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Smart Alerting System Mine Workers

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Abstract: ***The mining industry is known worldwide for its highly risky and hazardous working environment. Technological advancement in any metal and coal extraction techniques for proliferation of production levels has caused further concern for safety in this industry for mines workers. This paper presents Mines workers face numerous hazards while working in mines, and it is essential to provide them with a safe working environment. In this paper, we propose a smart alerting system for mines workers that utilizes sensors and sensing technique to detect potential hazards and alert workers in real-time. The proposed system is working smartly - it monitors, controls and alerting by itself and feedback Button is provided for workers from which they can with the help this system send alert signal to control room. The system proposed here consists of devices sensor & Button equipped with sensors that monitor various parameters such as temperature, gas concentration. The data transmitted to a central server, by Wi-Fi and using ESP NOW technique using for transfer deep mine data to central server and data collected by these sensors are used to analyze the data and detect potential hazards.***

Keywords: Wireless Fidelity (Wi-Fi), Espressif Systems (ESP), Smart Alerting , sensors, Mines.

I. INTRODUCTION

Studies indicate that mining is one of the most perilous occupations in the world in terms of injuries and fatalities, of human's life and long-term health effects associated with it.[1][2] Mining are non-renewable and limited natural resources and constitute vital role raw material in a number of basic and important industries. Mainly mining sector affect several natural resources of environment that are: Air, Water, Land & Health, and safety of species.[1] This system applicable in two types of mining methods surface and subsurface. Surface Mining, the ore is accessed directly from the Earth's surface, and contact is maintained with the surface throughout the operation. Surface mining may produce dust from blasting operations and haul roads.[3][2] Many coals mines release methane, greenhouse gases (Carbon dioxide, Methane, Nitrous oxide, Fluorinated gases: (Hydrofluorocarbons, perfluorocarbons, Sulphur hexafluoride, and nitrogen trifluoride are synthetic - powerful greenhouse gases that are emitted from a variety of household, commercial, and industrial applications and processes gases).[7][5] Underground or subsurface mining is accomplished with the help of tunnels going into the Earth, and does not occur on the surface.[1][3] Underground mining with the perspective of Health and safety of human life it extremely hazardous to being as safe or as dangerous as any other large scale industrial activity.[8][11] Underground mining is generally more has reduced in surface mining because of poor or ventilation and visibility and the danger of Rock falls the greatest health is arrives from dust which will lead to respiration problem and from exposure to radiation. In mines when Workers go inside the earth to extract the earth's subsurface elements.[9][1] Normally, when working within the mine, the oxygen level falls below the prescribed threshold, causing negative impacts on worker health. Mining Workers face many health and several problems within the mine, this model cover mainly subjected to three sorts of criteria, according we identified which are as follows: abnormal Temperature, Hazardous Gas, Trapped in mines.[2][5]

Mines workers are subjected to a range of dangers, including cave-ins, explosions, fires, and exposure to toxic gases.[2] The safety of workers is paramount, and employers must take appropriate measures to ensure the well-being of their staff. One of the key challenges inside the mining industry is providing timely and effective alerts to workers in case of emergencies or potential hazards.[4] Traditionally, mines workers have relied on manual warning systems such as bells, whistles, and horns to alert them of danger. These systems, however, have proven to be unreliable and ineffective, particularly in noisy environments. In present times, there is a sharp growth in the demand of smart alerting systems that can provide real-time notifications to workers in mines.[2][6]

The smart alerting system for mines workers is a project that aims to develop a reliable, efficient, and cost-effective, Effective & Accurate alerting system that uses advanced technologies to notify workers of potential hazards before it arising or if detected.[7] This system will leverage the latest in wireless communication, sensors, and data analytics to provide workers with real-time alerts. In this system we cover temperature, gas, trapping and communication.[13][7] This system is based on wireless technology which is easy to install, cost efficient and can easily be restored after any disaster.[12] As you move further into the mine, the temperature under the surface changes and may create problem in respiration.

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Mining for metals and coal typically entails the immersion of hazardous gases, which induce headaches, dizziness, and other symptoms in employees.[13][9] Mine produces lots of dust Due to blasting and drilling it may cause of Vibrations, which may occur surface disturbance in mines for workers, typically occur in the vicinity of tectonic plates, causing them to experience intense vibrations. Workers become trapped beneath the mine in all these scenarios.[10] Because of this all problems faced by workers this model is developed for safety of workers works in mining area. There are two module (sender & receiver) and Main components that are used DHT11- temperature sensor, Push (feedback or emergency) button, MQ2 gas sensor, controller board NodeMCU with ESP8266.[3][17] Using the "feedback button," person may send signal and notify the control room worker trapped in mines and their difficulty and request assistance for help. All these components work together to gather and interpret data, which is subsequently sent to the control room via another module. The ESP8266 board used ESPNOW method is used in this transmission. [15][6] Communication is just from sender to receiver; it is a one-way communication mechanism. After receiving the data, the receiver module examines it and provides relevant commands.[14]

II. BLOCK DIAGRAM DESCRIPTION

This smart alerting system contains several components like boards (Node mcu esp8266), LCD
(Liquid crystal display), different sensors and other small electronic components. This is detailed review of each of this part along with its principle. In this proposed system the coal mine safety systems are fixed with gas sensor modules, temperature sensor, Feedback button and relays. We integrate all the sensors to the controller. First, we need to create an account in the Thing Speak platform. In this system we mainly have monitoring, controlling systems and alerting. In monitoring system, we monitor all the data from different sensors and button. sensors detect the gas and temperature from mine environment. If the gas and temperature level exceed the normal level, then the buzzer gets high so that the mine workers get notified. for analysis and for further use. The Gas and temperature values are monitored inside the mine and send data control unit through ESPNOW. The proposed system block diagram shown in fig

