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Advanced Wireless Multipurpose Mine Detection Robot

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Abstract: The tasks involved in rescue operations in coal mines are hazardous and life-threatening. Many explosions take place from time to time, but the miners are not aware of them. It is also very difficult for the rescue squad to comprehend the situation within the mine. Hazardous gases, high temperatures, methane leaks, and low oxygen levels are examples of environmental issues. An environmental monitoring robot system for remote sensing in coal mines is introduced in this study. This robot system is designed to remotely collect information about the coal mine's surroundings, in addition to performing observational tasks. As a result, this device can be thought of as a multifunctional sensor that enables distant sensing. When it senses danger, the robot system will send out signals warning rescuers to keep their distance. Lessons from the creation of the robot system may be applied to the development of future search-and-rescue systems.
Keywords: coal mining, internet of things, environment monitoring, gas sensor, multipurpose coal mining robot

I. INTRODUCTION

The demand for raw resources has significantly increased in recent years. Since there are no more resources that can be accessed easily, we must keep digging deeper and deeper to uncover the Earth's undiscovered treasures. The majority of people despise and revere miners and consider mining to be risky and dangerous. Modern successful mining, however, depends more on cutting-edge technology than it does on magic. Modern mining must employ new technologies due to the demand for more resources, the difficult conditions in deep mines, and the global competition over output costs.

The Mine Magazine recently published a list of ten new technologies that have the potential to revolutionise the mining industry. Robotics, predictive maintenance, remote operating and monitoring centres, and sophisticated analytics have all been selected as components of the mining industry's future. Despite the fact that the term "deep underground mining" is general, each mine is distinct and depends on a number of elements, including the geology, the type of raw material used, the geometry of the deposit, the technology used, the size of the mine, the equipment used, and the presence of natural hazards (such as poisonous gases and a propensity for rock bursts). Every sophisticated answer should be customised for the use case being taken into account. In the deep underground copper ore mine we are considering, the majority of the technologies mentioned have been or are being used. One of the most challenging jobs is to maintain an ore transport network built on belt conveyors that is spatially distributed over a very large area. Getting the gas information for the rescuers is the most vital responsibility. The rescuers can move ahead and reach the robots if there are no threats, at which point they can activate the robot to begin the rescue. When the rescuers learn about the hazardous environment, it will alert them to the need for preparation. The rescuers will be significantly safer as a result of this.

Designing a robot system that can tackle a range of issues, including explosion-proof and waterproof design, barrier penetration, gas detection, data transmission, and more, presents significant challenges in coal mining. Despite these difficulties, coal mine monitoring systems have been developed in recent years, and some robots have received safety certification for use in mining.

To ensure the security of the area, the monitoring system places numerous sensors on a robotic vehicle. The car has a number of sensors and travels along a predetermined route. It works in a predetermined area, stopping at particular locations when sounds are heard, and then moving on. Using a variety of sensors, the vehicle continuously scans each location for possible issues such as gas leaks or mining accidents. We conclude by recommending the use of a completely autonomous security robot to continuously patrol large areas and maintain facility security.

II. LITERATURE REVIEW

Traditional safety precautions like sensors and switches might not be sufficient to protect workers in ports, particularly for those who are more at risk because of their line of work. This article proposes a novel warning system that combines smart alarm technology, the Internet of Things (IoT), and radio frequency identification (RFID). Each employee would be given an RFID tag holding their personal information as part of the system, which would also include a system that tracks their movements and can sound an alarm if a worker is in danger.

In this piece, we'll talk about a safety system that keeps an eye on employees in real time and looks for any threats. A wearable data observation device, a data processing device, and a remote tracking and control station make up the system. [3].

The paper focuses on one particular application of this system, a smart helmet system made for underground coal miners. The smart helmet system can track extremely risky conditions like humidity, temperature, and airborne gas constituents like sulphur dioxide and methane in real time. The system's goal is to protect employees by giving them timely information about the conditions in the mines and warning them of any dangers. [4][5].

