Smart Wearable Device for Ensuring Safety of Mine Workers

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ABSTRACT: Coal miners are suffering from various threats like gas explosion, sudden health changes, severe changes of the temperature and moisture level. Hence in any Mine, there are many risk factors. In order to safeguard the people working inside the mine its environment parameters are to be monitored. In earlier days if any harmful effects occur, they send a person and get report back. In our project we will avoid this risk by monitoring environment parameters. We can see the result of IOT that is happening in mining. In order to safeguard the people working inside the mine its environmental parameters are to be monitored. The main aim of our system is to design a helmet for the coal miners which will be equipped with the at work of sensors such as the humidity sensor, temperature sensor, heartbeat sensor, and gas sensor and the data from these sensors will be transmitted using wireless fidelity technology. So, Wi-Fi technology communication which has wider range of frequency and fast data transmission.
Key words:Humidity, Temperature, gas, Heart beat and Wi-Fi.

I. INTRODUCTION

Internet of Things (IoT) is nothing but the devices(things) communicating with one another by using the web. IoT applications vary on a large scale. European Research Cluster on the Internet of Things classifies major IoT applications as smart buildings, smart transportation, smart energy, smart industry, smart health and the smart city as major areas. IoT is a trending innovation in the data from sensors is stored in the local server, it can be easily accessed from the cloud. Such an emerging technology can be used in various IoT applications like agriculture, health, smart home etc., to make the already existing systems more efficient. The Key characteristics of the cloud include on-demand service provision, ubiquitous access, resource pooling and, elasticity. In India, we have 493 coalmines present. Coal place an important role in the world. These petroleum products are natural assets of the earth which help create power and for some, purposes, Coal is a non-sustainable source which can't be supplanted commonly by humans, there are numerous coalmine mischance's happening in the mines, and the diggers are putting their lives in hazard by working in the coal mines, even once in a while they wind up losing their lives in the coal mines which is an unfortunate part. Mainly these mistakes are happening due to old hardware and the wired systems, resulting in the terminate mischance's, spillage of the noxious gases in the coal mines are presenting immense danger to the excavators inside the coalmines. In the underground coalmines light is an essential thing to convey their work, they can't leave the mine if there is no legitimate lighting which coming about them to harm the mineworker's vision because of working under low lighting area. So, to avoid these issues we have structured the security framework. In our work, we have tackled the issues by checking every one of the information gathered by the sensors which we have utilized and the observing is finished in the platform. Controlling is possible by both automatically and manually. The microcontroller here in the work we have utilized is Node MCU.

II. LITERATURE SURVEY

P. Prabhu et.al.,proposed an intelligent wearable device for coal miners. This proposed system not only helps in talking about the poisonous gas that are present but also tracks them if any mishap occurs. The device is given methane and carbon monoxide gas sensor. It ensures the supervision on IoT (Internet of Things). We make use of mainly NRF module and RFID technology.

RFID can easily track an individual just in case of an accident. because the results of wearing this coat, more significance is given to the individual observation and also gives security supervision within the coal mining industry. It additionally alarms the individual within the event of basic crises and furthermore the supervision[1].

Jagadeesh R et.al.,author describes a prototype of intelligent mine safety helmet that is competent to detect various kinds of unsafe situations in the mining industries such as carbon monoxide gas. An IR sensor is employed to see whether the miner has removed his helmet or not. A pressure sensor determines the force experienced on the miner's head. The infrared sensor is often tweaked to figure just inside the security helmet by not provoking to internal reflections. The system is often enhanced by adding extra measuring equipment to see the worker's pulse and vital sign[2].

Tarek Eldemerdash et.al., author proposed a smart helmet system for mining industry application that will keep on monitoring the hazardous events such as temperature, humidity, gas, removal helmet of the miner and obstacle damage to the helmet. The programming and troubleshooting were conducted on mainly two sections, helmet section and room section. As the result of Wearing this helmet, it detects the hazardous gas surrounded by the miner's helmet was achieved, designing a monitoring system to update the control room with real time data was achieved and to integrate both design systems and evaluating the power consumption[3].