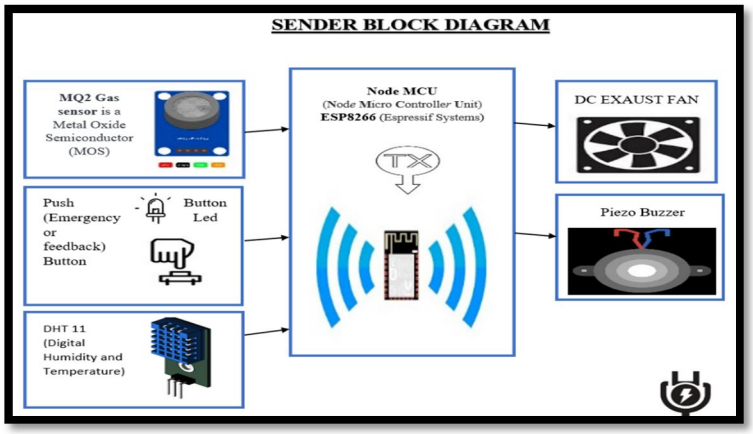


Fig:1.1 Block Diagram of Sender Module

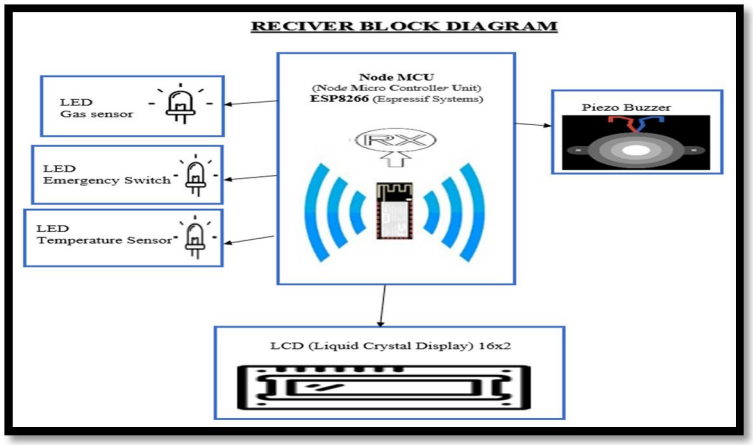


Fig:1.2 Block Diagram of Receiver Module

III. LITERATURE REVIEW

Yongping Wu and Guo Feng implement coal mine monitoring using Bluetooth wireless transmission system. As a unified global short-range wireless communication standard, Bluetooth technology aims to create a common low-energy, low-cost wireless air interface and software opening control system. This paper describes the development background, technical features and protocol stack structure of Bluetooth technology and proposes a Bluetooth host controller interface (HCI) wireless communication solution for the complexity of its development [1]

Mining is a dangerous occupation that poses significant risks to workers' safety and health. According to the International Labor Organization (ILO), the mining industry accounts for a high number of workplace fatalities and injuries worldwide. The ILO estimates that over 15,000 workers die every year from mining-related accidents, with many more suffering from injuries and illnesses caused by exposure to hazardous substances (ILO, 2019). To address these safety concerns, the mining industry has turned to technology to improve safety conditions and minimize risks to workers. One of the most promising technological innovations in the mining industry is the development of smart alerting systems for workers. These systems use advanced sensors, wireless communication, and data analytics to detect and alert workers of potential hazards and emergencies in real-time. In recent years, there have been several studies and projects aimed at developing smart alerting systems for mines workers. This literature review will provide an overview of the research conducted in this area and highlight the key findings and recommendations.[2]

A study by Chakraborty et al. (2018) proposed a smart alerting system that uses a combination of wireless sensors, machine learning algorithms, and cloud computing to detect and notify workers of potential hazards in mines. The system was designed to detect and monitor several types of hazards, including gas leaks, fires, and equipment malfunctions. The authors reported that the system was able to provide accurate and timely alerts to workers, which improved safety conditions in the mines. In a similar study, Zhao et al. (2020) developed a smart alerting system for underground coal mines that used wireless sensors and machine learning algorithms to detect and classify potential hazards. The system was able to detect several types of hazards, including gas leaks, fires, and rockfalls. The authors reported that the system was effective in alerting workers of potential hazards, and they recommended further research to improve the system's accuracy and reliability.[3]

Another study by Wu et al. (2019) proposed a smart alerting system for workers in open-pit mines that used wireless sensor networks and data fusion algorithms to detect and classify potential hazards. The system was able to detect several types of hazards, including slope instability, rockfalls, and equipment malfunctions. The authors reported that the system was effective in alerting workers of potential hazards, and they recommended further research to optimize the system's performance.[4]

In a study by Li et al. (2021), a smart alerting system was developed for workers in underground metal mines that used a combination of wireless sensors, machine learning algorithms, and cloud computing. The system was able to detect several types of hazards, including gas leaks, fires, and equipment malfunctions. The authors reported that the system was effective in providing timely alerts to workers, which improved safety conditions in the mines. In addition to these studies, several research projects have been conducted to develop and test smart alerting systems for mines workers. For example, the Smart Underground Monitoring and Integrated Control System (SUMICS) project, funded by the European Union, developed a smart alerting system for underground coal mines that used wireless sensors, machine learning algorithms, and data analytics to detect and classify potential hazards (SUMICS, 2019). [5]

In addition to the studies and projects discussed above, there have been several other research efforts aimed at developing and implementing smart alerting systems for mines workers. For example, a study by Zhang et al. (2018) proposed a system that used wireless sensors and machine learning algorithms to detect and alert workers of potential hazards in coal mines. The system was able to detect several types of hazards, including gas leaks, fires, and equipment malfunctions, and it provided real-time alerts to workers. The authors reported that the system was effective in improving safety conditions in the mines and recommended further research to optimize the system's performance.

Similarly, a study by Lian et al (2020) proposed a smart alerting system for workers in underground metal mines that used wireless sensors, data analytics, and cloud computing. The system was able to detect several types of hazards, including gas leaks, fires, and equipment malfunctions, and it provided timely alerts to workers. The authors reported that the system was effective in improving safety conditions in the mines and recommended further research to optimize the system's performance and reduce false alarms.

