COAL MINE SYSTEM FOR SAFETY ALERTING AND MONITORING

A PROJECT REPORT

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ABSTRACT

Safety is the most important aspect of any industry. Security and safety are absolutely essential in the mining industry. The mining industry follows a few fundamental safety measures to prevent any accidents. Underground mines still have accidents because of rising temperatures, rising water levels, and methane gas leaks. Here, we provide worker safety. He can call security by pressing the panic button when a worker is in danger. A reliable communication system between workers in underground mines and the fixed ground mine system is required to improve safety in underground mines. There must be no interruptions to the communication network at any time or under any circumstance. In this project, a low-cost, early-warning intelligence-based wireless mine supervision system is proposed. IOT allows for monitoring of worker status.Mines are the world's most dangerous place to work because in the mines, explosion often happens and thousand people are dying.

And a recent report states that in such mine accidents an average of around 12,000 people have died.

Coal is a non-sustainable origin that cannot be widely replaced by humans, there are several mishaps of coalmines occurring in the mines.

The diggers are putting their lives at risk, by working in the coal mines, even once in a while they end up losing their lives in the coal mines that are an unfortunate part.

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INTRODUCTION

Mines are the world's most dangerous place to work because in the underground mines, explosion often happens and thousand people are dying. And a recent report states that in such mine accidents an average of around 12,000 people have died. Coal is a non sustainable origin that cannot be widely replaced by humans, there are several mishaps of coalmines occurring in the mines, and the diggers are putting their lives at risk, by working in the coal mines, even once in a while they end up losing their lives in the coal mines that are an unfortunate part. Mainly such mishaps happen as a direct result of the old equipment and wired devices, resulting in the end, mishandling, spillage of the noxious gases in the coal mines, pose tremendous hazards to the excavators inside the coal mines. So we've designed the coalmine protection system to stay away from this problem. We tackled the issues in our research by testing each of the information collected by the sensors, we use and finishing the analysis using the Thinger system. Thus the Controlling can be done automatically or manually.So we've designed a useful coalmine protection system to stay away from this problem in future and currently We tackled the issues in our research by testing each of the information collected by the sensors, we use and finishing the analysis using the Thinger system.

It possess self-organized capability by wireless communication.

SCOPE AND OBJECTIVES OF PROJECT

- Mines are the world's most dangerous place to work because in the mines, explosion often happens and thousand people are dying.

- And a recent report states that in such mine accidents an average of around 12,000 people have died.

- Coal is a non sustainable origin that cannot be widely replaced by humans, there are several mishaps of coalmines occurring in the mines.

- The diggers are putting their lives at risk, by working in the coal mines, even once in a while they end up losing their lives in the coal mines that are an unfortunate part.

- Mainly such mishaps happen as a direct result of the old equipment and wired devices, resulting in the end, mishandling, spillage of the noxious gases in the coal mines.

The motivation for the mentioned project is from a Tamil movie named "O2" ,which I watched recently.

- Trapped in a landslide,the passenger of the bus gets struck,as the time passes lack of oxygen happens ,the location of the bus couldn't be identified.This is the plot of the movie.

- To reduce the risk of causing death under low supply of oxygen and other calamities in Coal Mine.

OBJECTIVES OF THE PROJECT

- In this system the coal mine safety systems are fixed with gas sensors modules,temperature sensor,water level sensors and relays

- In this system we mainly have monitoring and controlling systems.

- In this monitoring system we monitor all the data from different sensors.

- as sensors detects the gas in coal environment.

- These sensors values are continuously uploaded to the cloud for analysis and also for further use.

- The presented wireless monitoring system is capable of detecting and transmitting critical parameters in coal mines such as methane gas, high temperature, humidity, and fire.

- In an emergency, this monitoring system transmits distress signals.

- A buzzer will sound if emergency conditions are detected, and the monitored variables will be displayed on the user interface machine. Moreover, the Parameters are wirelessly transmitted to the control room, allowing people to determine the safety situation of the mine

.

- This model is easily re programmable. Experiments have demonstrated the system's

CHAPTER 2

LITERATURE SURVEY

CHAPTER 2

LITERATURE SURVEY

Over the past five years, researchers have devoted a great deal of time to this problem statement.

Title:1 IOT based Coal Mine Safety Monitoring And Alerting System

Author: Manohara K M, Nayan Chandan D C, Pooja S V, Sonika P, Ravikumar K I

Coal mines are one of the most important and industries in the country, as they are used as fuel in the steel and cement industries to extract iron from the stone and create cement. Every parameter, such as methane gas, high temperature, fire incidents, etc., should be regularly checked in the underground mining business. Due to the complexity of the mining environment and the variety of activities performed in coal mines, it is important to monitor the working environment. To address this issue, there is a system that monitors basic safety measures and regulates many restrictions on coal mines, such as gas leaks, temperature and humidity conditions, and fire sensor. All the sensors are assembled into a single unit and then placed in a coal mine.