Pulishetty Prasad et.al.,author describes a wireless helmet for coal miners using Zigbee wireless technology. The system may be a value powerful ZigBee-primarily based wireless mine supervising system. The application followed ZigBee wi-fi technology to build wireless sensor networks, found out actual-time surveillance with early-warning intelligence on temperature, leakage of gas in mining place, and alerting the control station the usage of wireless ZigBee technology. As after the result coal mine workers can easily identify the diverse gases, temperature or approximately sudden short coming herbal injuries which take place commonly in coal mine[4].

Ashish et al., author described a system equipped with an ARM controller and different sensors like temperature sensor, humidity sensor and gas sensor. An IR sensor is fixed within the mine to see the parameters[5].

Wakode et al., author suggested a system that mainly used to monitor the concentration of dangerous gases in the coal mine. To provide safety the systems give the alert that will be helpful to the workers in the mine to save their lives. An alert switch is placed at the transceivers and receivers' side for emergency purpose[6].

Dong et.al., author proposed a coal mine safety monitoring framework dependent on Zigbee and GPRS remote transmission was established. With GPRS innovation, remote information transmission accomplishes and informed through the short message sent to his cell phone, which adds to the early Id of genuine mishaps and continuous treatment, subsequently, expanding the security of coal mining[7].

Aarti et.al., author developed a system that monitors temperature, humidity, methane values in the coal mine and all the values are sent to the ARM9 processor and using a Wi-Fi module the values are continuously updated in the webpage[8].

Dheerajet.al., author suggested a framework that values of all parameters that are monitored are stored and visualized in the cloud and those can be controlled using smart phone so that the coal mine worker's safety is always monitoring[9].

Madhu et.al., author developed a coal mine safety monitoring system by utilizing Temperature, humidity and the amount of carbon-dioxide present are checked. If any uncertain condition occurs then message is sent to the forest and fire departments[10].

III. EXISTING SYSTEM
In the existing system the helmet is fixed with any one of the sensorlike gas, humidity, temperature or heartbeat sensor. In the suspect of the hazardous event the microcontroller sends the alarm to the control room. Here the data transmission is done through Li-Fi. The main disadvantage of the existing system is scalability.

IV. PROPOSED SYSTEM
We proposed the system as a smart wearable device which is equipped with the network of sensors such as the heart beat sensor which will be fixed to the coal mine worker which can constantly checks the blood volume

which is directly related with heart functions and monitors the workers' health. Temperature sensor collects the workplace temperature data. Humidity sensor gets the information of the moisture con tent of the work place and gas sensor gets the data of the various gas in the coal mine and these sensors are connected to the NodeMCU.Therefore, this system can be easily maintained by all the users in coal mines.
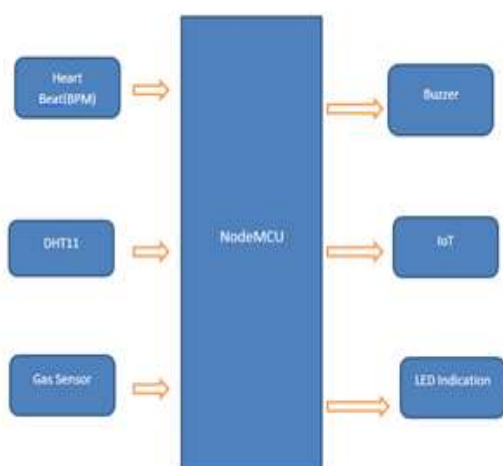

Fig 1.1. Block Diagram

V. WORKING PRINCIPLE

The smart wearable device will be equipped with heart beat sensor, humidity sensor, temperature sensor, and gas sensor these sensors will gather instant information or the status of the worker's environment and the data are transmitted through Wi-Fi module. In the occurrence of any hazardous event the information will be send to the authorized person through mail, this will be done with the help of IoT and data are also automatically stored in the server.

