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IoT Based Coal Mine Tracking and Worker Safety Emergency Alert

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Abstract: ***Due to global warming and climate change, there are now difficult conditions in the coal mining industry. Automation in the field of coal mine-shaft is in fact necessary to reduce costs and boost profitability while also improving product quality, and it will also reduce diggers' efforts. Mining is both necessary for the manufacture of goods, infrastructure, and services that improve people's lives and one of the world's most dangerous trades. The need for coal as a source of energy is always high and significant. However, hundreds of people have died in mining accidents around the world, and working in the earth poses a variety of security and health risks. Underground miners in some nations lack safety and social protection, and in the event of injury, they may be left to fend for themselves. There are also negative societal consequences, such as displacement and lost income. Among all industries, the mining industry has the greatest rate of occupational mortality. Rock falls, a sagging roof, and a sagging pillar are all common causes of workplace deaths. Underground mines provide a lot of case studies. To deal with all of these tragedies, we need to improve communication technology, which will be used to create an intelligent sensing and warning system. For communication within the mines, RF technology has been adopted. So, utilizing a microcontroller-based circuit on worker safety, we suggest a mining tracking and safety system for the mining business. To detect workers moving throughout the mining site, we deploy RF-based circuitry. The main microcontroller was an ARDUINO UNO. The system employs ATMEGA microcontroller-based RF tracker circuitry to transmit and receive data through the usage of an EM-18 RFID reader module and RFID cards. This aids in the tracking of workers' present locations across the entire mining site. The DHT11 sensor is used to determine the current temperature and humidity. The accelerometer sensor is used to determine whether or not a worker has fallen. MQ2 and MQ135 sensors are used in mines to detect dangerous chemicals and smoke and inform workers. A flame sensor detects a fire in a mine and alerts the workers. Furthermore, safety is the most important aspect of every industry. Safety and security are extremely important in the mining business. Each RFID card circuit includes an emergency button to prevent any form of mishap. When this button is touched, an emergency alert appears. This technology can be used to safeguard the safety of mine workers through the usage of IoT.***

Keywords: Safety of worker, Real Time Operating System, Monitoring System, NODEMCU, Arduino UNO, JSON Code, IP Address

I. INTRODUCTION

The process of obtaining coal from the earth is known as coal mining. Coal is used as a fuel in the steel and cement industries to extract iron from iron ore and to make cement. Every parameter, such as methane gas, high temperature, fire incidents, and so on, must be checked on a regular basis in the underground mining business. Coal mine safe production levels are still low, and tragedies in coal mines occur often, resulting in significant loss of property and life. These dangers are present in the coal industry. As a result, worker safety should always be a top priority in any type of construction project. In terms of worker safety and health, underground mining operations are a risky business.

To address this issue, we have proposed the use of a wireless sensor network in a coal mining safety system. We're utilizing an Arduino Uno as a slave controller and a Node-MCU as a master controller in this example. The Arduino Uno takes data from several sensors and sends it to the Node-MCU. As a result, Node-MCU may generate an IP address. We must copy the IP address and put it into a browser that is handy for us. As a result, the received data is shown on the webpage. Sensors such as an accelerometer determine if work is falling down or working, a flame sensor detects whether there is a fire nearby, a gas sensor detects methane or other gases, and a temperature sensor detects the temperature in that region. These many sorts of sensors reveal whether or not a person is able to operate in a certain environment. As a master controller, Node-MCU with the model ESP8266.The RF-Reader is connected to the ESP8266 and communicates in SPI to keep track of the worker’s attendance (Serial Peripheral Interface).

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II. COMPONENTS USED IN THE SYSTEM

A. Arduino UNO

Arduino is primarily an open-source platform used for creating electrical projects (Fig. 1).

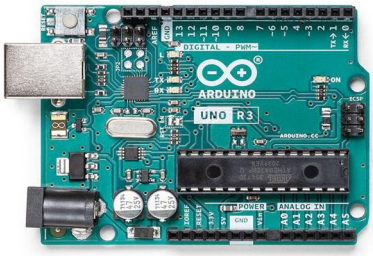


Figure 1: Arduino UNO

The most often used board is UNO [6]. The CPU is an ATMega328, running at a clock speed of 16MHz on a 5V supply. The ATMega328 is an eight-piece AVR RISC-based microcontroller with 32KB flash memory, 1KB EEPROM, 2KB SRAM, 23 GPIOs, 32 universally useful registers, three programmable clock/counters with look at modes, inner and outer intrusions, sequential programmable USART, a byte-arranged 2-wire sequential interface, SPI sequential port, six channels and ten pieces of A/D converter, programmable guard dog clock with internal oscillator.