Despite the promising results reported in these studies, there are still several challenges associated with implementing smart alerting systems in mines. One of the main challenges is the cost of these systems, which can be prohibitively high for many mines, particularly smaller operations. Additionally, there are concerns about the reliability and scalability of these systems, particularly in remote locations with limited access to reliable communication networks.

To address these challenges, researchers have proposed several solutions, including the use of low-cost sensors and communication technologies, the integration of multiple sensors and data sources to improve reliability and accuracy, and the development of hybrid systems that combine smart alerting systems with other safety measures, such as personal protective equipment and training programs.[7]

IV. STRUCTURE OF PROPOSED SYSTEM

The system's structure comprises several components, including the NodeMCU ESP8266 board and controller, which is the central processing unit.[1][4] The MQ-2 gas sensor measures gas concentrations and sends the data to the NodeMCU ESP8266. [2] The DHT11 temperature sensor detects temperature changes and triggers the appropriate actions.[11][3] The feedback (EMERGENGY) button is connected to the NodeMCU ESP8266 and enables workers to send emergency messages to the control room.[3] The 16x2 liquid crystal display provides information about the system's status and alerts, and the LED and buzzer provide visual and audible alerts, respectively

A. Proposed System

The proposed project is a smart alerting system for mine workers that aims to enhance their safety while working in the mine.[8] The system comprises several components, including an MQ-2 gas sensor, an DHT11 temperature sensor, a Feedback Button, a DC 5V exhaust fan, a NodeMCU ESP8266 (board + controller), a liquid crystal display(16X2), LED (red & green), a relay, and a buzzer.[2][7] The system is designed to be fully customizable, allowing it to be used by any industry that requires a similar safety alerting system. It is a wireless device that transfers data in a short packet transmission manner, and multiple devices can communicate with one another without using Wi-Fi, like low-power 2.4GHz wireless connectivity.[3][10] Additionally, it is a highly economical and intelligent system that monitors, analyses, controls, and alerts in real-time. The system's primary objective is to arrange a one-way communication data transfer between the sender and receiver. [1] The MQ-2 gas sensor measures LPG, smoke, alcohol, propane, hydrogen, methane, and carbon monoxide concentrations ranging from 200 to 10000 ppm. The DHT11 temperature sensor detects the temperature and triggers different actions depending on the temperature range.[3][5] For example, if the temperature is between 31 to 50 degrees, the exhaust fan will turn on to control the temperature.[2] If the temperature exceeds 51 degrees, then all the emergency devices got activated, exhaust fan is continuously run to pull down the over exceeded temperature, LED will turn on and the buzzer will make a noise to alert workers of exceeded temperatures until someone reset it (In this model we are using a 100-watt bulb for giving heat purposes only.[17][18] For a demonstration of fast and easy detection of external environment heat).[9] This feature can help prevent heat stroke, which can be deadly. If someone or all the workers got trapped in the mines then this feedback Button (push button) is provided to enable workers to send emergency messages to the control room to alert them.[7][16] This function allows workers to notify management of any danger or emergencies, enhancing their safety. The smart alerting system for mine workers is a highly advanced and intelligent system that can enhance the safety of workers in the mining industry.[20] It is a fully customizable and wireless system that can be used in any industry that requires similar safety alerting systems. With its various components and features, it can monitor, analyze, control, and alert workers and management of any dangers or emergencies in real-time.[1][23]

B. Hardware Design and Implantation

The component used in the hardware design of the present work has been tabulated in table 1.

Table 1.1 List of Hardware Components

S. No.	Name	Quantity	Specification
1	MQ-2 Gas Sensor	1	800 mw
2	DHT11 Sensor	1	1 MW
3	Push Button (Feedback Switch)	1	
4	Dc 5v Exhaust Fan	1	600MW
5	NODE MCU ESP 8266 (Controller Board)	2	400MW
6	16x2 Liquid Crystal Display	1	
7	Led (Red)	2	20MW
8	Led (Green)	2	20MW
9	Relay	1	450MW
10	Buzzer	2	75MW

C. Software Design and Implantation

In the present work, the programming of ESP8266 microcontroller has been done in embedded C language.