The safety system described in this article is especially crucial because going above a certain threshold for a particular parameter can lead to dangerous circumstances like choking, suffocation, flooding, gas poisoning, mine collapses, or explosions. In order to avoid such occurrences, the system constantly monitors these parameters using small sensors and radio frequency modules, and in the event of any alarming changes in the parameters, buzzers are used to send alerts to both ground control and workers. The system is particularly important in underground coal mining, where employees are subjected to high levels of psychological and physical stress, which can result in subpar performance and dangerous operations that could even be fatal. Therefore, the smart helmet's real-time monitoring and alert system can help reduce these risks and increase the safety of employees in dangerous settings. [6].

The article mainly concentrates on the execution of the worker's health parameters which are based on the individual health factors such as Body Mass Index (BMI), sleeping time and duration of sleep, age, chronic sickness, family related issues, as well as problems related to workplace such as type of work, duration of work and perception of maximum injury shift. This gives an indication that a worker who performs different tasks is more likely to experience different injuries, with older workers experiencing more injuries as compared to the younger workers. The study also found out that workers who have a disturbed sleep cycle or workers who get fewer sleep are more likely to experience different types of injuries such as puncture and scraping injuries. Also, the people coming from rural areas or rural backgrounds, who work in various industries and factories, such as pharmacies, textiles and mines are more exposed to dust and are at a higher risk of getting fatal diseases. The laborers also migrate to different places in search of work in order to feed their families. Overall, the execution of the worker's health parameters becomes a crucial part in order to ensure the safety of workers in different workplaces and to provide vital information on how to reduce injuries at a workplace and promote a better environment and well-being among workers. [7][8].

In order to resolve the lack of information issue about the risks and dangers related to workplaces, a real-time worker's health monitoring system has been developed. This system along with tracking the health of workers also provides information about those who have used the sick and disability benefits, along with the data on notable diseases. In addition to health tracking, the system also measures and alerts workers to the presence of toxic gases, such as H2S, CO, and methane, which can form in drainage and unused wells. The gas measurement and alerting system is designed to quickly detect the presence of these dangerous gases and present the information on an LCD screen in real-time. This provides workers with valuable information that can help them avoid hazardous situations and prevent potential health problems. [9].

The system indicates the levels of toxic gases such as H2S. CO and methane and if the levels of these toxic gases exceed a certain limit, an alert is generated and is sent to the assigned person through GSM, also an alarm is activated immediately. The aim is to provide an immediate and proper response to emergency situations by converting the toxic gases into clean air by diffusing it. A trash alerting system is developed to further reduce the air pollution in the environment. Using the Wi-fi module the parameters of the gas sensor can be monitored intensively using handset applications. This system can be of great use for the development of smart cities and can reduce the mortality rates of humans by providing early warning of hazardous situations and preventing exposure to toxic gases. [10].

III. METHODOLOGY

This architecture will be fixed with some sensors like temperature sensor, gas sensor, humidity sensor. We have used DHT 11 sensor for temperature and humidity measurement. This sensor has a temperature range of 0 – 50 Degree Celsius and can measure 20% - 80% relative humidity precisely. We have also used the MQ2 Gas sensor which allows easy and accurate detection of Propane, Hydrogen, Methane and other combustible steam. All these sensors are interfaced with Arduino UNO and parameters values are displayed on server through Thingspeak API. Thingspeak is an IOT-platform which allows users to analyse data in the cloud. Through serial communication Arduino is transferring information to Node MCU and then using Thingspeak the same information is transferred to Thingspeak database. Node MCU is an open-source prototyping board which has 17 General Purpose Input-Output Pins (GPIO). The Node MCU is controlling the motor driver through the GPIO pins and through that four motions are executed that are right rotation, left rotation, forward and backward. And the command for the motion is been received by the Node MCU who is acting as a server as GET request from the server.