Title:2 Coal Mine Safety Monitoring and Alerting System with Smart Helmet

Author: Mangesh Rudrawar, Shivam Sharma, Madhuri Thakur, Vivek Kadam

Traditional monitoring systems in coal mines are difficult to install, hazardous, and difficult to power. Because of the complexity of the mining environment and the wide range of operations performed in coal mines, it is vital to monitor and maintain the parameters in the background t increase the efficiency and safety of mineworkers. As a result, traditional monitoring methods cannot be relied on to ensure coal workers' safety. This research represents a ZigBee-based wireless monitoring system using a smart helmet. The presented wireless monitoring system is capable of detecting and transmitting critical parameters in coal mines such as methane gas, high temperature, humidity, and fire. In an emergency, this monitoring system transmits distress signals. A buzzer will sound if emergency conditions are detected, and the monitored variables will be displayed on the user interface machine. Moreover, the Parameters are wirelessly transmitted to the control room, allowing people to determine the safety situation of the mine. This model is easily reprogrammable.

Experiments have demonstrated the system's reliability and stability.

Title:3 : Safety Monitoring System in Coal Mine Using IoT

Author: Sathishkumar N1 , Manoj A M2 , Muniraj K2 , Naveenkumar M2 , Praveen C2

The key abstract is to use IoT to incorporate a coal mine safety monitoring system. The extraction of coal from the field is known as coal mining. Coal is used as a fuel in the steel and cement industry to extract iron from ore and to manufacture cement. Every parameter in the underground mining industry must be controlled on a regular basis, including methane gas, high temperatures, fire incidents, and so on. The level of safety in coal mines is still poor, resulting in fatalities. A coal mineshaft salvage action is profoundly perilous because of various elements. It is particularly risky for rescuers to enter a coal mineshaft burrow in a debacle without earlier attention to the climate on the grounds that ensuing blasts are probably going to happen at any second. It is along these lines basic to recognize unstable climate data like toxic gases and high temperatures, just as to direct a visual review of excavators caught in a fell passage through the imploded burrow. These information would aid rescuers in devising a strategy and equipping themselves to carry out the rescue operation defensively. This paper proposes a design for coal mines that will reduce the damage caused by a coal mine accident and allow for a more effective rescue operation.

2.1. OPEN PROBLEMS IN EXISTING SYSTEM

In the underground mining area, the methane gas level present in the mine is detect by Electronic Gas Sensor. The climatic conditions in underground mine including temperature and humidity is measures by the Temperature sensor. The vibrations occurring in the mines while mining is detect using the Vibration sensor. This senses the vibration level and occurrence of earthquake can be known easily. With a power supply given, the data which the various sensors collects are fed to the Arduino UNO ,the numbers are displayed in the LCD display module. The numbers also checks with the maximum level each parameters like gas, pressure, temperature, vibration etc., using the Zigbee module. If the number crosses the predefined level, the buffer

buffers and gives alert to the miners. The machine collects data in a coal mine using a sensor network based on (MEMS) Micro Electrical Mechanical Systems. The sensor module is made up of MEMS sensors that range in size from 1 to 100 micrometres.To reduce the risk of causing death under low supply of oxygen and other calamities in Coal Mine. “An Approach for Understanding and Promoting Coal Mine Safety by Exploring Coal Mine Risk Network”- Coal mining refers to one of the most hazardous industries worldwide.The diggers are putting their lives at risk, by working in the coal mines, even once in a while they end up losing their lives in the coal mines that are an unfortunate part. Mainly such mishaps happen as a direct result of the old equipment and wired devices, resulting in the end, mishandling, spillage of the noxious gases in the coal mines.

CHAPTER 3

REQIREMENT ANALYSIS

CHAPTER 3

REQUIREMENT ANALYSIS

3.1. SOFTWARE REQUIREMENTS SPECIFICATION DOCUMENT

Hardware used:

- NodeMCU Controller
- Gas sensor
- Water level Sensor
- Temperature Sensor
- Zigbee Sensor
- Wifi Module
- LCD Display
- Buzzer

Software Used:

- Arduino IDE
- Embedded C

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

In this proposed system the coal mine safety systems are fixed with gas sensor modules, temperature sensor, water level sensor and relays. We integrate all the sensors to the controller. First we need to create an account in the ThingSpeak platform. In this system we mainly have monitoring and controlling systems. In monitoring system we monitor all the data from different sensors. Gas sensor detects the gas in the coal mine environment. If the gas level exceeds the normal level then the buzzer gets high so that the mine workers get notified. These sensor values are continuously uploaded to the cloud . for analysis and also for further use. The temperature and water level values are also monitored inside the coalmine and send data control unit through zigbee.

