SMART WEARABLE GADGET FOR MINERS USING IOT

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Abstract. Safety is the most important part of any kind of assiduity is safety. In extreme circumstances, safety-related negligence could result in the destruction of expensive clothing or the loss of human life. Every mining diligence adhere to a few basic preventative measures in order to avoid any generally unwelcome wonders. The most important component at this time is communication in order to continuously monitor various parameters and take the appropriate actions as a result to avoid any risks linked with the product or the management of mortal funds. A stable and wide-range effective communication system between personnel in the mine and the control centre must be built in order to increase safety in underground mines. The cable communication network technology is ineffective within underground mines. Here we can tackle the matter of accidents which end with death of several people per annum. It is discovered that the speed of fatality within the coal pit industry is almost six times the speed for all private industries. And most of those accidents are because of toxic gases, fires, and a lack of rescue systems. By implementing mine surveillance gadgets, which may be used within the mine and detect the number of various gases, fall, emergency detection and report to them. This article focuses on the design and analysis of the smart wearable gadget for miners in the mining industry using IoT.

1 Introduction

The world has expansive and different natural coffers and over-sized mining assiduity. Proper supervision and proper communication are vital conditions of the mining assiduity, administrators are held responsible for all injuries sustained under their super-vision, and will thus bear in mind presumably parlous situations. The matter addressed is the enhancement of a mining helmet to make sure further safety mindfulness among miners. The security helmets do not have any technology added to them to let the administrator know when a fellow miner has encountered a dangerous event. thus, the design aims to switch an existing mining safety wearable contrivance to produce the contrivance indeed safer by adding a wireless detector knot network. A smart wearable gadget includes various features like the detection of hazardous gases, fall detection, emergency status and a panic switch that's pro-

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vided for the security of the miners. The detected information is sent to the room through a wireless network. This paper gives a summary of IoT-based coal mining safety for miners. But this consists of a gas sensor that is employed to observe the underground hazards. During this paper, we substantially concentrated on the hazards monitoring, all the detector values compared with the entered data from the detector with safety limits and if any hazards are detected, the control section is given the needed alert. The wireless monitoring device that is being demonstrated can identify and send vital coal mine characteristics like methane gas.
Fig.1the process of mining involves taking valuable geological eleents from the Earth.Work ing in the dangerous mining business requires utmost safety. An exigency occurs, and a straightforward patient accessible' fear' button notifies the room, which approached in an exceedingly matter of your time.

Fig.1 Typical Mining Industry

2 Literature Survey

Dr. R. Nagaraja A et.al [1] has proposed prototype of an intelligent mine safety helmet has been created that is capable of identifying several types of dangerous mining conditions, such as carbon monoxide gas build up, miners taking off their helmets, and crash detection (when a mine is struck by something on his head). The removal of the miner's helmet is determined using an Infrared sensor. Another potentially dangerous incident is when a mine worker has an accident and something hits him in the head with pressure more than 34 psi (Head and Neck Injury Criteria value of 1000). To measure the force acting on the miner's head, a pressure sensor was employed. Praveen Kulkarni et.al [2] has proposed a system for real- time monitoring is created to provide a more accurate and comprehensive view of the underground mine. The miners in the mine would gain advantages by prioritizing their safety before any harm takes place. This system provides the miners with monitoring devices that display crucial parameters. If the sensor values exceed a certain threshold, an alert is triggered. Furthermore, all the data is recorded on a computer for future analysis.

Dhanalakshmi et.al [3] proposed a system for smart helmet in order to detect dangerous situations, keep an eye on the environment, update data (such as GPS location and sensor data to the central console for easy tracking), and provide air to prevent the inhalation of harmful chemicals. With the help of the Internet of Things (IOT), the system can expand even further. It is possible to build a database that continuously tracks the sensor modules. Ankit Singh et.al [4] the Internet of Things (IoT) will bring about change in the mining industry's effort to go digital. SAGES' intelligence will undoubtedly increase as a result of IoT. It will assist in the effective and efficient monitoring of the depillaring zone by capturing sensor data and delivering it to cloud storage for real-time online data processing for decision-making. With the help of sophisticated data mining techniques, SAGES performance can be predicted. These forecasts' accuracy and the most recent data, which were just uncovered, might raise the machine's dependability, dependability, productivity, and safety.

