iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** IX **Month of publication:** September 2023

DOI: https://doi.org/10.22214/ijraset.2023.55758

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IX Sep 2023- Available at www.ijraset.com

Smart Helmet for Miners

Nilesh Vishwakarma[1], Aayushi Singh[2], Surabhi Yadav[3], Anuj Myageri[4], Prof. Shyamsundar Magar[5]
Department of Information Technology Engineering, Terna Engineering College, Navi Mumbai, India

Abstract: ***Smart helmet for miners offers a device for the coal mine workers which is easy to use and reliable. This device includes a basic monitoring system, which monitors the environment of the mine and help us know if it is suitable for miner to works in or not. The monitoring system installed on the m=helmet help us to collect the live data from the mine using radio transmission and this data is then transferred to the admin side for analysis and to monitor it briefly. The helmet id also installed with a GPS tracker, which would help us to locate the miner during the time of any accident or calamities. The accuracy of information is of the utmost, which helps us to safeguard the miner's life. This device also includes a panic button, which can be used by the miner to alert the workers outside in case of any emergency.***
Keywords: Coal mines, Sensors, Safety, Miners, Smart Helmet, Internet of Thing (IoT).

I. INTRODUCTION

Mining plays a pivotal role in any country's economy, offering numerous opportunities across various sectors. Our society greatly benefits from the materials and products extracted through mining processes. In the past, coal miners worked under harsh conditions, with minimal protection and rudimentary tools.

Today, the mining industry remains a cornerstone of development, responsible for uncovering and extracting valuable resources like iron, gold, coal, and diamonds. Safety stands as a paramount concern in any industry, but especially in mining. Rigorous safety measures are adhered to, utilizing advanced technology to monitor factors like temperature, humidity, and gas levels through sensors.

These measures mitigate potential hazards, triggering alerts via buzzers to avert accidents. India, for instance, houses approximately 11 coal mines, facing elevated safety risks due to ventilation issues, gas exposure, rockfalls, and head injuries.

To address these challenges, we've developed an IoT-based Smart Helmet for miners. This innovative solution incorporates an array of sensors to monitor miners' health, ambient temperature, and gas concentrations. These features are pivotal in preventing accidents and promoting a safer work environment.

The integration of IoT technology within mining operations has transformative potential, offering real-time data for informed decision-making and proactive safety protocols. The helmet's built-in interface allows supervisors to monitor miners' well-being effectively.

While embracing IoT's advantages, it's crucial to ensure sensor reliability, user-friendliness, and the helmet's overall durability within the demanding mining setting. Regular maintenance will be essential to sustain the system's functionality.

In essence, the IoT-based Smart Helmet holds promise for revolutionizing miner safety and productivity. It showcases how technology can be harnessed to elevate safety standards, enhance operational efficiency, and contribute to the overall growth of the mining sector.

II. LITERATURE SURVEY

A. "Intelligent safety system for coal miners" by Beena M Varghrese, Binisha Balan - 2021

The paper has proposed a system that help coal miners, by sensing the undesirable environmental parameters like temperature, humidity and methane gas inside the coal mine and could communicate efficiently through a most reliable and cost-effective wireless communication system. The main objective of this research is to provide a feasible solution to miners for their safety. By properly fixing appropriate power ratings, this model is expected to fit for practical industrial applications.

B. Iot Based Intelligent Helmet for Miners by Jeya Seelan S, Krittika J - 2021

The problem of alerting the miners during emergency is solved in the above mentioned paper. The sensors in the miners helmet monitors all the information and in case of emergency Buzzer is Activated and the rescue protocol is followed. Technology like ZigBee, XBee and sensors like gas sensor, temperature sensor and heart rate sensor is used along with Buzzer is used. Technology

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C. A Smart Helmet for the mining industry using LoRaWAN by G Pradeepkumar S Sanjay Rahul - 2021

In this proposed work, smart helmet for mining industry using LoRaWAN had developed, which comprises a quality device that keeps the user alert on air quality. The obtained results figure out that the proposed system performs good for the people working in mines.

D. A Survey of LoRaWAN for IoT: From Technology to Application by Jetmir Haxhibeqiri, EliDe Poorter - 2018

In this proposed work, an overview and complete analysis of SWOT analysis of LoRaWAN is done. In this paper, a literature review for LoRa and LoRaWAN is presented. It includes the most relevant papers published between 2015 and September 2018 regarding LoRa and LoRaWAN technological aspects and improvements.