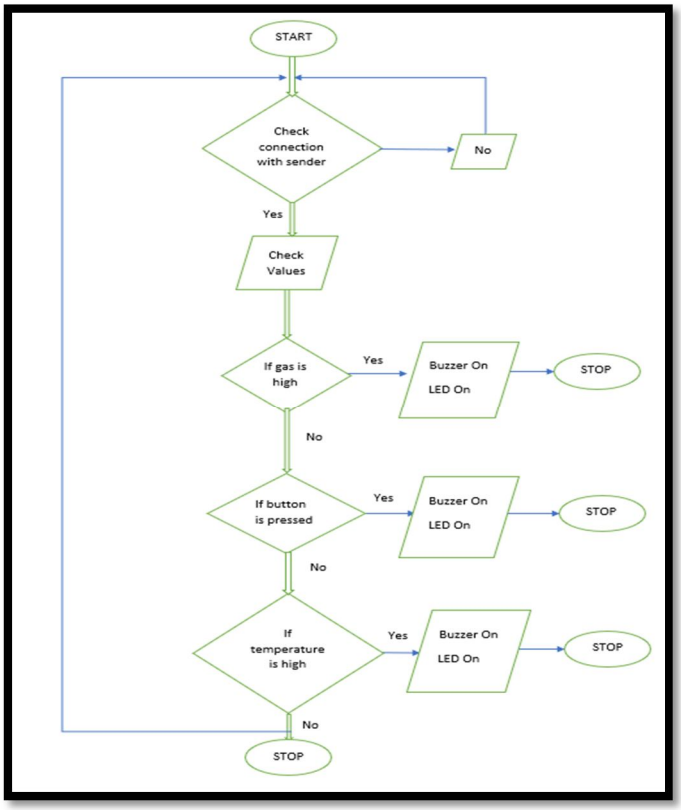


Fig:1.3 Flow Chart of Sender

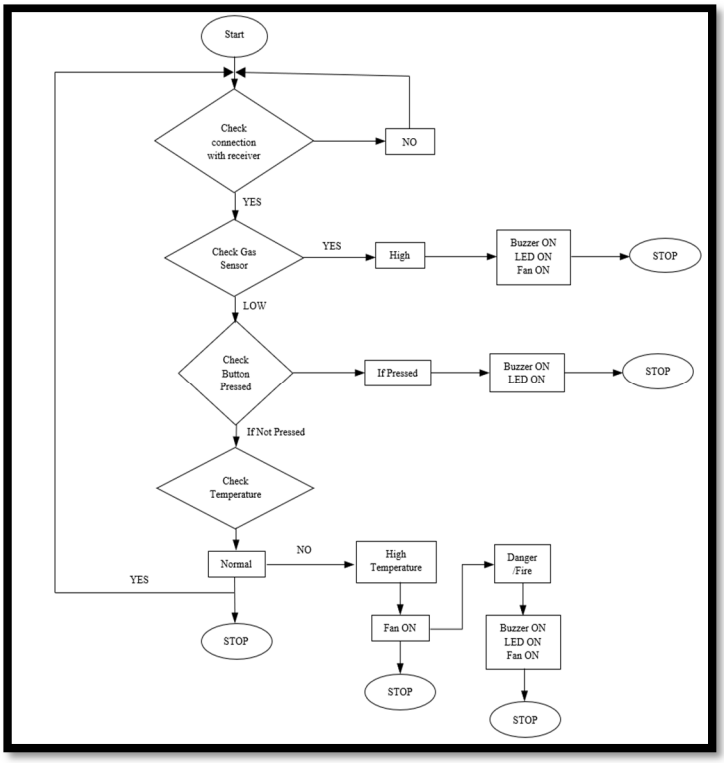


Fig:1.4 Flow Chart of Receiver

D. DHT11 Temperature Sensor

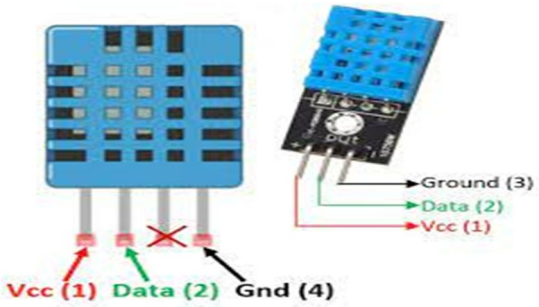


Fig:1.5 DHT11 Temperature Sensor

The widely used DHT11 temperature and humidity sensor has an exclusive NTC for temperature measurement and an 8-bit microprocessor to output the temperature and humidity measurements as serial data.
Voltage Range: 3.5 to 5.5V
Operating current: (measuring) 0.3 mA 60 uA (standby)
Data output in serial
Range of temperatures: 0°C to 50°C
Range of Humidity: 20% to 90%
The DHT11 temperature and humidity sensor is a low-cost, simple-to-use digital sensor that can accurately monitor temperature and humidity. It is a widely used sensor in a variety of applications such as home automation, weather stations, and greenhouse monitoring.[2][5][16] In this post, we will look at the DHT11 temperature sensor's capabilities, how it operates, and its uses. The DHT11 sensor has a small footprint and is made up of a thermistor and a capacitive humidity sensor.[20] It transmits data using a single-wire communication interface, making it simple to attach to a microcontroller or a single-board computer. The sensor is designed to monitor temperature from 0 to 50 °C with a 2 °C accuracy and humidity from 0% to 100% and the range of 20 to 80% with an accuracy of ±5%.[25][3] The DHT11 sensor's operation is dependent on the capacitance of the humidity sensor and the resistance of the thermistor. The humidity sensor is composed of two electrodes separated by a moisture-absorbing substance. As the humidity level varies, the capacitance of the sensor changes, which is detected and translated to a humidity value. The thermistor measures the temperature and alters its resistance as the temperature varies.[19][21] The resistance value is measured and translated to a temperature value. The sensor subsequently sends the temperature and humidity measurements through digital transmission.[16]
The DHT11 sensor is simple to use and may be connected to a microcontroller through a single digital pin.[7][9] It requires a 5V power supply and may be set to take readings. The DHT11 sensor has a wide range of uses. It may be used to monitor room temperature and humidity levels in home automation systems, which can then be utilized to regulate air conditioning or heating systems.[6][15] It is also employed in weather stations to measure temperature and humidity levels, which may be used to forecast weather patterns. The sensor may also be used in greenhouses to monitor temperature and humidity levels, which can be utilized to adjust the atmosphere for maximum plant development.[6][19] Finally, the DHT11 temperature and humidity sensor is a flexible and cheap sensor that may be utilized in a variety of applications. Its small design, precision, and ease of use make it a perfect choice for both enthusiasts and professionals.[3]