K.Hari Prasad et.al [5] has proposed a system on variety of gases and radiations can be detected. The programme evaluated one or more radioactive leaks as well as possibly dangerous gases, and the results were provided with high response rates and quickly. Alarms are used to signal an alert in industry and close to populated areas. If the radiation and gas concentrations are higher than normal, for examples warning will show up on a specific website and Android app. Ravi K Kodali et.al [6] In order for numerous NodeMCUs to continue transmitting sensor data from the Raspberry Pi, a network must be created. The broker, the Pi, keeps track of this data and notifies the appropriate parties whenever a bad circumstance arises. Using this program, we can provide security measures for coal mine workers, reducing the likelihood of mishaps or regrettable worker fatalities. We have been able to build cost-effective, low-power solutions with the use of IoT concepts, moving us closer to more efficient systems while preserving resources. Rohith Revindran et.al [9] has proposed the smart helmet for safety in mining industry. The main goals of this design were to keep track of, reduce the number of casualties, and provide quick aid to the tortured miners. A wireless detector network was created using a Zolertia Re-Mote on the miners' helmets. To check on the well-being of the stoner, a Phidgets thin force detector was attached to the detector snip. The snip in the helmet attempted to send a torture message to its Room director through the saved route whenever the force exerted by the helmet was greater than the predefined threshold value. Distance Vector Routing was utilised to determine the path (DVR). The molecules were made mobile by periodic enforcement of neighbour discovery along with DVR. Potential issues like knot or link failure were taken into account. Failure recovery was used to try and solve the knot/link failure problem. To monitor the health of all miners and assess the state of every dwelling, a graphical stoner interface (GUI) was distributed at the centre. GUI aided the centre employee in acting immediately and appropriately to aid the trapped miners. Pranjal Hazarika [10] has proposed a clever protective headgear for coal miners. Detection of an odorless and colorless gas is not an easy task, moreover some inaccurate device and improper sensor placement make the task more difficult. The smart safety helmet is going to be one of most effective and useful technique in mining industries due to its excellent sensing ability, low cost, good and reliable signal transmission. Also, the system can be monitored in LabVIEW and in a portable mini monitor panel, which gives the system versatility. Lab-view monitoring is more accurate but is little expensive due to the expense of the software. On the other hand, hand-held portable monitoring device is very cheap and good for monitoring few routers.

S. Kesavan et al. [11] proposed a smart mining helmet that has the ability to detect three potentially harmful scenarios: the presence of hazardous gases, removal of the miner's helmet, and tracking the miner's location. One of the hazardous situations identified was when a miner removes their helmet, which poses significant risks. However, the situation becomes even more perilous if a miner is struck by an object. To enhance the system, the researchers suggested incorporating additional measurement tools to verify the person's location. Furthermore, the helmet can also measure gas concentrations. To enhance the durability of the circuitry, flexible electronics will be utilized, making it more resistant to physical damage. Bolla Sravani et.al [12] has proposed a smart and secured helmet for mining workers. This technology will provide coal miners with safety, alter how they work, and regulate the vibrant environmental changes in mines. The original low power ZigBee wireless detection system design has been made available at a drastically reduced price. It is a dependable system with a simple installation process. The system might easily be expanded. It will improve system scalability and increase accuracy of underground miners in the future using ZigBee wireless positioning bias. Beena M Varghese et.al [13] the mine worker's safety helmet is the item of safety gear that this article specifically focuses on. This helmet is equipped with a range of environmental sensors, including temperature, humidity, gas, smoke, and air quality sensors, to continuously monitor the conditions in the mine. A microcontroller that is also a component of the helmet is connected to all these sensors. Data is transferred from the user's helmet to the hub using Zigbee technology, and the article also makes use of the idea of a wireless transmission network. The monitoring system uses IoT (Internet of Things) technology to transmit collected data with the relevant graphical representations to the web server, enabling remote monitoring of the mine's conditions.