E. Iot Based Coal Mine Safety and Health Monitoring System using LoRaWAN by T. Porselvi Sai Ganesh CS - 2021

This paper tells us about how a smart alert system is implemented using various sensors, for the safety of mineworkers by alerting themat the right time to escape from the mining environment in case of any accidents. Various Technologies like LPWAN, LoRaWAN and sensors like smoke sensor are used.

III. PROBLEM STATEMENT

The problem with the current situation is lack of medical support due to the inadequate and un-timely assistance required by the miners. When inside the mines, it is very difficult to alert the managers in time about the conditions below leading to major life threat to the miners. Research so far in the area of safety has revealed that the majority of incidents in this hazardous industry take place because of human error, the control of which would enhance safety levels in working sites to a considerable extent.

IV. PROPOSED SOLUTION

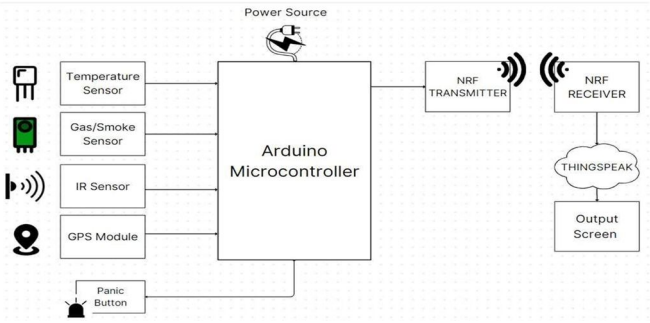


Figure 4.1: Block Diagram of proposed System

We have incorporated several key sensors: a temperature sensor, an IR sensor, and a gas/smoke sensor. The temperature sensor tracks the mine's temperature, providing precise insight into the miner's working conditions. Monitoring gases within the mine, the gas sensor alerts us to the presence of harmful substances. The IR sensor identifies and measures infrared radiation in the mine's vicinity. Among these sensors, a panic button is linked to the microcontroller. Utilizing a GPS module, the miner's location is pinpointed with an accuracy of up to 50 meters. The Arduino Microcontroller gathers data from these sensors and forwards it to an NRF Module. This module, functioning as a radio transceiver, facilitates data exchange between sources through radio transmission. One NRF module is attached to the miner's microcontroller to gather sensor data, while another NRF module at the administrator's end receives and showcases the data transmitted by the first NRF module. The end results will be displayed on a web page on the admin’s side. The real time data gets updated as the activity continues in the coal mines.

V. EXPERIMENTAL SETUP

The helmet employed by miners is adapted for this purpose. A plastic enclosure, affixed to the helmet, houses both sensors and a communication module. This system is bifurcated into two main components: the transmission module and the receiving module. The container housing the data transfer module and data-collecting sensors is distinct and attached to the helmet. The complementary receiving module is positioned on the administrator's side, responsible for receiving all transmitted and collected data.



Figure 5.1: Setup



Figure 5.2: Setup

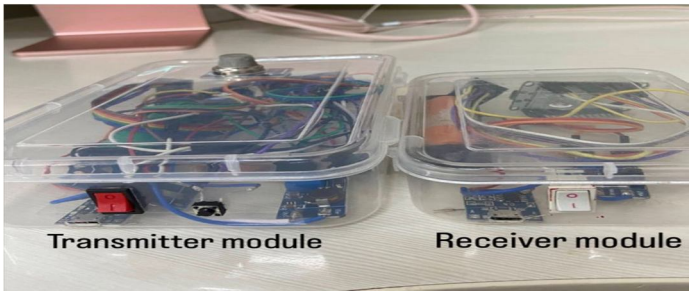


Figure 5.3: Setup

A. User Interface Design

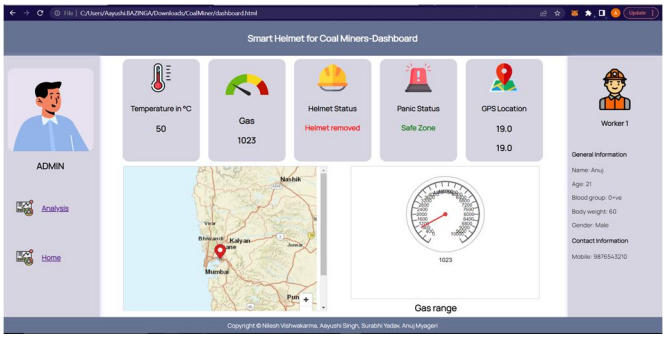


Figure 5.1.1: Admin Dashboard.

