-time connectivity, they redefine safety and emergency response standards in the coal mining industry. These innovations are a testament to our commitment to protecting the lives of those who work underground and ensuring they return safely to their loved ones after each shift..

II. RELATED WORKS

Hazardous gases such as propane and methane are flammable and can cause an explosion if confined in a tight room. The study described in this article includes a system that includes the detection and notification of hazardous gases present in the area. The system has three sensors; a hydrogen sensor, a liquefied petroleum gas (LPG) sensor, and a methane sensor that serve as switches with different setpoints. Each detected gas level is sent to the Arduino, which serves as a regulator that analyzes the level of gas present. This system provides early detection of hazardous gases and allows occupants to take necessary action or evacuate the area before dangerous levels are reached[1].

Safety plays a key role in today's world and it is imperative that noble safety systems are practiced in the workplace and in education. Even the slightest carelessness can pave the way for a large- scale environmental disaster. India has already witnessed such a deadly disaster that claimed the lives of thousands and plunged other lives into complete darkness.

The idea of TB Harivishnu was born as a measure that could reduce the impact of such disasters in the future. Here, a device was designed that could detect the presence of harmful gases and indicate if the amount of polluting gases exceeded a certain limit. The device can play a very important role because it can be implemented in any industry where there is a possibility of releasing these polluting gases, and it can also be connected to the exhaust pipe of vehicles.

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Assess the device's sensitivity to different gases and its specificity in distinguishing between different types of harmful gases to ensure accurate detection. Evaluate the system's ability to provide early warnings before gas concentrations reach dangerous levels, allowing for early preventive action. Using sensors, the system offers real-time monitoring of gas levels, enabling immediate response to changing conditions. Current Research Consider how well the equipment adapts to different industrial settings or exhaust systems, taking into account variations in gas types and concentrations[2].

Assistance services in medical scenarios are constantly expanding, said falls have proven to be the second leading cause of involuntary death in the world according to the World Health Organization. According to statistics, adults over the age of 65-70 are most likely to be the victims of fatal falls. Therefore, it is necessary for the elderly and some patients to develop a fall detection system with the help of technology and the simplicity of daily life to improve the quality of life. It keeps pace with existing systems and to increase fall prevention, this fall detection system provides results in less time and in a more precisely specified manner. We use a host chair with a connected Internet of Things. (IoT) based device to sense and monitor the required critical factors. The novelty of this project goes hand in hand with the automation of aspectsof the fall detection process, the fall notification, the display of the requested update in the application, and the familiarization of the user. Assistance services in medical scenarios are constantly expanding, and falls are the second leading cause of unintentional injury deaths worldwide, according to the World Health Organization. According to statistics, adults over the age of 65-70 are most likely to be the victims of fatal falls. Therefore, it is necessary for the elderly and some patients to develop a fall detection system with the help of technology and the simplicity of daily life to improve the quality of life. It keeps pace with existing systems and to increase fall prevention, this fall detection system provides results in less time and in a more precisely specified manner[3].

Falls are one of the leading causes of injury and death in older people aged 65 and also in industry. A fall detection system is essential for identifying fall activities outside of activities of daily living. Although new methods have shown the research paper, thenumber of studies in vision-based systems is still growing. However, existing vision-based fall detection systems have many weaknesses that need to be generalized, especially due to difficulties such as different physical appearances, different camera viewpoints, occlusion, background clutter, and darkness. The position of a person's head and upper body provides critical information at the time of a fall. This paper presents a vision-based fall tracking method where the joints of the upper body are grouped into one segment to increase the fall classification ratio. The segment consists of combinations of head and shoulder joints representing the upper region and the head region. The segmentation method can be beneficial to achieve effective human activity tracking and provide a powerful technique for distinguishing falls from activities of daily living[4].

Falling is one of the most serious accidents for the elderly and it can happen at any time. As the population ages, the urgent need to develop fall detection systemsis inevitable. Fall detection and monitoring is an active area of research, so this thesis used available research advances and public datasets as a springboard for a senior year project. There were two main goals in this work, to develop a fall detection algorithm and to build a wearable fall detection device. A public dataset was used to test the performance of this threshold classifier. The developed algorithm had 86.95% sensitivity, 96.08% specificity and 90.83% accuracy.The chosen thresholds were later programmed into the on-board hardware. Jayanth; M.B. Poorvi et al[5].