Punam S. Tajane et al. [14] conducted an analysis of wearable technology and its application in the mining industry. The study involved reviewing the use of wearable technology in the mining sector and recommended the implementation of a wearable safety management system for miners and other mining operations. Several companies are actively working on integrating wearable technology into mining practices. The successful adoption of these technological advancements in other industries suggests their potential for delivering valuable outcomes in mining as well. In a related study by Sishi.M. et al. [15], it was found that depending on the type of mine, a smart vest equipped with various sensors can be utilized to monitor radiation levels, temperature, humidity, presence of hazardous substances in the air, and other relevant parameters. Additionally, the helmet incorporates yellow to red LEDs that function as an emergency alarm system and facilitate communication between miners and supervisors. A tracking system employing a location transponder is also employed to monitor the movement of objects and track worker activities. P. Roja et.al [16] To detect the dangerous CO and CO2 gases that accumulate in the mines, an intelligent helmet is created. The miner can immediately identify the dangerous gas by wearing this hat. In the mining business, this technology can warn a miner when their helmet is taken off. Data is sent from the mining industry to the server via GPRS in this system. Data transmission methods are widely utilized, including the Internet of Things (IOT).

B. Priyanka et.al [17] has proposed an automated system that detects the hazardous gas surrounding the miner's helmet, a monitoring system that updates the control room with real-time data, and by integrating both design systems and evaluating the proposed system's power consumption, the project's goal was successfully attained, as can be seen from the summary points. If this system is put into place, workers will be informed when harmful gases are present and will be monitored in the event of an accident. The instrument's design also has sensors for methane and carbon monoxide gases. The prototype is capable of continuously detecting the presence of gas in the air, the miner's respiration rate, changes in temperature and humidity, and the miner's location. All of these specifications will be sent via Wi-Fi to a dynamic internet protocol. They can all pass through the shield without a problem. The base camp can monitor the miner's GPS location by using a pulse sensor attached to the miner's body. To save the most people during a crisis, it might be vital to build a coal mine as soon as feasible. We can create a database and, if necessary, communicate with a local hospital with the use of IoT. We'll look at market trends and difficulties that WHDs should be aware of in our final point. B Hettige et.al [18] a review of a smart helmet that can detect potentially dangerous scenarios, keep track of local environmental factors, issue messages in real time when specific conditions arise, and update data like GPS location and sensor readings to a central monitoring system. The system's development can make use of wireless networks. The development of a wireless network-based smart helmet for tracking worker health and safety is underway. The measurement of parameters such as air quality, pH levels, body temperature, and pH levels will be conducted. In a paper by Suwarna Karna et al. [19], the development and construction of a smart helmet driven by the Internet of Things (IoT) for real-time monitoring of the health and safety of underground mine workers are described. The integration of the LoRaWAN wireless protocol enables the smart helmet to connect to a cloud-based system and communicate with a command center. The helmet incorporates a variety of ambient and flexible body sensors, ensuring effective data collection and transmission. Testing and analysis were done to determine the efficacy and performance of this smart helmet. Sumit Kumar et.al [23] wireless sensor networks have been used to analyze a study on the real-time monitoring of poisonous gases and other factors present in deep mines. A real-time monitoring system has been developed to provide a comprehensive and accurate view of the underground mine. This system is designed to assist all miners inside the mine in prioritizing their safety and preventing any potential harm. The parameters are displayed on both the LCD located in the subterranean region where the sensor unit is positioned and the monitoring unit. If the sensor values exceed the predetermined threshold, an alert is triggered.

Patel et al. [20] have developed a model that enables the real-time collection and processing of environmental data. This data is instantly updated in the cloud, allowing access from any location. Whenever a safety concern arises, an alert notification is sent to the supervisor, enhancing the capabilities of the wearable device. The helmet model implemented in this study ensures the identification of each individual by creating separate channels on the IoT platform for unique user IDs. Similarly, in the research conducted by R. Shashidhar et al. [21], the focus is on ensuring miners' safety in hazardous situations. The developed model facilitates the immediate processing and gathering of environmental data, which is then stored and accessible in the cloud. Whenever a safety issue is detected, a notification alert is sent to the supervisor, thereby expanding the functionalities of the wearable device. By adopting this helmet concept, it becomes possible to identify each person individually through separate user ID channels established on the IoT platform.

Sujitha et al. [24] have proposed an IoT-based smart mine safety system utilizing Arduino. Their proposed system involves the development of a prototype for mine safety using the Arduino microcontroller. The system combines both hardware and software components. The hardware part consists of various sensors, while the software part includes an Android-based interface connected to the Arduino board and other hardware components using the Internet of Things (IoT). The Android interface comprises signals and a database that displays readings from the sensors and interacts with the hardware components. The integration of wireless networking in the mine safety system aims to enhance safety and improve mining operations. This research aims to automate the monitoring process of the mining unit and provide updates via mobile networks. The hardware components of this system interface with the sensors. This design optimizes mining operations by utilizing detectors that sense the terrain, which are controlled by the Arduino microcontroller to automatically activate or deactivate the buzzer based on the level of danger.