Figure 2: Arduino IDE

The Arduino IDE is a tool for writing code and sending it to the loader (Fig. 2). There are two ways to operate an Arduino board. One using the USB connection from the PC, and two using the force barrel jack from the AC mains. A voltage controller on the board distributes balanced DC voltages to each component. It features a precious stone oscillator to provide the 16MHz clock repetition, a reset button to reset the system, 3.3V and 5V output supply pins, a ground pin, and a 3.3V and a 5V output supply pin.
The Arduino UNO contains six straightforward pins for examining data from basic sensors and converting it to a computerized structure for the microcontroller's comprehension. There are 6 PWM age pins and 1 UART pin among the 14 computerized I/O sticks. The Tx, Rx, and force LEDs are also included on the Arduino UNO board. It provides a common structural factor that divides the components of the smaller scale controller into an expanding set of options.

B. NODEMCU:

The ESP8266 is a potent, reasonably priced Wi-Fi module suitable for integrating Wi-Fi functionality into an already-existing microcontroller project through a UART serial connection. If power is added, the module will even be reprogrammed to function as an independent Wi-Fi connected device. The ESP8266 chip is very integrated with the antenna switch balloon, power management device, bottom external electrical equipment, front-end module, and full resolution intended to reduce the space taken up by PCB. The system comes with ESP8266, which has the following leading features: energy-saving VoIP that switches quickly between sleep and wake patterns, front-end signal processing functions, low-power operation adaptation radio bias, troubleshooting, and radio systems that are characteristics to eliminate cellular, Bluetooth, DDR, LVDS, and alphanumeric display interference. A full and independent Wi-Fi network solution, the ESP8266 may carry code applications and disable all Wi-Fi networking features. The non-volatile storage will be launched straight from an external move once the device is attached and since it is the only application of the appliance processor. Cache memory that is built into the system can help boost speed and reduce the need for memory. Another situation is that, once wireless internet access takes on the role of a Wi-Fi adaptor, you can easily add it to any microcontroller-based design using either a hardware AHB bridge interface or the SPI / SDIO interface.

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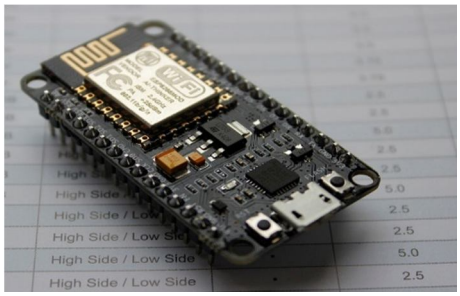


Figure 3: NODEMCU

C. MQ135 Sensor

An air quality gas sensor is a device that is used to detect, measure, or monitor gases like ammonia, benzene, Sulphur, Carbon dioxide, smoke, and other dangerous gases. The MQ135 air quality sensor, which is a member of the MQ gas sensor family, is frequently used to identify dangerous gases and smoke in outdoor air. This article provides a quick explanation of how to use a MQ135 air quality sensor to measure and identify gases.



Figure 4: MQ135 SENSOR

D. MQ2 Sensor

MQ2 is one of the commonly used gas sensors. It is a metal oxide semiconductor type gas sensor also known as chemiresistors. MQ2 gas sensor works on 5Dc and draws around 800mW. Detects LPG, smoke, Alcohol, propane, hydrogen, methane and carbon monoxide concentrations anywhere from 200 to 10000ppm.



Figure 5: MQ2 Sensor

E. RFID Reader

A radio frequency identification (RFID) reader is a tool that extracts data from an RFID tag, which is used to track certain items. Data is sent from the tag to a reader via radio waves. In principle, RFID technology is analogous to bar codes. However, neither direct scanning of the RFID tag nor line-of-sight to a reader are necessary. The RFID tag must be in the 3-to-300-foot reading range of an RFID reader in order to be read. RFID technology makes it possible to swiftly scan a number of objects and easily identify a certain product, even when it is surrounded by numerous other things.

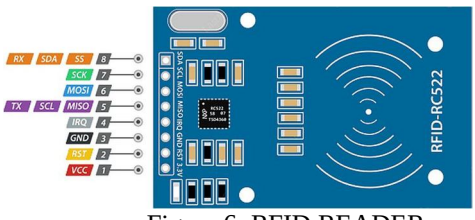


Figure 6: RFID READER

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F. DHT11 Sensor

The DHT11 is a commonly used temperature and humidity sensor. The sensor comes with a deliciated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature as serial data. The sensor can measure temperature from 0 degree to 60 degree. And humidity from 20% to 90%.