4.1. ARCHITECTURE / OVERALL DESIGN OF PROPESED SYSTEM

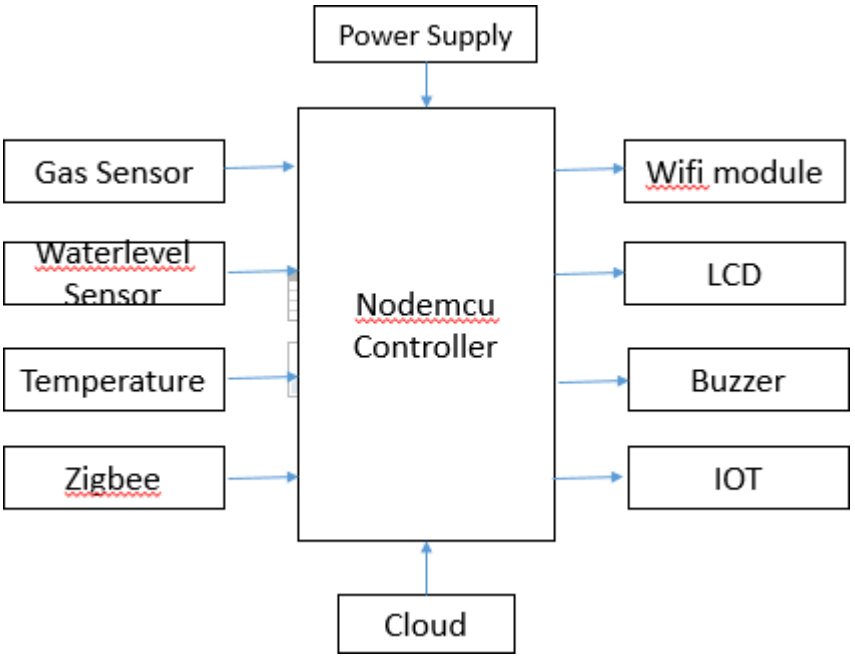


Fig 4.1: System Architecture for setting up coal mine safety systems

CHAPTER 5

SYSTEM ARCHITECTURE

5. SYSTEM ARCHITECTURE

NODE MCU:

NodeMCU is an open-source IoT platform. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware that is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266. It uses many open-source projects, such as lua-JSON and SPIFFS. NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems began production of the ESP8266. The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core,widely used in IoT applications. NodeMCU started on 13 Oct 2014, when Hong committed the first file of nodemcu-firmware to GitHub. Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform, and committed to NodeMCU project, then NodeMCU was able to support the MQTT IoT protocol, using Lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glib to NodeMCU project, enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.

In summer 2015 the creators abandoned the firmware project and a group of independent contributors took over. By summer 2016 the NodeMCU included more than 40 different modules. Due to resource constraints users need to select the modules relevant for their project and build a firmware tailored to their needs.

ESP8266 Arduino Core:

As Arduino.cc began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate toolchains to allow Arduino C/C++ to be compiled for these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the

Arduino IDE to compile an Arduino C/C++ source file for the target MCU's machine language. Some ESP8266 enthusiasts developed an Arduino core for the ESP8266 WiFi SoC, popularly called the "ESP8266 Core for the Arduino IDE".[16] This has become a leading software development platform for the various ESP8266-based modules and development boards, including NodeMCUs.

Fig.4.2.1. NodeMCU Development board

5.1. TEMPERATURE SENSOR

Temperature is the most often-measured environmental quantity. This might be expected since most physical, electronic, chemical, mechanical, and biological systems are affected by temperature. Certain chemical reactions, biological processes, and even electronic circuits perform best within limited temperature ranges. Temperature is one of the most commonly measured variables and it is therefore not surprising that there are many ways of sensing it. Temperature sensing can be done either through direct contact with the heating source, or remotely, without direct contact with the source using radiated energy instead. There are a wide variety of temperature sensors on the market today, including Thermocouples, Resistance Temperature Detectors (RTDs), Thermistors, Infrared, and Semiconductor Sensors.

THERMOCOUPLE:

It is a type of temperature sensor, which is made by joining two dissimilar metals at one end. The joined end is referred to as the HOT JUNCTION. The other end of these dissimilar metals is referred to as the COLD END or COLD JUNCTION. The cold junction is actually formed at the last point of thermocouple material. If there is a difference in temperature between the hot junction and cold junction, a small voltage

is created. This voltage is referred to as an EMF (electro-motive force) and can be measured and in turn used to indicate temperature.

RTD:

The RTD is a temperature sensing device whose resistance changes with temperature. Typically built from platinum, though devices made from nickel or copper are not uncommon, RTDs can take many different shapes like wire wound, thin film. To measure the resistance across an RTD, apply a constant current, measure the resulting voltage, and determine the RTD resistance. RTDs exhibit fairly linear resistance to temperature curves over their operating regions, and any nonlinearity are highly predictable and repeatable. The PT100 RTD evaluation board uses surface mount RTD to measure temperature. An external 2, 3 or 4-wire PT100 can also be associated with measure temperature in remote areas. The RTDs are biased using a constant current source. So as to reduce self-heat due to power dissipation, the current magnitude is moderately low. The circuit shown in figure is the constant current source uses a reference voltage, one amplifier, and a PNP transistor.