E. LCD (Liquid Crystal Display)

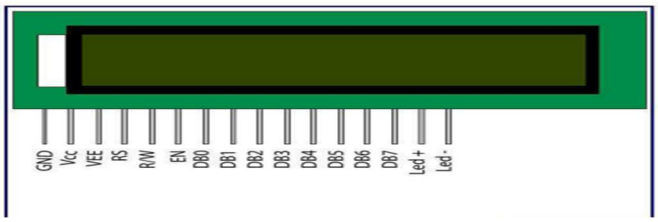


Fig:1.6 LCD (LIQUID CRYSTAL DISPLAY) 16x2

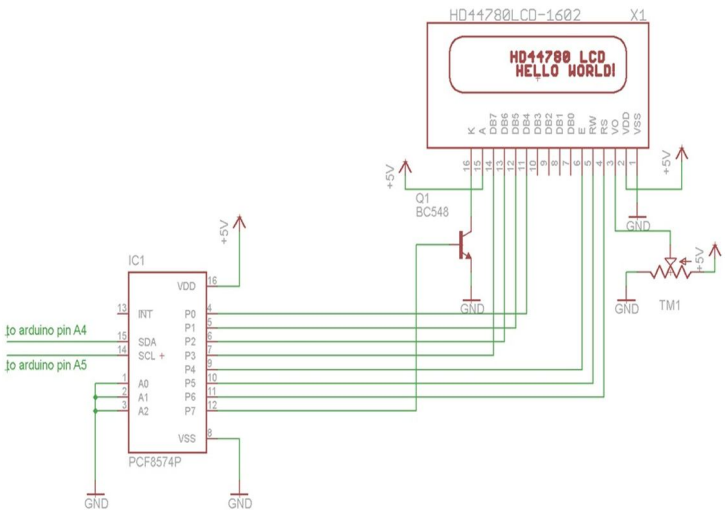


Fig:1.7 Block diagram of LCD 16x2 with I2C module

LCD, or Liquid Crystal Display, is a display technology that has transformed the industry. It creates pictures or words on the screen by utilizing a layer of liquid crystals that can be adjusted to let light through or block it. LCD, screens are widely utilized in devices such as televisions computer monitors, and smartphones.[18][2] One of the primary benefits of LCD technology is its low power consumption. LCD panels consume far less electricity than earlier display technologies such as CRT.[6][22] LCD displays do not require high voltage to develop a picture and only waste energy when the image has to be altered. Another advantage of LCD panels is their sharpness and clarity. LCD panels can display high-resolution pictures, making them excellent for watching films. LCD screens also have higher color accuracy and a wider color spectrum than many other display technologies. LCD technology has also allowed for the creation of thinner and lighter screens.[20][23] This has enabled manufacturers to produce slim and portable products such as laptops and smartphones that would not have been viable with prior display technology.[4] Overall, LCD technology has had a huge influence on the display industry, offering energy-efficient, high-quality, portable screens that have become ubiquitous in modern life.[3][19]

F. Piezoelectric Buzzer



Fig:1.8 Piezo Electric Buzzer

A piezoelectric buzzer is an electrical device that generates sound by utilizing the piezoelectric phenomenon. This phenomenon refers to the ability of some materials to develop an electrical charge in response to mechanical stress.[17] When a voltage is supplied to a piezoelectric material, it deforms and generates an acoustic wave, which produces sound. Piezoelectric buzzers are extensively employed in electronic devices such as alarms, timers, and other
sorts of notification systems. One of the primary benefits of piezoelectric buzzers is their low power consumption.[5][4] They do not require a separate power source to make sound since the voltage generated by the piezoelectric action is sufficient. Furthermore, they are compact and light, making them perfect for usage in portable electronic gadgets. Piezo buzzers are also extremely dependable and have a long life. They are not influenced by magnetic fields and hence may be used in areas with high electromagnetic interference.[1]

They are also stress and vibration resistant, making them excellent for use in harsh working environments. Unfortunately, piezoelectric buzzers have several drawbacks.[6] They are not appropriate for creating high-quality sound since the sound they create is often low in frequency and can be extremely harsh. They are extremely susceptible to temperature fluctuations, which might impair their performance.[1][3] Overall, piezoelectric buzzers are a common choice for electrical gadgets that require a simple and dependable sound-producing mechanism. Its low power consumption and small size make them excellent for use in portable devices, but their durability and immunity make them perfect for use in industrial applications.[23][20]

G. MQ-2 Gas Sensor

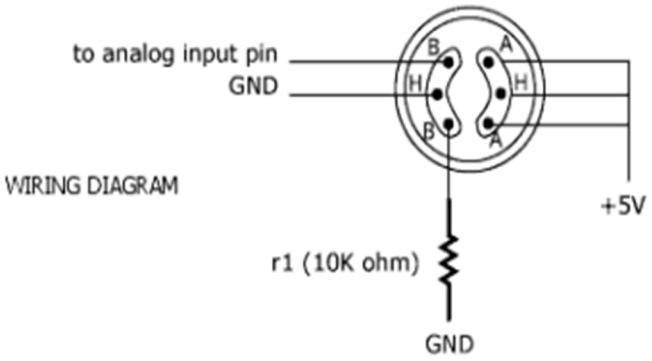


Fig:1.9 DHT11 GAS SENSOR

The MQ-2 gas sensor is a prominent gas sensor that is used in a variety of applications to detect gases such as methane, propane, carbon monoxide, and alcohol. It is a low-cost and widely available gas sensor capable of detecting gas concentrations ranging from 200 to 10,000 ppm (parts per million).[1][4] The MQ-2 gas sensor operates based on resistance change when the gas interacts with the sensor material. The sensor comprises of a heating element and a sensing element composed of metal oxide semiconductor material.

When the sensor is turned on, the heating element warms up the detecting material, which begins to absorb gas molecules from the surrounding environment.[2][13] The adsorption of gas molecules causes a change in the resistance of the sensing element, which the sensor circuit measures. The MQ-2 gas sensor has a wide sensitivity range, making it useful for detecting a variety of gases.[11] Nevertheless, because the sensor's sensitivity changes depending on the gas, it must be calibrated before use. Calibration can be accomplished by exposing the sensor to a known concentration of the gas and changing the sensor circuit accordingly.[9] The MQ-2 gas sensor has a low power consumption, making it excellent for battery-powered applications. It also has a short reaction time, enabling for instant detection of gas concentrations.[6][7] The MQ-2 gas sensor has a wide range of applications, including industrial, environmental, and safety monitoring. It may be utilized in gas leak detection systems, indoor air quality monitoring, and automobile exhaust monitoring. It is also utilized in fire detection systems to detect smoke and other flammable gases.[8][3] Finally, the MQ-2 gas sensor is a flexible and cost-effective gas sensor that has found broad use in a variety of applications. Its sensitivity to a wide spectrum of gases, low power consumption, and quick reaction time makes it a popular choice for gas detection and monitoring. Nonetheless, it is critical to calibrate the sensor for a specific gas before usage to ensure accurate findings.[2][11]