Noor Md Mujahed et.al [25] As part of this research endeavor, we created a cutting-edge helmet to protect mine workers from potential hazards. The described approach can be utilised for security and mining. The system is strong and lightweight because it uses simple, readily available components. The invention uses an infrared detector to alert the user if a falling object might hit the top of his skull.

Heavy machinery operators, including haul truck, excavator, dozer, grader, and water truck drivers, wear safety helmets equipped with identical brain activity monitors. This type of smart vest alerts workers to potential dangers in the mining area and keeps an eye out for any lack of brain impulses that might suggest exhaustion, insufficient water, or medical issues that might make miners lethargic. The purpose of this is to make drivers more aware and offer them the ability to avoid collisions.

3 Hardware requirements

3.1 ESP8266

The ESP8266 is powered by a 32-bit processor with 16-bit instructions. It follows the Harvard architecture, which means that the instruction memory and data memory are completely separate. The ESP8266 includes a Read-Only Memory (ROM) as depicted in Figure 2. This module is a cost-effective and widely available Wi-Fi module packaged in a compact form. It is equipped with the 80 MHz L106 RISC 32-bit microprocessor core. Some initial code and library functions are stored in its onboard memory, while the remaining code needs to be stored in an external flash memory. The flash memory allows for periodic access to the data, allowing the processor to read or write large contiguous groups of bytes in a sequential manner within the address space.

Fig.2. ESP 8266

3.2. MQ 3

Among the MQ detector series, the MQ3 detector is commonly utilized [7]. Figure 3 displays a Metal Oxide Semiconductor (MOS) detector. These detectors, also referred to as essence oxide detectors, operate based on the alteration in resistance of the sensing material upon alcohol exposure, thus enabling them to perform a distinct function.

Fig. 3. MQ3

3.3 POWER SUPPLY

A power supply is an electrical device that supplies electricity to an electrical load. Its main purpose is to convert electrical current from a source into the required voltage, current, and frequency necessary to operate the load. This is why power supplies are sometimes referred to as electric power transformers. While certain power supplies are built into the appliances they power, others exist as separate standalone units of equipment.

3.4 Capacitor

A capacitor is a device that uses the accumulation of electric charges on two nearby surfaces that are electrically isolated from one another to store electrical energy in an electric field. It has two terminals and is a passive electrical component which is clearly visible in the Fig.4

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Fig. 4. Capacitor

3.5 Relay

Relays are electrical switches that operate using an electrical current. The device consists of a set of output terminals, which perform the switching action, and a set of input terminals that receive one or more control signals. The switch can have various types of connections, including connections that make a circuit, connections that break a circuit, or combinations of both.

3.6 LED

LEDs (light-emitting diodes) are commonly employed in electrical devices as a traditional lighting source. They find application in a wide range of products, including mobile phones and large advertising billboards. LED technology is often utilized in devices that present vibrant visual information and display the time, among other uses.

3.7 Buzzer

A beeper or buzzer, depicted in Figure 5, serves as an example and can be designed as electromechanical, piezoelectric, or mechanical. Its primary purpose is to convert an audio signal into sound. Typically powered by DC voltage, it finds application in devices such as clocks, alarm clocks, printers, computers, and other electronic devices. Depending on the specific designs, it can generate various sounds such as alarms, music, bells, and notifications [22].

Fig. 5. Buzzer

3.8 Accelerometer

Accelerometers are devices used to measure acceleration, which refers to the rate of change in an object's velocity. In the study by C.J. Behr et al. [8], acceleration is typically measured in G-forces or meters per second squared (m/s^2). On Earth, one G-force is equivalent to 9.8 m/s^2, although this value may slightly vary with elevation. It should be noted that different planets may have different gravitational pulls, resulting in varying G-force values. Accelerometers, as depicted in Figure 6, are valuable in applications where orientation needs to be determined or vibrations in systems need to be detected.