Thermistors:

Similar to the RTD, the thermistor is a temperature sensing device whose resistance changes with temperature. Thermistors, however, are made from semiconductor materials. Resistance is determined in the same manner as the RTD, but thermistors exhibit a highly nonlinear resistance vs. temperature curve. Thus, in the thermistors operating range we can see a large resistance change for a very small temperature change. This makes for a highly sensitive device, ideal for set-point applications.

Semiconductor sensors:

They are classified into different types like Voltage output, Current output, Digital output, Resistance output silicon and Diode temperature sensors. Modern semiconductor temperature sensors offer high accuracy and high linearity over an operating range of about 55°C to +150°C. Internal amplifiers can scale the output to convenient values, such as 10mV/°C. They are also useful in cold-junction compensation circuits for wide temperature range thermocouples. A brief details about this type of temperature sensor are given below.

SENSOR ICS

There are a wide variety of temperature sensor ICs that are available to simplify the broadest possible range of temperature monitoring challenges. These silicon temperature sensors differ significantly from the above mentioned types in a couple of important ways. The first is operating temperature range. A temperature sensor IC can operate over the nominal IC temperature range of -55°C to +150°C. The second major difference is functionality.

A silicon temperature sensor is an integrated circuit, and can therefore include extensive signal processing circuitry within the same package as the sensor. There is no need to add compensation circuits for temperature sensor Ics. Some of these are analogue circuits with either voltage or current output. Others combine analogue-sensing circuits with voltage comparators to provide alert functions. Some other sensor ICs combine analogue-sensing circuitry with digital input/output and control registers, making them an ideal solution for microprocessor-based systems.

Digital output sensor usually contains a temperature sensor, analog-to-digital converter (ADC), a two-wire digital interface and registers for controlling the IC's operation. Temperature is continuously measured and can be read at any time. If desired, the host processor can instruct the sensor to monitor temperature and take an output pin high (or low) if temperature exceeds a programmed limit. Lower threshold temperature can also be programmed and the host can be notified when temperature has dropped below this threshold. Thus, digital output sensor can be used for reliable temperature monitoring in microprocessor-based systems.

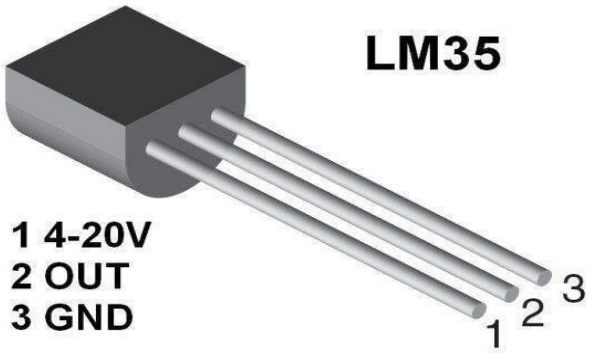


Fig.4.2.2. LM35

Above temperature sensor has three terminals and required Maximum of 5.5 V supply. This type of sensor consists of a material that performs the operation according to temperature to vary the resistance. This change of resistance is sensed by circuit and it calculates temperature. When the voltage increases then the temperature also rises. We can see this operation by using a diode.

Temperature sensors directly connected to microprocessor input and thus capable of direct and reliable communication with microprocessors. The sensor unit can communicate effectively with low-cost processors without the need of A/D converters. An example for a temperature sensor is LM35. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius temperature. The LM35 is operates at -55˚ to +120˚C.The basic centigrade temperature sensor (+2˚C to +150˚C) is shown in figure below.

Features of LM35 Temperature Sensor:

- Calibrated directly in ˚ Celsius (Centigrade)
- Rated for full l −55˚ to +150˚C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Low self-heating,
- ±1/4˚C of typical nonlinearity

Operation of LM35:

The LM35 can be connected easily in the same way as other integrated circuit temperature sensors. It can be stuck or established to a surface and its temperature will be within around the range of 0.01˚C of the surface temperature.

This presumes that the ambient air temperature is just about the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature.

The temperature sensors have well known applications in environmental and process control and also in test, measurement and communications. A digital temperature is a sensor, which provides 9-bit temperature readings. Digital temperature sensors offer

excellent precise accuracy, these are designed to read from 0°C to 70°C and it is possible to achieve ±0.5°C accuracy. These sensors completely aligned with digital temperature readings in degree Celsius.

5.2Gas Sensor

The MQ4 methane gas sensor is extremely used for detecting gas leakage at home or in industries like Methane (CH4) & CNG Gas. This gas sensor is highly responsive in very little time, so based on the sensitivity requirements; it can be adjusted through a potentiometer. This is an analog output sensor, used like a CNG (compressed natural gas) sensor within the series of MQ sensors.