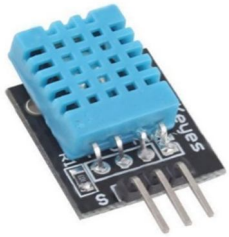


Figure 6: DHT11 SENSOR

G. Accelerometer Sensor

A sensor that can measure acceleration is an accelerometer. Masses, dampers, elastic components, sensitive components, and adaptive circuits are typically included. The sensor measures the inertial force acting on the mass block during acceleration and calculates the acceleration value using Newton's second law. Common accelerometer sensors include capacitive, inductive, strain gauge, piezo resistive, piezoelectric, and others, depending on the sensitive parts of the sensor.

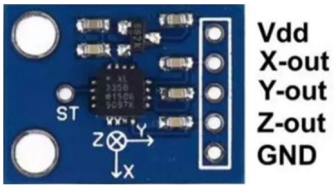


Figure 7: ACCELEROMETER

H. Flame Sensor

One type of detector that is primarily made for both detecting and responding to the advent of a fire or flame is a flame-sensor. Depending on how it fits, the flame detection reaction may vary. It has a fire suppression system, a propane line, a natural gas line, and an alarm system. Industrial boilers utilize this sensor. This has the primary purpose of providing verification of the boiler's correct operation. Because of their technique for sensing the flame, these sensors respond more quickly and accurately than a heat or smoke detector.



Figure 8: FLAME SENSOR

I. Emergency Button

A push-button, often known as a pushbutton or just a button, is a straightforward switch mechanism used to operate a machine or process. Hard materials, usually plastic or metal, are used to make buttons.



Figure 9: PUSH BUTTON

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III. EXPERIMENTAL SETUP

The esp8266 Wi-Fi module is used to operate the entire system through the Arduino UNO board. Using sensor modules and a Wi-Fi module to relay data to a server, the situation underground may be determined. This system is mostly utilized to carry out activities, such as monitoring the situation underneath.

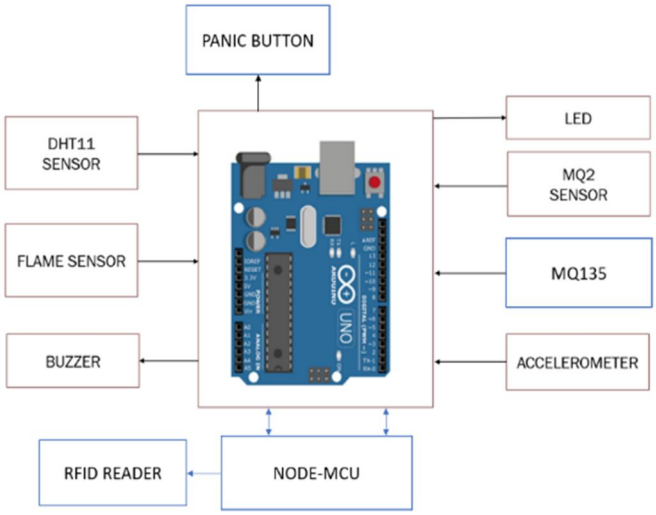


Figure 8: Block Diagram of the System

IV. EXPERIMENTAL SETUP

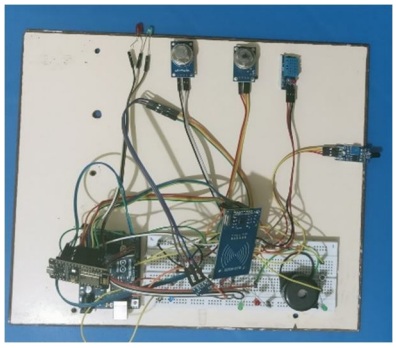


Figure 9: Without Power Supply

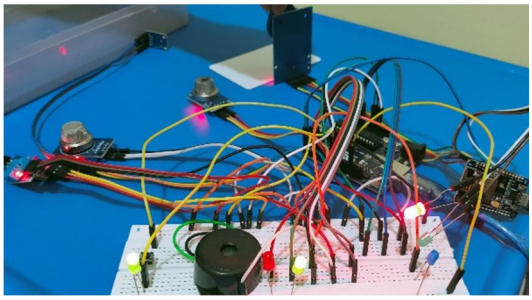


Figure 10: With Power Supply

V. APPLICATIONS

Monitoring and warning of the environment, worker free fall alert, monitoring and warning of the device, tracking supervision of subterranean employees, and wearable technology.