Fig:1.10 DHT11 GAS SENSOR

H. NodeMCU (ESP8266)

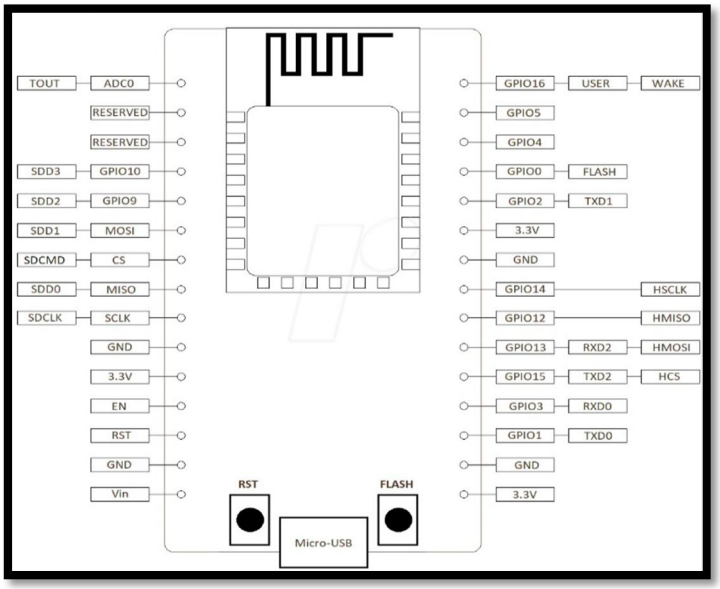


Fig:1.11 Pin Diagram of ESP8266

The module is mainly based on ESP8266 which is a low-cost Wi-Fi microchip incorporating both a full TCP/IP stack and microcontroller capability.

Features

1) Open-source
2) Arduino-like hardware
3) Status LED
4) Micro USB port
5) Reset/Flash buttons
6) Interactive and Programmable
7) Low cost
8) ESP8266 with inbuilt Wi-Fi
9) USB to UART converter
10) GPIO pins

Based on the ESP8266 Wi-Fi module, NodeMCU is an open-source firmware and development kit. It makes it simple to program and construct IoT (Internet of Things) devices using the Lua scripting language.[2] The NodeMCU board includes an integrated Wi-Fi module, making it suitable for connecting to the Internet and interfacing with other devices. The ESP8266 is a low-cost, low-power Wi-Fi module that allows for simple wireless connectivity with other devices.[4][1] It is a highly integrated semiconductor that incorporates a microprocessor, Wi-Fi module, and memory. The NodeMCU development board, which is based on the ESP8266, gives easy access to the GPIO pins, making it simple to connect to sensors and other electronic components.[3][12] The NodeMCU development kit contains a built-in USB to serial converter, making it simple to programmed the board via a USB cable. The NodeMCU board is compatible with the Arduino IDE, allowing for simple programming in the C++ programming language. Nevertheless, for programming on a NodeMCU board, it is advised to utilize the Lua scripting language because it is lighter and easier to understand. The convenience of connecting to the Internet is one of the benefits of utilizing a NodeMCU board.[15][4] The built-in Wi-Fi module allows you to connect to a wireless network and communicate with other devices.[7][13] This permits the creation of IoT devices that can be controlled and monitored remotely. The NodeMCU board also supports OTA (over-the-air) upgrades, which means firmware changes may be distributed wirelessly.[1] This is a huge benefit for IoT devices that might be difficult to reach physically. Overall, the NodeMCU development kit based on the ESP8266 provides a strong and versatile platform for designing IoT devices. Its low price and ease of use make it [4][2] accessible to both enthusiasts and professionals, and its built-in Wi-Fi module and support for OTA updates make it a great choice for projects that require wireless communication.[24]

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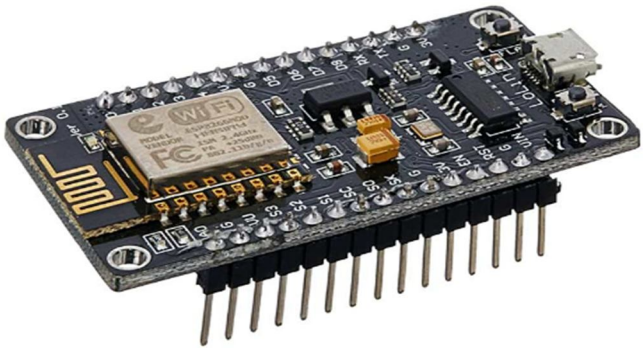


Fig:1.12 NODE MCU ESP8266

I. DC Fan

DC fans, often known as direct current fans, are electrical devices that create air movement using a direct current source.[5] These fans are extensively utilized in a range of applications, including personal computers, gaming consoles, and home appliances. One of the primary benefits of DC fans is their energy efficiency, as they consume substantially less energy than standard AC fans. Furthermore, due to their brushless motor construction, DC fans are frequently quieter and more robust than their AC counterparts. Overall, DC fans are a dependable and cost-effective alternative for cooling and ventilation demands in a variety of scenarios.[7][13]



Fig:1.13 DC EXAUST FAN

V. METHODOLOGY

The mining industry is one of the most hazardous industries in the world, and the safety of mine workers is of utmost importance. To ensure the safety of mine workers, a smart alerting system has been developed, based on the principle of “Sense-Think-Act.” This system employs sensors, microcontrollers, and wireless communication to detect and alert mine workers of potential hazards in real-time. The “Sense-Think-Act” principle is the backbone of this smart alerting system. Sensors are used to sense various parameters such as gas concentration and temperature. The temperature sensor and MQ2 gas sensor are the two sensors used in this project.[6][18] The microcontroller collects data from these sensors and analyses the parameters to make decisions based on this analysis. The system takes actions based on these decisions, such as sounding an alarm or buzzer to alert the mine workers in the case of contingencies, for example, abnormal temperatures.[7] The system uses wireless communication, specifically the ESPNOW method, to transmit data from the sensors to the control room.[3] The sender module consists of the temperature sensor, gas sensor, and a push button for emergency feedback.