So this sensor is suitable for detecting the concentration of natural gas like methane within the air. For this sensor, if the gas concentration increases then the output voltage will be increased. This sensor works with 5V DC and draws 750 mW around. This article discusses an overview of the MQ4 methane gas sensor and its working with applications. MQ4 methane gas sensor is a MOS (metal oxide semiconductor) type sensor, used to detect the methane gas concentration within the air at either home or industries & generates output like analog voltage by reading it. Here, the range of concentration for sensing ranges from 300 pm – 10,000 ppm which is appropriate for the detection of a leak.

This gas sensor mainly includes a detecting element like ceramic based on aluminum-oxide (Al_2O_3), coated with Tin dioxide (SnO2) and arranged within a stainless-steel mesh.

Fig.4.2.3. MQ4 Methane Gas Sensor

When methane gas and detecting elements get in contact with each other then the resistivity of the detecting element will be changed. After that, the change is measured to get the methane gas concentration. The ignition of Methane gas is extremely exothermal which means it generates a huge amount of heat once ignited.

Pin Configuration:

The pin configuration of the MQ4 methane gas sensor is shown below. This sensor includes three pins which are discussed below.

Fig.4.2.4. MQ4 Methane Gas Sensor Pin Configuration

Pin1 (H Pins): These pins are two where one of them is used to connect supply and remaining pin is connected to ground

Pin2 (A Pins): Both the pins like A & B are interchangeable which will be connected to supply voltage.

Pin3 (B Pins): A & B pins are exchangeable where one pin acts like output and another pin will be pulled to the GND terminal.

The pin configuration of the MQ-4 methane gas sensor module includes four pins which are discussed below.

VCC Pin: This pin provides voltage to the module and the typical operating voltage is +5V

GND Pin: This pin is used to connect the sensor module to the GND terminal of the system

DO (Digital Out) Pin: This pin provides digital output by setting a threshold value with the help of the potentiometer

AO (Analog Out): This pin provides output analog voltage which ranges from 0 to 5V

depending on the intensity of gas.

Features & Specifications:

The features and specifications of the MQ4 methane gas sensor include the following.

Sensitivity is good for combustible gas in an extensive range

Sigh sensitivity for natural gas, methane gas

Small sensitivity for smoke and alcohol

Quick responsive, long life and stable

The drive circuit is simple

Load resistance is 20KΩ

Detecting resistance ranges from 10KΩ to 60KΩ

Preheat time is above 24Hrs

The required voltage is 5V

DO output: is 0.1 to 5V

AO output is 0.1 to 0 .3 V

Detection gas is methane or natural

The concentration of detection ranges from 200 to 10000ppm

Interface : TTL compatible input & output

Heater utilization is low than 750mw

Operating temperature ranges from 14 to 122 ° Fahrenheit or -10 to 50°Centigrade

MQ-4 equivalent sensors are MQ 214, MQ306A, MQ-5, MQ306A & MQ-2. Alternative MQ Gas sensors are MQ2, 3, 4, 5, 6, 7, 8, 9, 131, 135, 136, 137, 138, 214, 216, 303A, 306A, 307A, & 309A.

For the MQ4 methane gas sensor, the resistance value is not the same for different types of gases, it varies. So adjustment of sensitivity is very essential while using this sensor. It is suggested to adjust the sensor methane concentration within the air (5000ppm) & use a load resistance value of about 20KΩ.

MQ4 gas sensor is simply used to detect the gas by using an analog pin or digital pin. Once the sensor module is powered with 5Volts then it starts detecting the methane gas. Once it is detected then the LED will start glowing otherwise the LED will be OFF. Before working with these gas sensors, we have to set aside pre-heating time before you can work with them. Now, bring in the sensor to the methane gas & notice that the voltage throughout the output LED will be high like 5V, so the LED will be turned ON otherwise it will be turned OFF, so the voltage will be low like 0V. Similarly,

the analog pin can also be used for detecting methane gas.

5.3. Water level sensor

If you have ever had a water heater explode or ever tried to make submersible electronics, then you know how important it is to detect when water is around.

With this Water Level Sensor, you can do just that!

This sensor can be used to measure the water level, monitor a sump pit, detect rainfall or detect leakage.

Hardware Overview:

The sensor has a series of ten exposed copper traces, five of which are power traces and five are sense traces. These traces are interlaced so that there is one sense trace between every two power traces.

Usually these traces are not connected but are bridged by water when submerged.

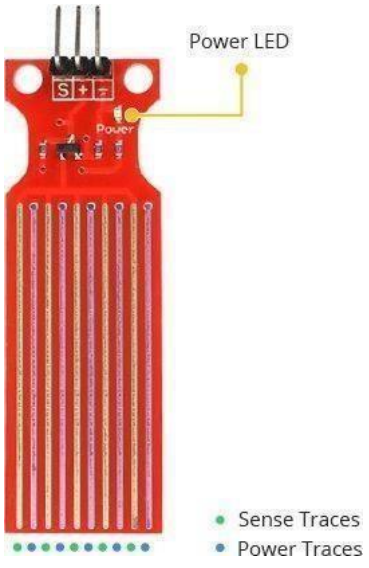


Fig.4.2.5. Water Level Sensor

There's a Power LED on the board which will light up when the board is powered.