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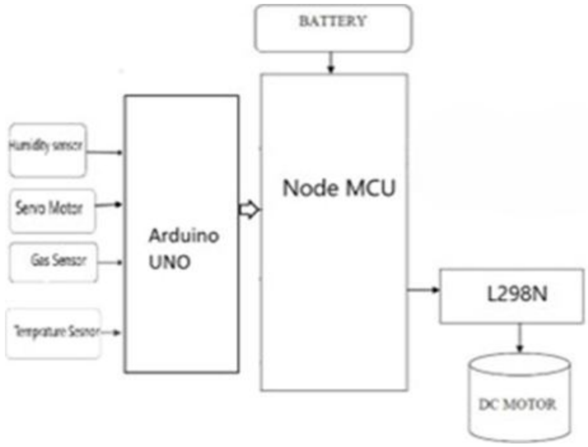

Fig. 1. Block Diagram

Fig. 1 shows the block diagram wherein we can see the main components we have used are Arduino UNO and Node MCU. The inputs to the Arduino uno are the humidity sensor DTH-11, the gas sensor and temperature sensor. And the output is through the cam module and the dc motor.

IV. RESULTS AND DISCUSSIONS

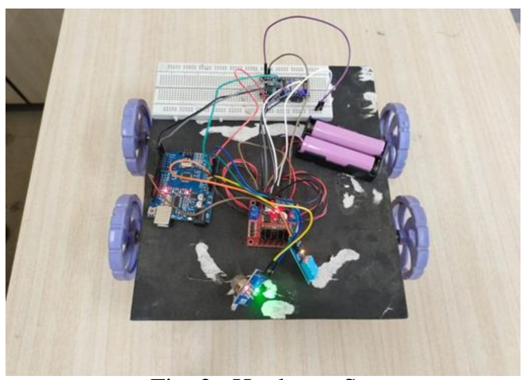

Fig. 2. Hardware Setup

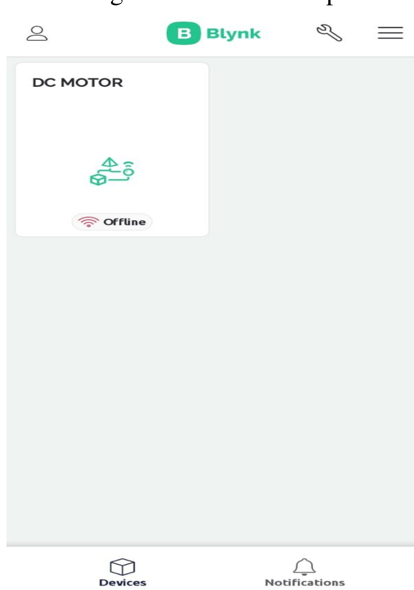

Fig 3. Application Interface

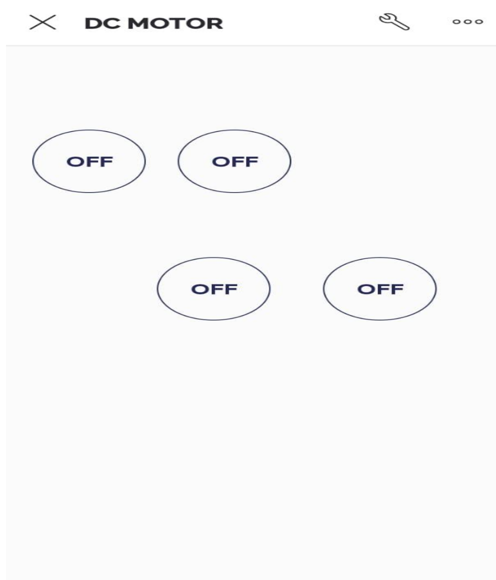

Fig. 4. Operational modes of the vehicle

The hardware was successfully implemented. Fig. 2 shows the hardware implementation of the project in which all the components are mounted on the robot vehicle. Fig. 3 shows the user interface of the application which shows the status of the connection i.e., online or offline with notifications. Fig. 4 shows the operational modes of the robot i.e., on or off. The four buttons represent the four wheels of the robot. Number of wheels can be selected which can be turned on or off as per the need of the user. This particular figure shows that all the buttons are turned on and the robot is running.

V. CONCLUSION AND FUTURE SCOPE

The applications of wireless network devices can improve the protection of coal mines drastically. The wireless networks additional provide versatility, avoid rewiring and also greatly improve the performance and transmission of the coal mine safety system. During the application, we tend towards storing the values of the parameters within the server, however the keep values may not be able to notice the hazards before they happen. When we provide this data to the personnel overseeing the safety in the mines, it will be extremely helpful for them to avoid loss of life. Further enhancements and modifications can be made to make the system autonomous and robust. Accuracy of the system can be increased by makAing use of more powerful sensors like DHT 22 Temperature And Humidity sensor. ESP CAM 32 Module can also be integrated in the system, which will be able to provide real-time imaging. GPS Module can also be used to acquire real-time co-ordinates of our robot.

