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Smart Helmet Security System For Industrial Miners Using Iot

Er.S.R.Karthiga[1], S.Harini[2], M.Lavanya[3], S.Hazira shahana[4], S.Anitha[5]

[1]Assistant Professor, Department of Electronics and Communication Engineering, Krishnasamy College of Engineering and Technology, Cuddalore, Tamilnadu, India.

[2,3,4,5] Students, Department of Electronics and Communication Engineering, Krishnasamy College of Engineering and Technology, Cuddalore, Tamilnadu, India

ABSTRACT :

Mining is the first step in the dirty life cycle of coal. When coal mines movie in, whole communities are forced off their land by expanding mines, coal fires, subsidence, and overused and contaminated water supplies. Mines are quick to dig up and destroy forests and soils. But once the coal is one, the problems they leave behind, like acid mine drainage, can persist for decades. Around the world, Greenpeace campaigns to help communities stop coal mines, and speed up the shift to 100 present clean safe renewable energy.

Introduction :

Primary resource of energy in India, Which has significantly contributed to the rapid industrial development of the country. About 70% of the power generations is dependent on it thus, the importance of coal in energy sectors in disenable Underground mining operations proves to bear risky venture as far as the safety and health of workers are concerned. These risks are due to different techniques used for extracting different minerals. The deeper the deeper the mine, the greater is the risk. These safety issues are of grave concerne specially incase of coal industries. Thus, safety of workers should always be of major consideration in any form of mining, whether it is coal or any other minerals. Underground coal mining involves a higher risk tan open pit mining due to the problems of ventilation and potential for collapse. However, the utilization of heavy machinery and the methods performed during excavations result into safety risks in all types of mining. Modern mines often implement several safety procedures, education and training for workers, health and safety standards, which lead to substantial changes and improvements and safety level but in opencast and under ground mining..

Literature review :

[1] Yongping Wu and Guo Feng proposed Bluetooth wireless transmission technology for a coal mine monitoring system. Low-power, low-cost wireless bridging systems used for unified, global short-range communication will become standardized thanks to Bluetooth technology. Utilizing well-known CAN bus technology, the system integrates wired and wireless data transfer techniques successfully .

[2] Bluetooth is a short-range wireless technology, making it challenging to use cables, which presents the system's main challenge. Jingiiang Song and Yingli Zhu implemented an automatic coal mine safety monitoring system with a wireless sensor network.The microcontroller sends the sensor groups' measurements of the system's temperature, humidity, and other factors in the deep mine to the wireless communication module.

[3] The data is transmitted across a cable to a remote monitoring site. Pranjal Hzarika urged mandating the use of safety helmets for coal mine workers. This helmet comes with carbo monoxide and methane gas sensors.This sensor can detect gas using a wireless Zigbee module attached to the helmet, and the information is remotely transmitted to the control center.

[4] They unveiled a wearable IoT-based jacket. It is designed to protect those who work in coal mines and are frequently exposed to risks. This prototype isconstructed to sense various things, including hazardous chemicals, a coal miner's heartbeat, the circumstances beneath, and the miner's location via GPS. These details will likely be sent to a dynamic internet protocol through a Wi-Fi encrypted Channel.

[5] development of automation benefited coal miners tremendously. It was developed in South Africa for the miners.Cooperative research was done on coal port detection (CID). They did this by employing two commonly used methods, analysis and a safety system mine employees based on Zig Bee technology. Additionally, it monitors gas levels, which is dangerous because the accumulation of hazardous gases in the mines is the primary cause of mine related fatalities. Several LEDs are turned on when the value reaches the threshold, and a ZigBee warning is sent out.

[6] Cheng Qiang et al. proposed a wireless IoT based communication system for coal miners that monitors temperature, humidity, and CH4 (methane) levels. Through voice communication, the miner is alerted about the situation by the man tracking in the floor channel

EXISTING SYSTEM :

- A coal mine safety system is implemented using a things lot platform as a medium to transmit the data. The system is implemented to monitor and control various parameters in the coal mines such as light detection, leakage of gas, temperature and humidity conditions, Fire detection in the coal mine. These all sensors are together considered as one unit and are placed in the coal mines.
- All the esteems of the sensors are continuously uploaded to the thinger for analysis. Here the gas is continuously monitored if any uncertainties in the level of gas arise, then buzzer is used to alert the workers. In this system LDR sensor is utilized to detect the presence of light. Automatically light gets one and can be controlled using the led button.
- In case if any fire occurs in the coal mine, then an alert notification is send to the mail of the authorized person. Temperature and humidity values are also continuously monitored and displayed on the serial monitor and also in the thinger platform.
- The developed system is mainly implemented to improve the working condition inside the coal mines and also to ensure workers safety.The methane gas present in the mine and to intimate the officials about the presence of hazardous gas. If so found it can be indicated by an alarm.