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VI. ADVANTAGES

A. Improved services in coal mines.
B. Cost-effective.
C. Efficient.
D. Wireless connection security.

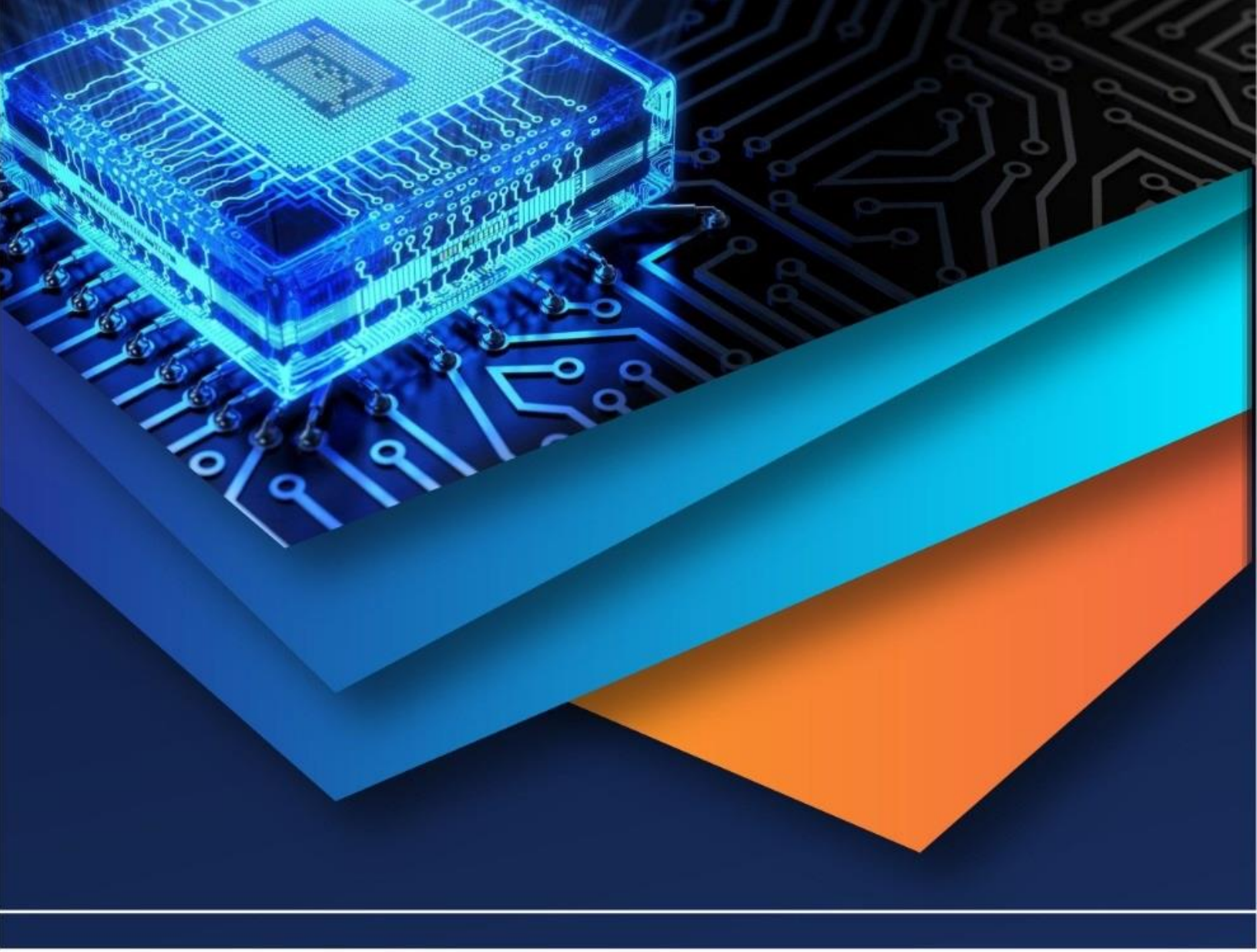
VII. CONCLUSION

The protection of personnel, assets, and the environment is necessary for mining activities. Arduino, Gas sensor, Fire sensor, MQ2 sensor, and DHT11 sensor are used to create the coal mine safety system. The flame sensor will notify the worker when flame is detected to promote worker safety in the coal mine. Workers are protected from hazardous gases using MQ2 sensors. DHT11 sensor is used to monitor temperature and humidity. Accelerometer sensor interface is used to determine if a worker is falling or is in a normal state. Additionally, Node-MCU is interfaced with Arduino to update the observed data on the IoT webpage. Node-MCU and Arduino start talking to one other. Node-MCU serves as the master device in this instance, while Arduino serves as the slave device. We can monitor the worker's work space and offer safety by employing this technology.

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