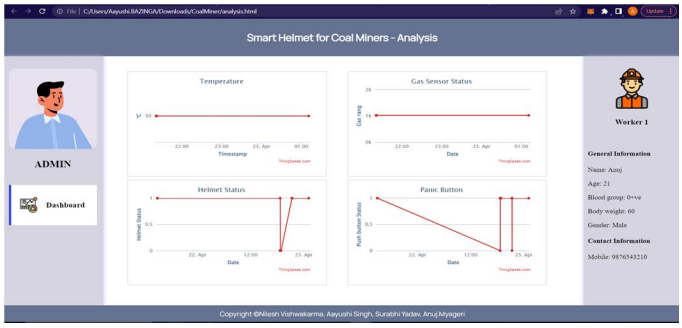


Figure 5.1.2: Admin Visual Analysis Page.

VI. IMPLEMENTATION

A. Hardware

The hardware components used are as follows:

1) Arduino Uno

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

2) LM35 Temperature Sensor

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. It can measure temperature from -55 degree Celsius to +150 degree Celsius. The voltage output of the LM35 increases 10mV per degree Celsius rise in temperature. LM35 can be operated from a 5V supply and the stand by current is less than 60uA.

3) MQ-6 Gas Sensor

The MQ-6 gas sensor is used to detect gas such as LPG and Butane. MQ-6 gas sensor is made up of Al2CO3ceramic tube with SnO2 layer. Generally, it is consists of 4 pins to work with. A digital pin is attached to it which can visualize the analog output as a digital value by altering the potentiometer embedded in it.

4) IR Sensor

The IR sensor, also known as infrared sensor, is a device that emits or detects IR radiation to determine specific properties in its surroundings. It consists of an emitter and detector LED in which IR LED (Light Emitting Diode) acts as emitter, and IR photodiode as detector. Photodiode detects IR light of the same wavelength that the IR LED emits.

5) GPS Module

The Global Positioning System (GPS) is a navigation system that uses satellite for tracking and gives users information about location and time. The position of a GPS receiver is calculated by accurately timing the signals sent by GPS satellites.

6) NRF Module

NRF24L01 is a radio transceiver module (SPI protocol) used to send and receive data at ISM operating frequency from 2.4 to 2.5 GHz where each module can send and receive data. It operates on the 2.4 GHz ISM band. This module can cover 100 meters (200 feet) when operated efficiently.

B. Software

1) ThingSpeak

ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize, and analyse live data streams in the cloud. You can send data to ThingSpeak from your devices, create instant visualization of live data, and send alerts. You can also analyse and visualize your data with MATLAB or other software.

VII. RESULTS AND DISCUSSIONS

The data collected from the sensors is transferred to the admin side using the NRF transmitter. The data collected at the admin side is then analysed and displayed in ThingSpeak, from where it is displayed on a web application.