GAS SENSOR

Gas sensors are electronic devices that detect and identify different types of gases. They are commonly used to detect toxic or unwanted gasses and measure gas concentration. Gas sensors vary widely in size, range, and sensing ability. They are often part of a large embedded system, such as hazmat and security system, and they are normally connected to an audible alarm or interface. Because gas sensor is constantly interacting with air and other gasses, they have to be calibrated more often than many other types of sensor.

Depending on their intended environments and functions, the physical makeup and sensing process can very notably between sensors. Metal oxide-based system is most commonly used sensor to identifying the unwanted gases in the environment. This type of sensor employs a semi resistor which comes and reacts with target gasses. Metal oxide gas sensor increase their electrical resistance as they come into contact with gasses such as carbon monoxide. Hydrogen, methane, and butane. Mostly oxide-based sensors or used in the home-based system.

Fig 1.2. Gas Sensor

HEART BEAT SENSOR

The working of the heart beat sensor is very simple. The sensor has two side one is attached with ambient light sensor with LED light and another side is a circuit side. The circuit is mainly used for cancel the noise and amplifying in the working place. The front side of the LED is placed vein in the human body such as finger tips, ear tips. In some other cases it should be placed directly to the vein.

Now the LED emits light to the vein. There is a blood flow in the vein through the flow of blood the heart is pumping. So, we can monitor the blood flow to measure the heart beat as well. If the flow of blood is detected, the light is reflected by the blood and it pick up a lighter. This minor change in light the heart beat is analyzed over a time to determine it.

To use the sensor power, it in the Vcc and ground pins, the sensor can operate at +5V or 3.3V system. Once powered connect the Signal pin to the ADC pin of the microcontroller to watch the change in output voltage.

Fig 1.3. Heart Beat Sensor

TEMPERATURE AND HUMIDITY SENSOR

The DHT11 is basic and ultra-low-cost digital temperature and humidity sensor. It uses humidity sensor and a thermistor to live the encompassing air, and spits out digital signal on the info pin (no analog input pins are needed). It's simple to use, but requires timing to grab data. The DHT11 calculates the relative humidity by measuring the electrical resistance between the two electrodes. The humidity sensing component of the DHT11 may be a moisture holding substrate with the electrodes applied through surface.
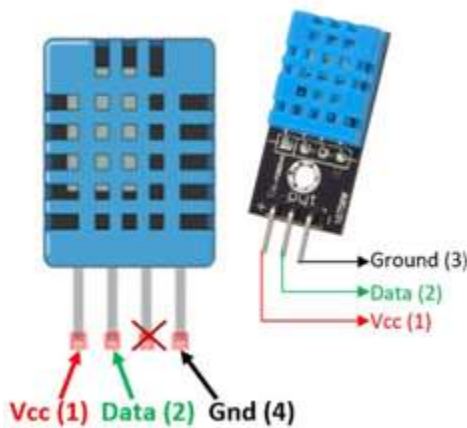

Fig 1.4. Temperature and Humidity Sensor

BUZZER

A buzzer is a small yet sufficient component to add sound features to our project/ system. It is very small and compact 2-pin structure. So that it is used on breadboard, perf board and even on PCBs. It is also known as widely used component in most electronic applications.

There are two types of buzzers. The one shown here is a simple buzzer which powered will make a continuous sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound is due to internal oscillating circuit present inside in it. But the one shown here is most widely used because it can be customized with help of other circuits to fit easily in our application.

This buzzer can be used by DC power supply ranging from 4V to 9V. A 9V battery can also be used, but it is recommended to use a +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or OFF the buzzer at required time and require interval.

Fig 1.5. Buzzer alarm

NodeMCU
The ESP8266 is a self-contained Wi-Fi networking solution which offer a bridge from existing micro controller to Wi-Fi and is capable of running self-contained application. This module comes with inbuilt in USB connector and a rich assortment of pin-outs. With micro-USB cable, you can be able to connect NodeMCU devkit to laptop and flash it without trouble, it is just like Arduino. It is also immediately breadboard friendly.