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All these components work together to gather and interpret data, which is subsequently sent to the control room via the receiver module.[14] The ESP8266 board is used for this transmission, and communication is one-way, from sender to receiver. The receiver module examines the data and provides relevant commands to address the situation. This smart alerting system is designed to be reliable, efficient, and cost-effective, leveraging the latest in wireless communication, sensors, and data analytics. The use of sensors allows for real-time monitoring of the mine's conditions, ensuring the safety of the workers.[3] The system's analysis of data enables quick decision-making, ensuring timely actions are taken. The wireless communication enables the control room to receive alerts in real-time, allowing for quick response times. In conclusion, the smart alerting system for mine workers is a much-needed solution for ensuring the safety of mine workers. [19][20] This system's use of the "Sense-Think-Act" principle, sensors, microcontrollers, and wireless communication is a revolutionary development that ensures mine workers' safety in the hazardous working conditions of the mining industry. With this system, mine workers can work in a safer environment, allowing them to focus on their work and improving productivity.[7]

VI. RESULTS

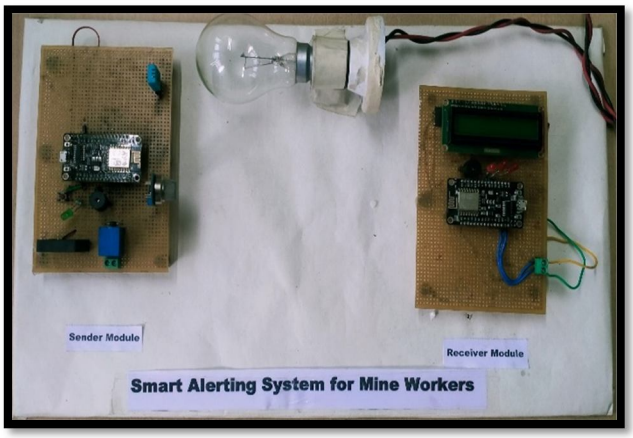


Fig:1.1 Hardware model

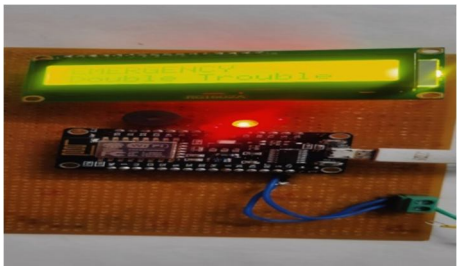


Fig: 1: Output Instruction Display of Gas Sensor

In (fig:1) you can see that LCD showing instruction of "hello mines, gas detected" is means gas is detect by gas sensor in mines area and data is transmitted by sender module to control room in receiver module and make alerting noise by buzzer in both the places and red led on in receiver module.



Fig: 2; Output Instruction Display of Push (feedback or emergency) button.

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In (fig:2) you can see that LCD showing instruction of "Emergency, Double trouble" is means someone is trapped in mines or any emergency occur in mines or something abnormality happened in mines. PUSH (feedback or emergency) button is pressed by any of worker to make alert in mines and control room. Data is transmitted by sender module in mines to make alert in control room in receiver module and make alerting noise by buzzer in both the places and led on in receiver module with buzzer make noise in both areas.



Fig:3. (a) Output Instruction Display of Temperature Sensor

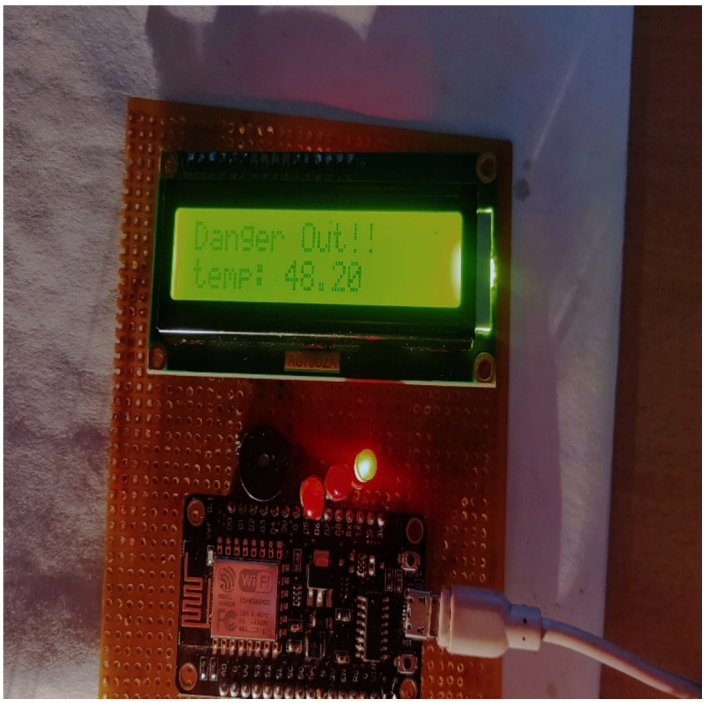


Fig: 3; (b) Output Instruction Display of Temperature Sensor

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In fig: 3; (a) you can see that LCD showing instruction of "torrid heat, high temp:37.60" is means temperature of mine suddenly increasing. fan is sender module is tried to controlling it as 31-50 is the given range and it is high temperature.
In fig: 3; (b) you can see that LCD showing instruction of "Danger out, temp:48.20" is means temperature is over exceed and crossed the range [51-100].[9] It's an emergency situation in mine and temperature is very high, temperature real time data is continually transmitting and make alert in mines & control room and make alerting noise by buzzer in both the places and led on in receiver module with buzzer make noise in both areas.