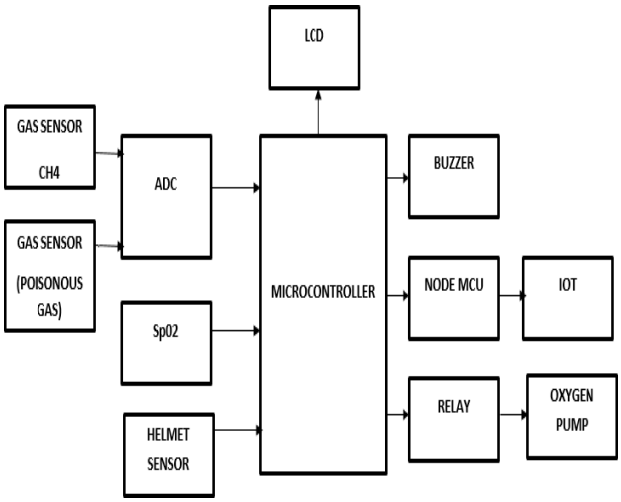


Fig. 1. Systematic Block diagram of Proposed work

PROPOSED WORK :

In our proposed system using various sensors to track parameters and using IOT. It encodes information on radio waves using chirp pulses. Here CH4 sensor is used to sense the level of methane gas present in the mine and to intimate the officials about the presence of hazardous gas. If so found it can be indicated by an alarm.This paper proposes interfacing different sensors to make a monitoring system for the laborers' safety in the mining industry. The values collected by the sensors are transmitted to the Microcontroller. In the Cold mining process the toxic level is sensed by SPO2 sensor and displayed in the LCD. The obtained data is transmitted by the IOT transmitter to the receiver end. The above work is done to enhance the safety for the underground mining workers.

A.HARDWARE DESCRIPTION

- *Gas sensors (poisoning gas):* The Sensitron SMART 3-G is specifically designed for use within mines and tunnels, and is employed to detect the presence of flammable and toxic gases in areas classified as Group I.The detector is available with a front display, alongside a four digit back-lit visibility for the gas concentration reading.It measure the corresponding gas includes CO, O2, NH3, H2S, NO2, O3, SO2, CL2, HF, H2, PH3,HCL, etc.The gas composition in mines represents a wide variety of hazardous situations. Therefore,different types of gas sensors are installed in many underground gas detection equipment.
- *CH4 Gas sensor:* The use of machine-mounted methane monitors is required by federal regulations to alert miners to the presence of potentially dangerous concentrations of methane while mining coal.The monitors must be permanently mounted on a mining machine to provide continuous readings of methane levels .The miniature NDIR CH4 sensor SJH is based on NDIR technology that is superior to thermal catalysis and heat conduction technology, and can detect 0 to 100% methane (CH4) concentration..
- A methane gas leak detector, or a methane detector, is a piece of sensing equipment designed to monitor the presence of methane gas in a given environment. Typically, these devices provide accurate and quick information on the presence of methane gas. Many are designed

using a laser light system for detection.

Fig.3.Gas Sensor Modules

Typically, these devices provide accurate and quick information on the presence of methane gas. Many are designed using a laser light system for detection.Under the Coal Mine Safety and Health Act 1999 and the Coal Mining Safety and Health. Regulation 2017, if methane concentration is equal to or greater than 2.5% then the underground mine is dangerous and workers must be withdrawn from the mine. Methane is explosive between 5% and 15%.