The working of the water level sensor is pretty straight forward. The series of exposed parallel conductors, together acts as a variable resistor (just like a potentiometer) whose resistance varies according to the water level. The change in resistance corresponds to the distance from the top of the sensor to the surface of the water.

The resistance is inversely proportional to the height of the water:

The more water the sensor is immersed in, results in better conductivity and will result in a lower resistance. The less water the sensor is immersed in, results in poor

conductivity and will result in a higher resistance.

The sensor produces an output voltage according to the resistance, which by measuring we can determine the water level.

Water Level Sensor Pinout:

The water level sensor is super easy to use and only has 3 pins to connect.

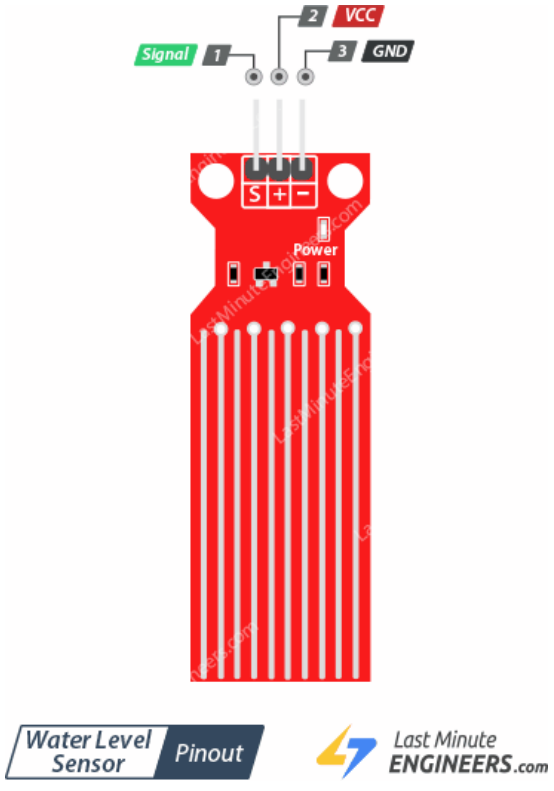


Fig.4.2.6. Water Level Sensor Pinout

S (Signal) pin is an analog output that will be connected to one of the analog inputs on your Arduino.

+ (VCC) pin supplies power for the sensor. It is recommended to power the sensor with between 3.3V – 5V. Please note that the analog output will vary depending on what voltage is provided for the sensor.

- (GND) is a ground connection.

ZIGBEE :

ZigBee Physical Layer

ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless M2M networks. The ZigBee standard

operates on the IEEE 802.15.4 physical radio specification and operates in unlicensed bands including 2.4 GHz, 900 MHz and 868 MHz.

The 802.15.4 specification upon which the ZigBee stack operates gained ratification by the Institute of Electrical and Electronics Engineers (IEEE) in 2003. The specification is a packet-based radio protocol intended for low-cost, battery-operated devices. The protocol allows devices to communicate in a variety of network topologies and can have battery life lasting several years.

The ZigBee Protocol:

The ZigBee protocol has been created and ratified by member companies of the ZigBee Alliance . Over 300 leading semiconductor manufacturers, technology firms, OEMs and service companies comprise the ZigBee Alliance membership. The ZigBee protocol was designed to provide an easy-to-use wireless data solution characterized by secure, reliable wireless network architectures.

The ZigBee Advantage:

The ZigBee protocol is designed to communicate data through hostile RF environments that are common in commercial and industrial applications.

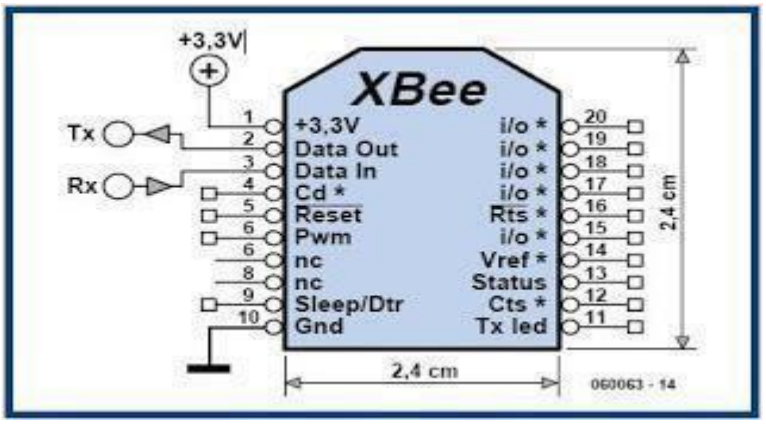


Fig.4.2.7. Pin diagram

ZigBee is a specification for a suite of high-level communication protocols used to create personal area networks built from small, low-power digital radios. ZigBee is based on an IEEE 802.15.4 standard. Though its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics, ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach

more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi.