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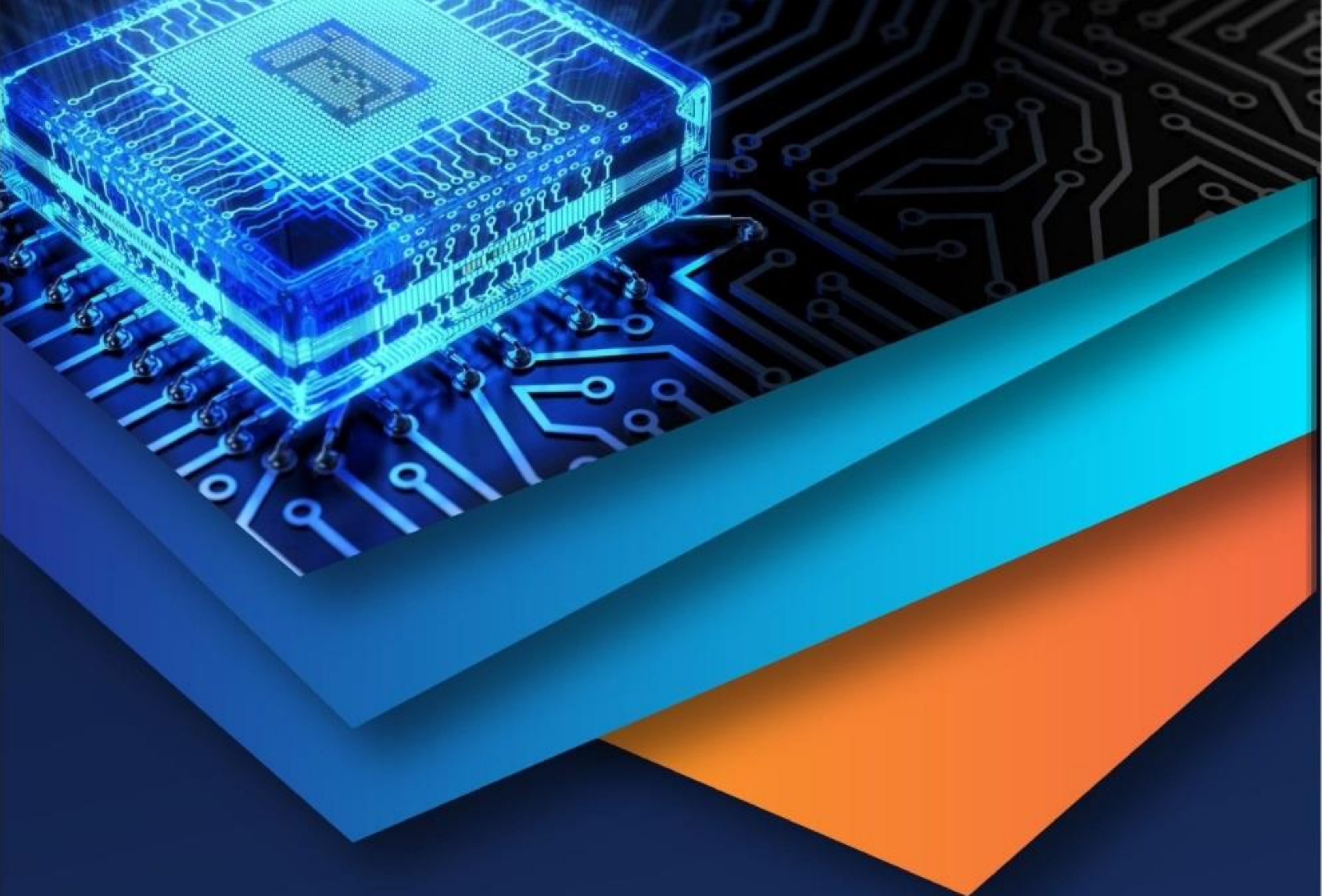

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