- *ADC:* An ADC is used to convert an analogue signal such as voltage to a digital form so that it can be read and processed by a microcontroller. Some microcontrollers have built-in ADC converters.The task of the ADC is to determine a digital output number that is the equivalent of its input voltage. The design of such circuits is a non-trivial task. Many very different ADC circuits have been developed, targeted towards different applications. Some, like the dual ramp ADC, are slow but with very high accuracy, and useful for precision measurements such as digital voltmeters.
- The ADC accepts an input voltage that is infinitely variable. It converts this to one of a fixed number of output values.It is fast but of lesser accuracy, and are used to convert high-speed signals such as video or radar.Others, like the successive approximation ADC, are of medium speed and medium accuracy,and useful for general-purpose industrial applications.
- *SPO2*: Medical data such as Sp02, heart rate and blood pressure are very crucial in judging the status of an individual or a patient in a medical context. They provide very vital information regarding their current state of their body, and thus easing this process of acquiring such data with devices has substantial benefits .Although several pulse oximeter designs are available, our design, due to its IOT capabilities, makes the entire data acquiring process very user-friendly and convenient. This design can be used anywhere by plugging into a USB adapter/port with a 5 V electrical supply .The Pulse Oximeter instrument can be used to measure the Heartbeat and SPO2 of the person by applying IoT based Wi-Fi technology, which can help to monitor oxygen saturation level and also regular check-up to avoid any the critical situation of health.
- *Helmet sensor:*The IR sensor consists of a transmitter infrared LED and an infrared receiver. An infrared Transmitter is a light-emitting diode that emits infrared radiations. IR Receiver will sense and detect whether the Miner is wearing a Helmet. Environment monitoring is done using temperature and pressure sensors.Force sensors are used each time the miners collide with a heavy item.When a miner takes off their helmet, an Infrared sensor alerts the central console.To identify the presence of dangerous gases in the atmosphere, gas sensors are utilized.
- The Smart Helmet is a personal protection equipment for industrial employees that aids in preventing head injuries while on the job. Protection against head injuries. Safety helmet are designed to protect the head against falling objects and the side of the head, eyes, and neck from any untoward impacts, bumps, scrapes, and electrical exposure, etc.
- *AT89s52 Microcontroller:* The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the Indus-try-standard 80C51 instruction set and pin out

Fig. 4. AT89s52 Microcontroller

Features:

- Compatible with MCS®-51 Products.
- 8K Bytes of In-System Programmable (ISP) Flash Memory.
- Endurance: 1000 Write/Erase Cycles.
- 4.0V to 5.5V Operating Range.
- Fully Static Operation: 0 Hz to 33 MHz.
- Three-level Program Memory Lock.
- 256 x 8-bit Internal RAM.

LCD: LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

BUZZER: A buzzer often emits a loud, constant, and frequently unpleasant sound. It is commonly employed as an alarm or warning signal in industrial settings or during emergencies. Generally speaking, ”buzzer” and ”beeper” are frequently used interchangeably, and their precise meanings can differ depending on the situation.

NODE MCU: The ESP8266 is the name of a micro controller designed by Espress if Systems. The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing microcontroller to WiFi and is also capable of running self-contained applications.This module comes with a built in USB connector and a rich assortment of pin-outs. With amicro USB cable, you can connect Node MCU dev kit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

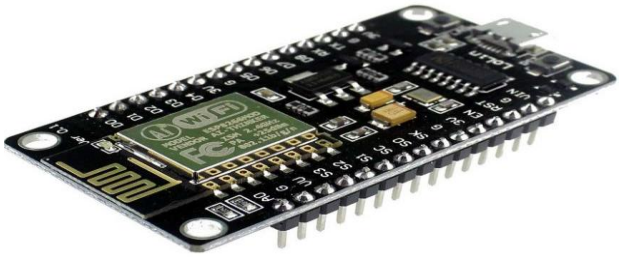


Fig.5. Node MCU

RELAY: Relays and contactors use a low level control signal to switch a much higher voltage or current supply using a number of different contact arrangements.Thus far we have seen a selection of Input devices that can be used to detect or “sense” a variety of physical variables and signals and are therefore called Sensors. But there are also a variety of electrical and electronic devices which are classed as Output devices used to control or operate some external physical process.

Fig.6.Relay consideration

These output devices are commonly called Actuators.Actuators convert an electrical signal into a corresponding physical quantity such as

movement, force,sound etc. An actuator is also classed as a transducer because it changes one type of physical quantity into another and is usually activated or operated by a low voltage command signal.For example, a relay is a binary actuator as it has two stable states, either energised and latched or de-energised and unlatched, while a motor is a continuous actuator because it can rotate through a full 360o motion. The most common types of actuators or output devices are Electrical Relays, Lights, Motors and Loudspeakers. We saw previously that solenoids can be used to electrically open latches, doors, open or close valves,and in a variety of robotic and mechatronic applications, etc.

Electrical Relays can also be divided into mechanical action relays called "Electromechanical Relays"and those which use semiconductor transistors, thyristors, triacs, etc, as their switching device called"Solid State Relays" or SSR's.

*IOT:*Enable mining companies to automate workflows, improve efficiency while reducing costs, and improve safety and ESG credentials. IoT supports mining operations such as autonomous drilling, driverless haul trucks, health and safety monitoring, energy management, and environmental monitoring.The Internet of Things (IoT) is a key driving factor in enabling the development of industrial automation systems. IoT coupled with computer automation controls helps streamline industrial systems and improve data automation, with the aim of removing errors and inefficiencies,primarily from the people.