Fig.6. Accelerometer

3.9 9V Relay cube

This cell relay has an operating voltage of 9V and has a uttermost current capacity of 10A. This makes it most suitable for use in micro regulator- grounded bias.A9v relay cube is shown in the Fig.7

Fig.7. 9v Relay cube

3.10 Switch

An electric switch is a device that interrupts the flow of electrons in a circuit. Light switches are a common example of such switches, which function in an on/off manner. When a switch is turned off, it breaks the circuit, ceasing the flow of power. Circuits typically consist of a power source and a load, as illustrated in Fig.8.

Fig. 8. Switch

4 SOFTWARE REQUIREMENTS

The Arduino Software (IDE), also referred to as the Arduino Integrated Development Environment, is a software tool provided for programming Arduino boards. It comprises several components, including a text editor for code writing, a message area, a text console, a toolbar with commonly used function buttons, and a range of menus. It establishes a connection with Arduino hardware for program uploading and communication purposes. Earlier, assembly level programming was used to create a large number of embedded programmes. They did not, however, offer portability. The development of several high-level languages, including C, Pascal, and COBOL, overcame this drawback. The C language, however, initially received and still enjoys wide adoption for embedded devices. The C code that was built is simpler to understand and more dependable, scalable, and portable. Every single embedded system we come across in daily life, such as cell phones, washing machines, and digital cameras, is powered by a CPU that is programmed in embedded C. Each CPU has integrated software attached to it. The embedded software that determines how the embedded system will operate is the most important factor.

5 Proposed system

We've enforced a defensive contrivance that comes with detectors, cautions, and discovery. originally, dangerous feasts are detected using gas detectors. Whenever the toxic gas is detected, an alert is transferred to the control room. Cover the conditions inside the mines and insinuate the status in case of exigency. The alternate bone is detecting fall and inferring the control room in case of fall detected. The fear switch is manually operated by the miner to seek help from the central press in largely exigency conditions. Ensuring the safety of the staff is an important responsibility, which involves implementing measures such as real-time proximity detection, monitoring mining conditions (e.g., dangerous gas levels), detecting falls, and providing a panic switch, as depicted in Figure 9. This system also gathers health-related data, such as poisonous gas indicators, and can trigger alerts for evacuation or initiate other accident prevention measures during emergencies. The hardware architecture and connections are illustrated in Figure 10. To transmit the sensor data to the management-monitoring system, the system is designed to support various wireless technologies, including Bluetooth and Wi-Fi.

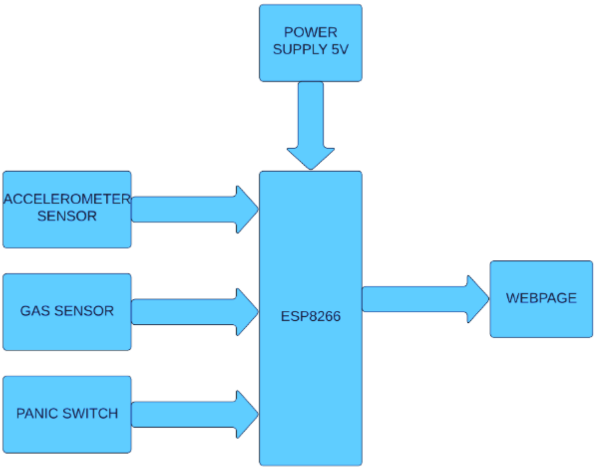

Fig.9. Block Diagram

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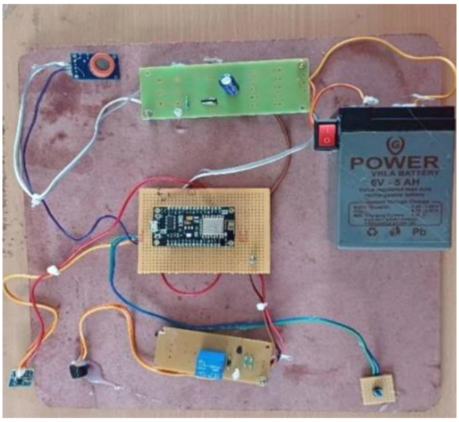
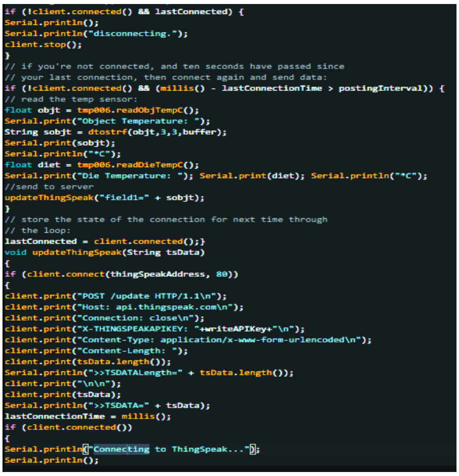