Fig 1.6. NodeMCU

NodeMCU is open-source firmware and development kit which plays a vital role in designing own IoT product using few Lua script lines. Multiple GPIO pins on the board which permit you to attach the board with peripherals which are capable of generating PWM, I2C, SPI, and UART serial communications. The interface of module is split into two parts including Firmware and Hardware where former runs on the ESP8266 Wi-Fi SoC and on the ESP-12 module. The firmware is based on Lua – A scripting language which is easy to learn, giving a simple programming environment layered with a fast-scripting language that connects you with well-known developer community. And open-source firmware gives you the pliability to edit, modify and rebuilt the prevailing module and keep changing the whole interface until we achieve optimizing the module as per our requirements. USB to UART converter is added on the module which helps in converting the USB data to UART data which mainly understands the language of the serial communication. Instead of the regular USB port, the Micro USB port is included in the module which connects it with the computer for dual purposes. The board incorporates the status LED that blinks and turns off immediately, giving you the current status of the module if it is running properly when it is connected with the computer. The ability of the module to determine a flawless Wi-Fi connection between two channels makes a perfect choice for incorporating with other embedded devices like Raspberry Pi.

Fig 1.6. Pin Diagram for NodeMCU

INTERNET OF THINGS

An IoT system is equipped with the sensor, which communicates with the cloud. The data which are gathered by the sensor are stored in the cloud, the stored data are processed, based on the processed data and then the desirable action is performed. The user can make action on the other side without any physical contact with it and the changes is done through the system which is on the user interface. The network of the sensor, data processing and a user interface are the some important of the IoT system.
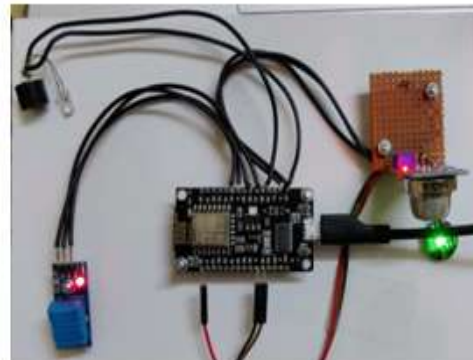

VI. EXPERIMENTAL SETUP

In this experiment, the device which is equipped with all the sensors are connected through Wi-Fi, and the data from the sensors are easily transmitted. There will be a user login in which all the data from the sensors are viewed by the webpage. If any sudden changes happen in the environment the buzzer will get activated and a small text message will be sent through mail.

VII. RESULTS

As a result, our smart wearable device can able to fetch all the values from the sensor and they can be viewed by the authorized person In the above Figure, all the sensors are connected in the NodeMCU and Wi-Fi module is integrated in NodeMCU and for power supply it is connected to micro-USB port.
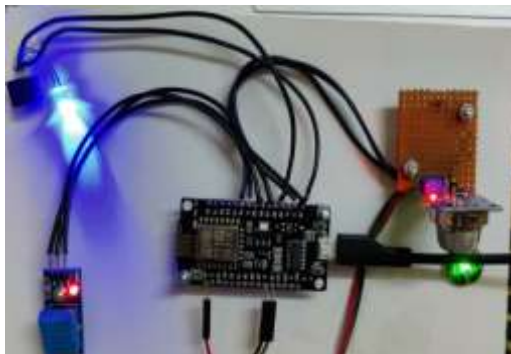
The above figure describes that if there is any leakage of gas like methane, butane, CO2 the buzzer gets activated by indicating blue LED light ang the values will sent through mail.

For viewing the sensor values, the user should register his details like name, phone number, email, username and password.

After successful login, the user can able to see the values which is fetched from the sensors in underground by clicking the sensor value page.

VIII. CONCLUSION

Safeties of worker are very important in many industries. This paper is proposed to reduce life risk of the coal miners at the various situation by the efficient monitoring and fast data transmission which is achieved by the wireless fidelity technology.

IX. FUTURE WORKS

In future we would like to improve the accuracy of the device and by adding the GPS we can able to find if any threats happen. The mail will go to nearby hospital for the safety of mine workers and hey can easily rescued. Scalability will also be increased.

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