Medicinesare a primitive solution to the prevention and treatment of most diseases. A number of high-risk diseases can be cured and prevented with the right medicines. The main goal of our proposed system is to provide a user-friendly design that patients can use as a reminder to take their daily medication on time. Prevention and early intervention: By notifyingthe user of significant changes in heart rate, the device contributes to the prevention and early intervention of potential health problems. Priyanka kumari et al[6].

In general, the human body provides information about its health on a regular basis. However, data is available through devices that measure or detect the amount and variation in certain areas of the body. Health professionals use the principles of medical decision-making in diagnosis and management to improve the health of patients. Access to comprehensive health data enables personalized and targeted treatment plans, optimizing the effectiveness of interventions and drugs Prevention and early intervention: By alerting the user to significant changes in heart rate, the device contributes to the prevention and early intervention of potential health problems[7].

The IoT-based health monitoring system enhances communication between patients and healthcare providers, fostering a more collaborative approach to healthcare management. continuous monitoring of vital health parameters like temperature, blood pressure, and sugar levels, providing real-time data for a comprehensive health assessment.

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group of registered users and a central server using a GSM module via SMS and AT commands. The system provides continuous, real-time tracking using GPS technology, allowing for accurate location monitoring of the device. Utilizing a GSM module for communication ensures reliable and widespread coverage for sending location data via SMS, enhancing the system's reach[8].

Medicines are the primitive solution for the prevention and cure for most of the diseases. Many risky diseases can be cured and prevented with the use of proper medication. The main objective of our proposed system, is to ensure a user friendly design that the patients can use as a reminder alert to take their daily medications on time. The use of IoT technology and real-time GPS data enables paramedic services to navigate through traffic more efficiently, reducing response times and reaching patients in critical conditions faster. Issuing unique IDs and passwords enhances the security of the system, restricting access to authorized paramedic officials and preventing unauthorized individuals from tampering with or accessing sensitive data[9].

The HEALTH MONITORING SYSTEM' structure is valued for the particular viewpoints and the decisions are made on the data which are obtained from the source are relied upon to do the survey. The IoT-based health monitoring system enhances communication between patients and healthcare providers, fostering a more collaborative approach to healthcare management. IoT devices enable continuous monitoring of vital health parameters like temperature, blood pressure, and sugar levels, providing real-time data for a comprehensive health assessment[10].

III. METHODOLOGY

The proposed system the following methodology:

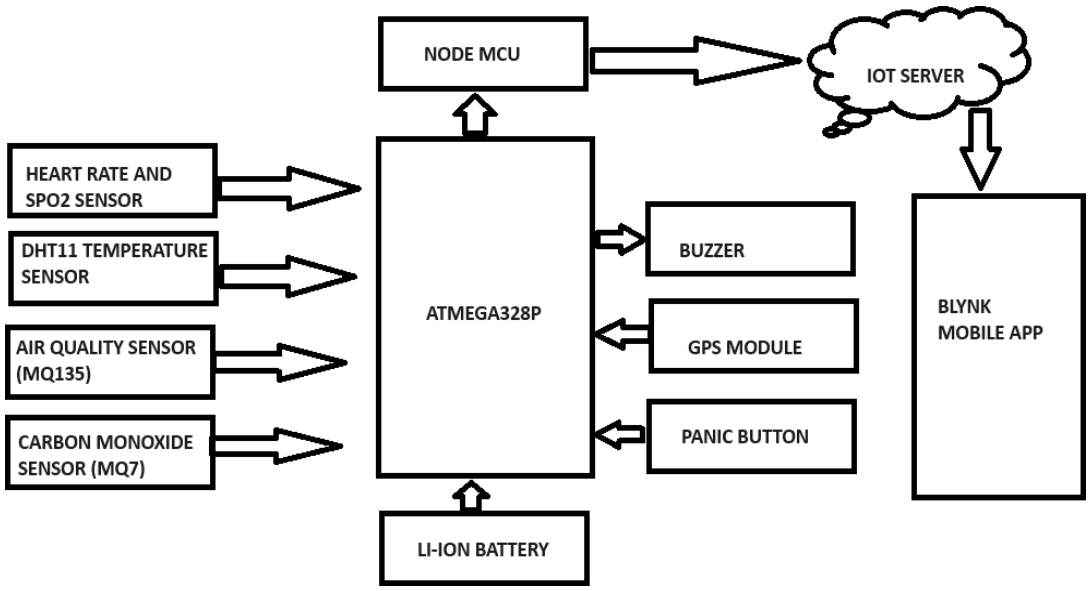

Figure 1.1: Block Diagram

Hazard Gas Detection and Alert System: The heart of the helmet's safety system is the hazardous gas detection module and the warning module. Atmega 328p is responsible for processing data from gas sensors that are carefully placed in the helmet. These sensors are calibrated to detect air quality, carbon monoxide and warn when they are out of range.