Fig.10. Hardware Implementation

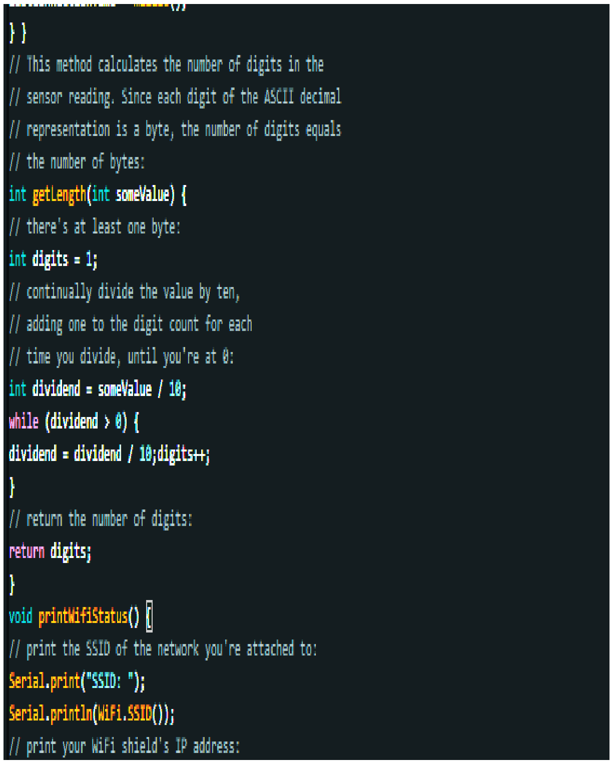
```
#ifndef __CC3200R1M1RGC__
// Do not include SPI for CC3200 LaunchPad
#include <SPI.h>
#endif
#include <WiFi.h>
#include <Wire.h>
//#include "Adafruit_TMP006.h"
#include <stdlib.h>
// ThingSpeak Settings
char thingSpeakAddress[] = "api.thingspeak.com";
String writeAPIKey = "VNED7PKXQOY10V1X";
const int updateThingSpeakInterval = 16 * 1000; // Time interval in milliseconds to update
ThingSpeak (number of seconds * 1000 = interval)
//buffer for float to string
char buffer[25];
// your network name also called SSID
char ssid[] = "";
// your network password
char password[] = "";
// initialize the library instance:
WiFiClient client;
unsigned long lastConnectionTime = 0; // last time you connected to the server, in
milliseconds
boolean lastConnected = false; // state of the connection last time through the main loop
const unsigned long postingInterval = 10*1000; //delay between updates to xively.com
int failedCounter = 0;
Adafruit_TMP006 tmp006(0x41); // start with a diferent i2c address!
void setup() {
//Initialize serial and wait for port to open:
Serial.begin(115200);
// attempt to connect to Wifi network:
Serial.print("Attempting to connect to Network named: ");
// print the network name (SSID);
Serial.println(ssid);
// Connect to WPA/WPA2 network. Change this line if using open or WEP network:
WiFi.begin(ssid, password);
while ( WiFi.status() != WL_CONNECTED) {
// print dots while we wait to connect
Serial.print(".");
delay(300);
}
if (! tmp006.begin()) {
```