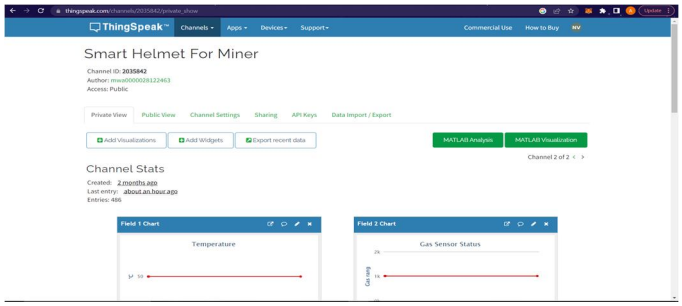


Figure 7.1: ThingSpeak page and result

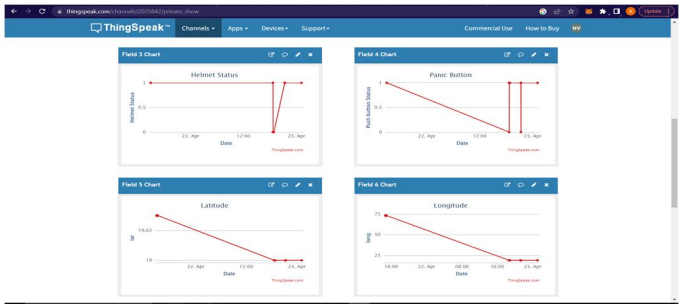


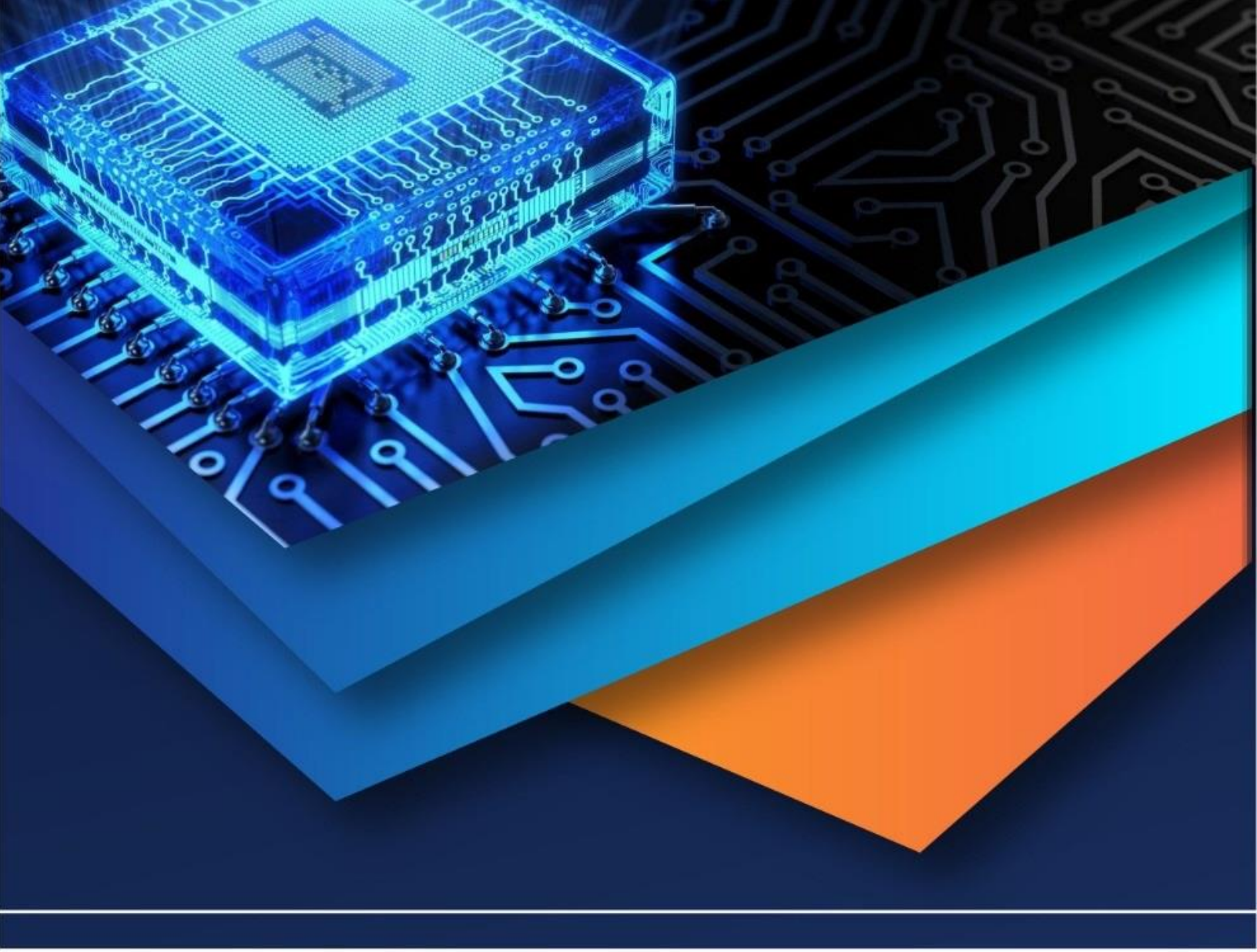
Figure 7.2: ThingSpeak page and result

VIII. CONCLUSION

The smart helmet for miners has been designed specifically for coal miners. The helmet is capable of detecting a range of events that occur inside the mines, the events that could be dangerous for the life of a miner. Some events and accidents go unrecognized by the workers outside the mines because of lack of information of what goes under the mine. The helmet will help the workers outside the mine to keep a close eye on what is the condition under the mine and if it is suitable for a miner to work under or not. The helmet gives a live status of different parameters like temperature under the mine, presence of any poisonous gases. Along with this the helmet has a GPS module, so that one can easily locate the miner's location under the mine and can be rescued in time. The panic button attached to the helmet helps miners to ask for help in case of any accident, the miner can simply press the button once that would warn the workers outside the mines. The IR sensors enable us to know if the miner is wearing the helmet or not. The helmet is a low-cost, efficient and reliable prototype designed and tested properly.

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