In the mining industry, IoT is used as a means of achieving cost and productivity optimization,improving safety measures and developing their artificial intelligence needs.The Industrial Internet of Things (IIoT) is a similar concept but is used by more sophisticated devices for production and supply chain monitoring, to provide accurate data for machine-to-machine automation.

Oxygen pump:

Fresh air is funneled into mines so that the miners have fresh air to breathe. When oxygen levels are at less than 10%, the air gets behind a failed leaking gas seal designed purposely to prevent the migration of oxygen into mined-out areas where coalbed methane is normally and safely contained.Flow through" ventilation: air is sucked into a shaft underground by fans on the surface, while extractors at the top of the mine drag the air back out. As it passes through the various passageways of the mine it brings with it the fresh supply of oxygen.

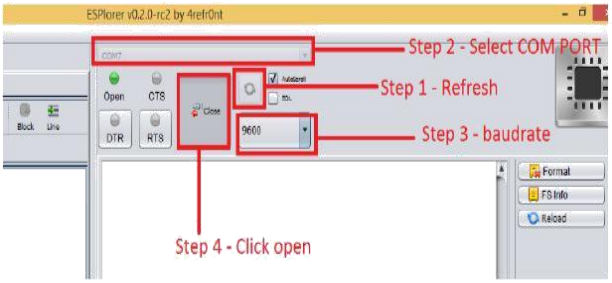
Coal dust is made of dangerous carbon-containing particles that coal miners are at risk of inhaling, which is why it is mostly considered an occupational (workplace) disease. Coal miners may also be exposed to silica-containing dust because coal mining may involve some drilling into silica-containing rock.Industries use 99.7% pure oxygen because the impurities present in the naturally occurring oxygen or low purity oxygen will not serve industrial requirements. Oxygen used in steel making must be of high quality in order to sustain burning processes.

SOFTWARE DESCRIPTION:

Right now you don't need to worry how this code works, but how you can upload it to your ESP8266.
Having your ESP8266+PL2303HX Programmer connected to your computer, go to the ESPlorer IDE:

Look at the top right corner of your ESPlorer IDE and follow these instructions:

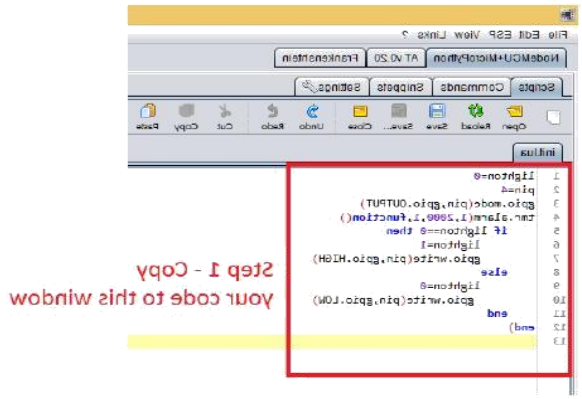
- Press the Refresh button.
- Select the COM port for your FTDI programmer.
- Select your baudrate.
- Click Open.



Then in the top left corner of your ESPlorer IDE, follow these instructions:

1. Select NodeMCU
2. Select Scripts
3. Create a new filled called “init.lua”

Copy your Lua script to the code window (as you can see in the Figure below):



The next step is to save your code to your ESP8266!

At the left bottom corner click the button “Save to ESP”.In your output window, it should start showing exactly which commands are being sent to your ESP8266 and it should look similar to the Figure below.

Note: If you want to delete your “init.lua” file, you can do that easily. Simply type file.remove(“init.lua”) and press the button “Send” (see Figure above). Or you can type the command file.format() to remove all the files saved in your ESP8266. You can type any commands and send them to your ESP8266 through that window.

After uploading your code to your ESP8266, unplug your ESP8266 from your computer and power up the ESP8288 module.

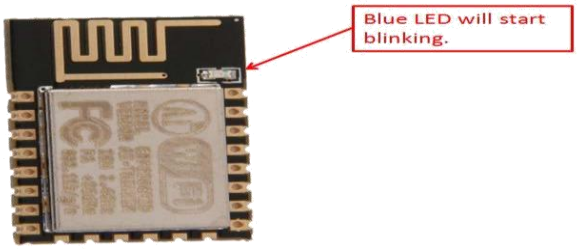


Fig.7. Blue Link

NodeMCU GPIO for Lua: The GPIO(General Purpose Input/Output) allows us to access to pins of ESP8266 , all the pins of ESP8266 accessed using the command GPIO, all the access is based on the I/O index number on the NoddMCU dev kits, not the internal GPIO pin, for example, the pin ‘D7’ on the NodeMCU dev kit is mapped to the internal GPIO pin 13, if you want to turn ‘High’ or ‘Low’ that particular pin you need to called the pin number ‘7’, not the internal GPIO of the pin.