Fig.11. Software Code



```
if (!client.connected() && lastConnected) {
Serial.println();
Serial.println("disconnecting.");
client.stop();
}
// if you're not connected, and ten seconds have passed since
// your last connection, then connect again and send data:
if (!client.connected() && (millis() - lastConnectionTime > postingInterval)) {
// read the temp sensor:
float objt = tmp006.readObjTempC();
Serial.print("Object Temperature: ");
String sobjt = dtostrf(objt,3,3,buffer);
Serial.print(sobjt);
Serial.println("*C");
float diet = tmp006.readDieTempC();
Serial.print("Die Temperature: "); Serial.print(diet); Serial.println("*C");
//send to server
updateThingSpeak("field1=" + sobjt);
}
// store the state of the connection for next time through
// the loop:
lastConnected = client.connected();}
void updateThingSpeak(String tsData)
{
if (client.connect(thingSpeakAddress, 80))
{
client.print("POST /update HTTP/1.1\n");
client.print("Host: api.thingspeak.com\n");
client.print("Connection: close\n");
client.print("X-THINGSPEAKAPIKEY: "+writeAPIKey+"\n");
client.print("Content-Type: application/x-www-form-urlencoded\n");
client.print("Content-Length: ");
client.print(tsData.length());
Serial.println(">>TSDATALength=" + tsData.length());
client.print("\n\n");
client.print(tsData);
Serial.println(">>TSDATA=" + tsData);
lastConnectionTime = millis();
if (client.connected())
{
Serial.println("Connecting to ThingSpeak...");
Serial.println();
```

Fig.12 Software Code



```
} }
// This method calculates the number of digits in the
// sensor reading. Since each digit of the ASCII decimal
// representation is a byte, the number of digits equals
// the number of bytes:
int getLength(int someValue) {
// there's at least one byte:
int digits = 1;
// continually divide the value by ten,
// adding one to the digit count for each
// time you divide, until you're at 0:
int dividend = someValue / 10;
while (dividend > 0) {
dividend = dividend / 10;digits++;
}
// return the number of digits:
return digits;
}
void printWifiStatus() {
// print the SSID of the network you're attached to:
Serial.print("SSID: ");
Serial.println(WiFi.SSID());
// print your WiFi shield's IP address:
```

Fig.13 Software Code

Fig.11, Fig.12 and Fig,13 represents the Software Code for developing the Project

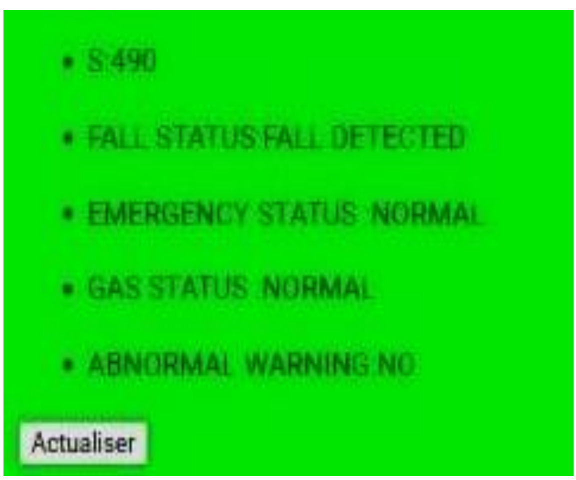


Fig .14. The sensor data can be viewed on the web page

6 Results and discussions

All modules of smart wearable gadget are functioning properly and provide accurate readings. The proposed system is therefore developed successfully. The contrivance unit collects dangerous gas and fall data and has been designed to warn the control room in case of an abnormal condition. The fear button can be penetrated externally in case of extremities. The Output of the Project is shown in the Fig.14. A smart wearable device refers to an intelligent electronic device that can be attached to the body or worn using accessories. Various forms of smart wearables exist, such as helmets, watches, spectacles, contact lenses, fabrics, headbands, beanies, caps, rings, bracelets, and earrings. The suggested system can be incorporated into any type of wearable device based on the specific need, convenience, and requirement.

7 Conclusion

Thus, a smart wearable gadget for miners for hazardous detection, a panic button can be operated manually by the miners in case of updating data from sensors, for example, to regulate the space and make tracking easier. The system can also be improved by providing extra oxygen to prevent breathing in dangerous gases. and tracking location. Smart wearable gadgets have the potential to greatly benefit miners by improving their safety, efficiency, and overall working conditions. Some examples of smart wearable gadgets for miners include personal gas detectors, real time health monitors, location tracking devices, and augmented reality glasses. These gadgets can help prevent accidents, track the miners' vital signs and movements, and provide them with real-time information and assistance, such as navigation, communication, and access to data and instructions. However, when considering the implementation of smart wearable gadgets for miners, it is important to also take into account factors such as user adoption, training, and maintenance, as well as privacy and security concerns. Therefore, thorough planning, testing, and evaluation are necessary to ensure the effective and safe integration of these technologies into mining operation

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