Accelerometer Interface for Fall Detection and Alert: If irregularities or abnormal heart rates are detected, such as a sudden increase or decrease, the helmet activates an alert. These notifications are transmitted to the mobile application via the NodeMCU and an audible alarm is activated in the helmet.

Heart Beat Measurement and Abnormality Detection: If irregularities or abnormal heart rates are detected, such as a sudden increase or decrease, the helmet activates an alert. These alerts are transmitted to the mobile app via NodeMCU and an audible alarm is activated within the helmet.

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GPS Location Tracking: In emergency situations such as falls or gas leaks, this feature becomes invaluable in quickly locating miners and facilitating rescue efforts.

SOS Panic Emergency Button: The panic signal is communicated via the NodeMCU to the central system, which then transmits the warning to the appropriate responders. At the same time, the helmet emits a loud and distinctive alarm for fellow miners in close proximity.

Real-time monitoring with IoT mobile app: The NodeMCU controller provides IoT connectivity for real- time monitoring through a dedicated blynk mobile app. Miners and security personnel have access to a wealth of data, including gas levels, heart rate, blood oxygen and GPS locations.

Ambient temperature measurement: The helmet is equipped with ambient temperature sensors, which ensures the comfort and safety of miners. The Atmega 328p is responsible for monitoring the temperature and humidity levels in the mine**.**

Oxygen Measurement and Low Oxygen Alert: Oxygen levels in the mine can fluctuate and affect miners' miners' health. The helmet is equipped with a blood oxygen sensor and warning system that ensures miners are notified of any abnormalities in oxygen levels.

IV. RESULT AND DISCUSSION

The diagram represents the system architecture where the ATmega328P microcontroller is the central element of the operation. It interfaces with various sensors and modules to monitor environmental and health conditions. The system is powered by a Li-Ion battery, ensuring portability and independence from permanent energy sources.

Sensors attached to the microcontroller include a heart rate and SPO2 sensor that measures vital signs, a DHT11 temperature sensor that monitors ambient temperature, an air quality sensor (MQ135) that checks for pollutants in the air, and a carbon monoxide sensor (MQ7). which specifically detects the presence of carbon monoxide. These sensors continuously feed data to the ATmega328P which processes the inputs.

In addition, the system includes a GPS module that provides location data, an emergency button for emergency situations, and a buzzer for audible alerts. The NodeMCU module is used for network connectivity and allows the system to communicate with the IoT server. This server likely processes and stores data, allowing users to monitor conditions remotely via the Blynk mobile app. The Blynk platform provides a user-friendly interface to monitor and control the system in real-time, making it accessible through smartphones.Overall, the system appears to be designed for health and environmental monitoring, possibly for use in safety-critical applications where real- time data and alerts are essential.

V. CONCLUSION

The development of advanced safety helmets for miners represents a significant advance in the field of miner safety. By integrating technologies such as real-time hazardous gas detection, fall detection, health monitoring, GPS tracking and emergency warning systems, these helmets go beyond their traditional role as protective equipment. They are becoming intelligent, life-saving devices that address the unique risks miners face.

The combination of Atmega 328p and NodeMCU controllers in these helmets ensures that miners are always connected, monitored and protected, even in the most demanding environments. This innovation not only increases the immediate safety of coal miners, but also sets a new standard for the industry, ensuring that those who work underground can do so with greater peace of mind.

FUTURE ENACEMENT

Incorporate more advanced sensors to detect a wider range of hazardous gases and environmental conditions, providing more comprehensive monitoring. to faster and more reliable communication technologies such as 5G to ensure uninterrupted data transmission and real-time alerts. Develop longer-lasting and more efficient battery systems to ensure helmets can operate for longer periods of time without the need for frequent recharging Implement AI and machine learning algorithms to predict potential hazards based on trends in sensor data, enabling proactive safety measures and decision- making. Analyze equipment data to predict failures and plan maintenance.

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