When you are programming with generic ESP8266 this confusion will arise which pin needs to be called during programming, if you are using NodeMCU devkit, it has come prepared for working with Lua interpreter which can easily program by looking the pin names associated on the Lua board

If you are using generic ESP8266 device or any other vendor boards please refer to the table below to know which IO index is associated to the internal GPIO of ESP8266.

RESULT & ANALYSIS:

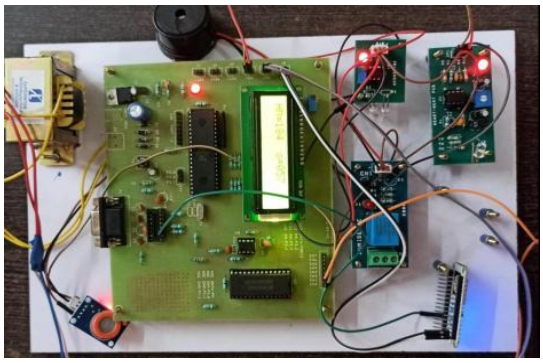


Fig:8. Output

This section discusses the results of the proposed system. The sensors sense the environmental conditions around the miner working in underground mining. All the real time data is display on LCD, and also updated on the web by using IoT. If any of the environmental parameters exceeds its standard value the miner, co-miners, supervisor and the control station get notify by buzzer. If any hazardous event occurred in the mine in such case the control station will be able to provide the rescue team as early as possible.

To build this system, open-source solutions were provided, and components used in the proposed safety alert system, such as CH4 ,CO Gas Sensor, ADC, SPO2, Helmet sensor(IR Sensor), Node MCU(ESP8266) and LCD display 16×2 is used to to display the critical situation in the mines to the control station.By incorporating various sensors and communication technologies, Smart Helmets can detect and alert miners to the presence of hazardous conditions, such as toxic gases, high temperatures, excessive noise levels, and impacts, in real-time.

CONCLUSION :

- IoT-based Smart Helmets have IoT-based Smart Helmets have the potential to revolutionize hazard detection and monitoring in the mining industry, improving worker safety, increasing operational efficiency, and reducing costs.
- By incorporating various sensors and communication technologies, Smart Helmets can detect and alert miners to the presence of hazardous conditions, such as toxic gases, high temperatures, excessive noise levels, and impacts, in real-time.
- The data collected by the Smart Helmets can also be used for real-time monitoring, decision-making, and regulatory compliance .However, the deployment of IoT-based Smart Helmets also presents challenges and imitations, including technology adoption, sensor performance, wireless communication, and data security and privacy, and battery life.
- Addressing these challenges requires a thorough understanding of the specific mining environment, careful selection of sensors and communication protocols, robust security measures, and ongoing maintenance and optimization of the system.
- In summary, IoT-based Smart Helmets have the potential to significantly enhance hazard detection and monitoring in the mining industry, contributing to safer and more efficient mining operations. As technology continues to advance and the challenges and limitations are addressed, IoT-based Smart Helmets are likely tbe come an increasingly integral part of the mining industry's safety practices and procedure.

FUTURE SCOPE:

While smart helmets have already made significant advancements in Enhancing safety in mining, there are several areas of future work that can further Improve their effectiveness. Here are some potential areas of focus:

1.Enhance the helmet's sensor capabilities to detect a wider range of hazards Specific to mining environments. This could include the detection of specific Gases, particulate matter, radiation levels, and seismic activity.

2.Integration with advanced analytics and machine learning algorithms can Enable real-time analysis of sensor data and prompt alerts for potential Dangers. Implement comprehensive data analytics systems to collect and Analyze data from Smart Helmet.. This can provide valuable insights into Safety trends, identify areas for improvement, and support decision-making Processes for safety protocols and equipment optimization.

3.These analytics can also help in conducting post-incident analysis an Understanding the root causes of accidents for continuous safety Improvements.

Develop more efficient power management systems to extend the battery life of Smart helmets. Longer battery life ensures uninterrupted usage during long shifts, Reducing the need for frequent recharging or battery replacement.

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