Zigbee protocol features include ;

Support for multiple network topologies such as point-to-point, point-to-multipoint and mesh networks

Low duty cycle – provides long battery life

Low latency

Direct Sequence Spread Spectrum (DSSS)

Up to 65,000 nodes per network

128-bit AES encryption for secure data connections

Collision avoidance, retries and acknowledgements

Mesh Networks:

A key component of the ZigBee protocol is the ability to support mesh networking. In a mesh network, nodes are interconnected with other nodes so that multiple pathways connect each node. Connections between nodes are dynamically updated and optimized through sophisticated, built-in mesh routing table. Mesh networks are decentralized in nature; each node is capable of self-discovery on the network. Also, as nodes leave the network, the mesh topology allows the nodes to reconfigure routing paths based on the new network structure. The characteristics of mesh topology and ad-hoc routing provide greater stability in changing conditions or failure at single nodes.

ZigBee Applications:

ZigBee enables broad-based deployment of wireless networks with low-cost, low-power solutions. It provides the ability to run for years on inexpensive batteries for a host of monitoring and control applications. Smart energy/smart grid, AMR (Automatic

Meter Reading), lighting controls, building automation systems, tank monitoring, HVAC control, medical devices and fleet applications are just some of the many spaces where ZigBee technology is making significant advancements.

Digi ZigBee Technology:

Digi is a member of the ZigBee Alliance and has developed a wide range of networking solutions based on the ZigBee protocol. XBee and XBee-PRO modules and other XBee-enabled devices provide an easy-to-implement solution that provides functionality to connect to a wide variety of devices.

Wifi Module:

In 2014, an ESP8266 Wi-Fi module was introduced and developed by third-party manufacturers like AI thinkers, which is mainly utilized for IoT-based embedded applications development. It is capable of handling various functions of the Wi-Fi network from another application processor.

It is a SOC (System On-chip) integrated with a TCP/IP protocol stack, which can provide microcontroller access to any type of Wi-Fi network. This article deals with the pin configuration, specifications, circuit diagram, applications, and alternatives of the ESP8266 Wi-Fi module.

An ESP8266 Wi-Fi module is a SOC microchip mainly used for the development of end-point IoT (Internet of things) applications. It is referred to as a standalone wireless transceiver, available at a very low price. It is used to enable the internet connection to various applications of embedded systems.

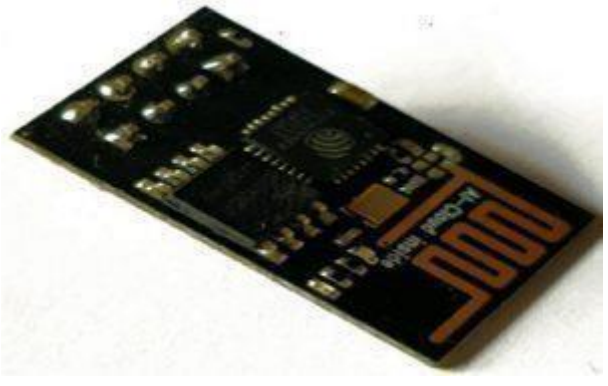


Fig.4.2.8. ESP8266 Wi-Fi Module

Espressif systems designed the ESP8266 Wi-Fi module to support both the TCP/IP capability and the microcontroller access to any Wi-Fi network. It provides the

solutions to meet the requirements of industries of IoT such as cost, power, performance, and design.

It can work as either a slave or a standalone application. If the ESP8266 Wi-Fi runs as a slave to a microcontroller host, then it can be used as a Wi-Fi adaptor to any type of microcontroller using UART or SPI. If the module is used as a standalone application, then it provides the functions of the microcontroller and Wi-Fi network.

The ESP8266 Wi-Fi module is highly integrated with RF balun, power modules, RF transmitter and receiver, analog transmitter and receiver, amplifiers, filters, digital baseband, power modules, external circuitry, and other necessary components. The ESP8266 Wi-Fi module is a microchip shown in the figure below.

A set of AT commands are needed by the microcontroller to communicate with the ESP8266 Wi-Fi module. Hence it is developed with AT commands software to allow the Arduino Wi-Fi functionalities, and also allows loading various software to design the own application on the memory and processor of the module.