VII. CONCLUSIONS

Mining is a dangerous industry that poses significant risks to the environment and human lives. Both surface and underground mining operations can have serious long-term health effects associated with them, and miners are exposed to several hazards, including cave-ins, explosions, fires, and exposure to toxic gases. To solve these problems, an intelligent warning system for mine workers was developed. It is a reliable, effective, cost-effective, and accurate warning system that uses advanced technology to alert workers to potential hazards before they occur or if they are detected. The system consists of several components, including an MQ-2 gas sensor, DHT11 temperature sensor, feedback button, DC 5V exhaust fan, NodeMCU ESP8266 (board + driver), liquid crystal display (16X2), LED (red and green), relay and buzzer. The system uses wireless technology that is easy to install and easy to recover from any disaster. This project aims to increase the safety of mine workers and solve their problems with abnormal temperatures, dangerous gases, and entrapment in mines. Utilizing the latest in wireless communication, sensor, and data analysis technologies, the intelligent warning system provides real-time alerts to workers and helps make mining operations safer for all involved.
In this work, it was used to monitor, control and warn through sensors and buttons in various dangerous parameters especially for underground mine, which can warn the workers and send the data to the control station through espnow for help. However, this technique can be further extended for other applications. Some of the other applications of this smart alert system for mine workers are: Monitoring the health status of workers in underground mines and sending a help signal using espnow if there is any emergency.The proposed system was successfully tested and showed a quick response to dangerous parameter changes. The tested range of parameters is shown in Table 1.2. We can state that this system will significantly help to reduce future casualties caused by sudden changes in these parameters and will contribute to increasing work safety. Compact and efficient design ensures practical implementation of the system. The system has been tested for the following predetermined range. However, depending on the environment of different mines, it can be changed as required by easy software modification.

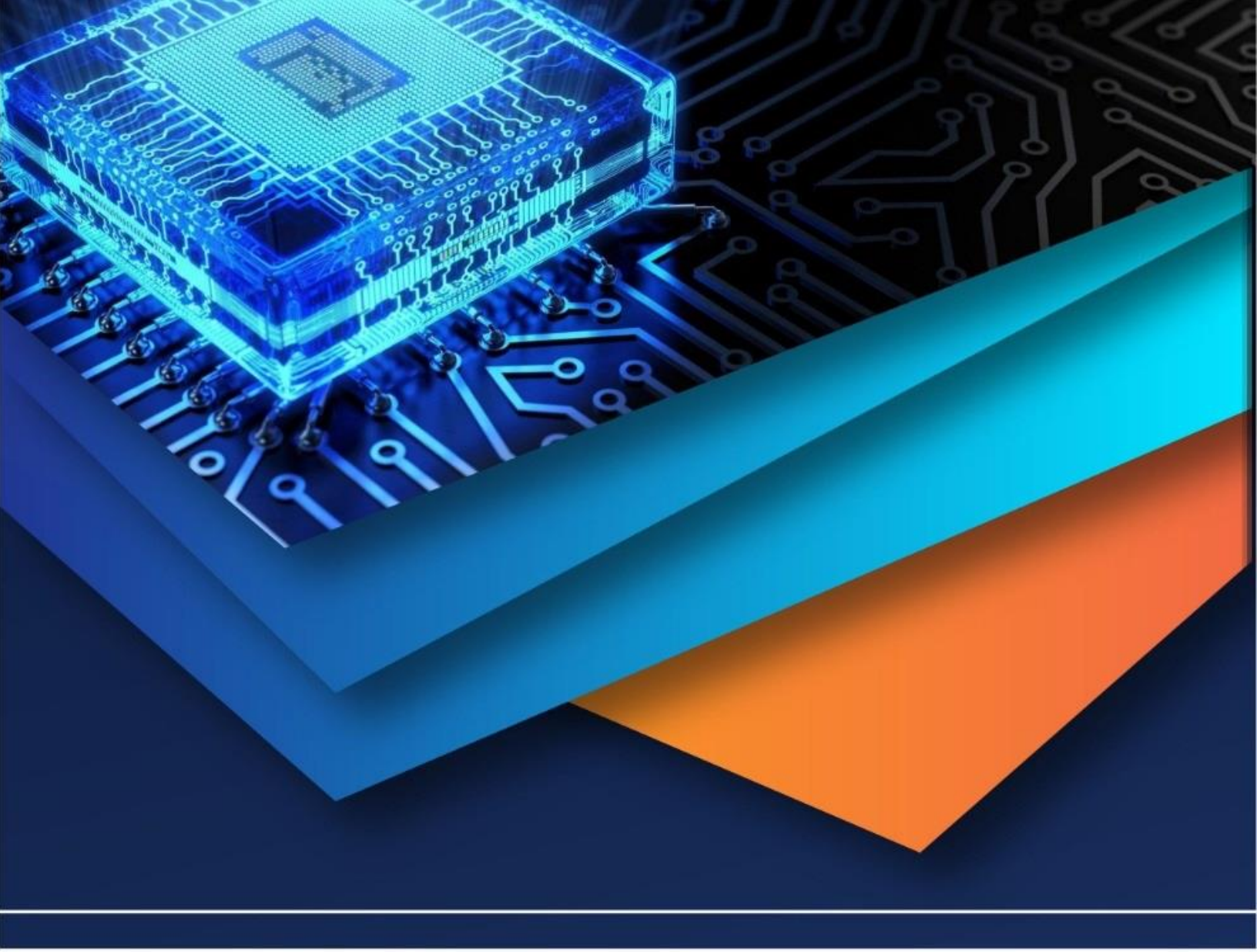
Table 1.2 Parameters Range

S.no.	Parameter	measuring range	Sensing period
1	Temperature	0-80°C	1s
2	Smoke, liquefied, natural gas (LNG), butane, propane, methane, alcohol, and hydrogen Content	200-10000ppm	-

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