The processor of this module is based on the Tensilica Xtensa Diamond Standard 106 micro and operates easily at 80 MHz. There are different types of ESP modules designed by third-party manufacturers. They are,

ESP8266-01 designed with 8 pins (GPIO pins -2)

ESP8266-02 designed with 8 pins (GPIO pins -3)

ESP8266-03 designed with 14 pins (GPIO pins- 7)

ESP8266-04 designed with 14 pins (GPIO pins- 7)

The ESP8266 Wi-Fi module comes with a boot ROM of 64 KB, user data RAM of 80 KB, and instruction RAM of 32 KB. It can support 802.11 b/g/n Wi-Fi network at 2.4 GHz along with the features of I2C, SPI, I2C interfacing with DMA, and 10-bit ADC. Interfacing this module with the microcontroller can be done easily through a serial port. An external voltage converter is required only if the operating voltage exceeds 3.6 Volts. It is most widely used in robotics and IoT applications due to its low cost and compact size.

Pin Configuration/Pin Diagram:

The ESP8266 Wi-Fi module pin configuration/pin diagram is shown in the figure below. The ESP8266-01 Wi-Fi module runs in two modes. They are;

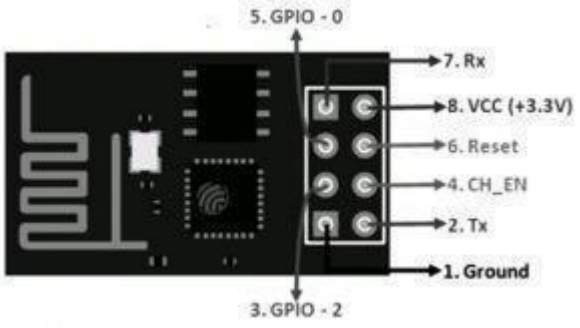


Fig.4.2.9. Pin Configuration of ESP8266

Flash Mode: When GPIO-0 and GPIO-1 pins are active high, then the module runs the program, which is uploaded into it.

UART Mode: When the GPIO-0 is active low and GPIO-1 is active high, then the module works in programming mode with the help of either serial communication or Arduino board.

LCD Display:

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

One each polarisers are pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction

When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent.

When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired

characters.

The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations.

The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly.

The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.

Crystalonics dot –matrix (alphanumeric) liquid crystal displays are available in TN, STN types, with or without backlight. The use of C-MOS LCD controller and driver ICs result in low power consumption. These modules can be interfaced with a 4-bit or 8-bit micro processor /Micro controller.

The built-in controller IC has the following features:

Correspond to high speed MPU interface (2MHz)

80 x 8 bit display RAM (80 Characters max)

9,920 bit character generator ROM for a total of 240 character fonts. 208 character fonts (5 x 8 dots) 32 character fonts (5 x 10 dots)

64 x 8 bit character generator RAM 8 character generator RAM 8 character fonts (5 x 8 dots) 4 characters fonts (5 x 10 dots)

Programmable duty cycles

1/8 – for one line of 5 x 8 dots with cursor

1/11 – for one line of 5 x 10 dots with cursor

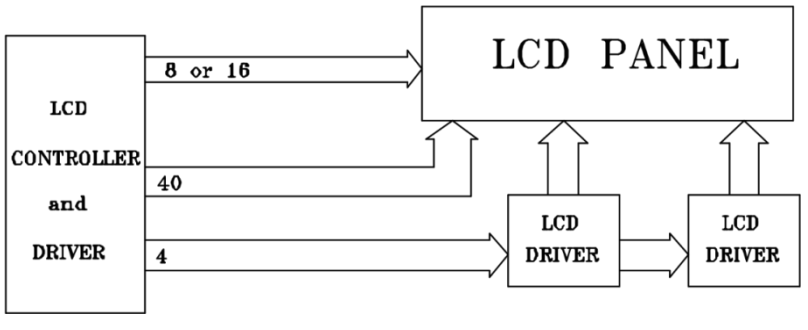
1/16 – for one line of 5 x 8 dots with cursor

Wide range of instruction functions display clear, cursor home, display on/off, cursor on/off, display character blink, cursor shift, display shift.

FUNCTIONAL DESCRIPTION OF THE CONTROLLER IC REGISTERS:

The controller IC has two 8 bit registers, an instruction register (IR) and a data register (DR). The IR stores the instruction codes and address information for display data RAM (DD RAM) and character generator RAM (CG RAM). The IR can be written, but not read by the MPU. The DR temporally stores data to be written to /read from the DD RAM or CG RAM. The data written to DR by the MPU, is automatically written to the DD RAM or CG RAM as an internal operation.

When an address code is written to IR, the data is automatically transferred from the DD RAM or CG RAM to the DR. data transfer between the MPU is then completed when the MPU reads the DR. likewise, for the next MPU read of the DR, data in DD RAM or CG RAM at the address is sent to the DR automatically. Similarly, for the MPU write of the DR, the next DD RAM or CG RAM address is selected for the write operation. The dot-matrix liquid crystal display controller and driver LSI displays alphanumeric, Japanese kana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4- or 8-bit microprocessor. Since all the functions such as display RAM, character generator, and liquid crystal driver, required for driving a dot-matrix liquid crystal display are internally provided on one chip, a minimal system can be interfaced with this controller/driver.



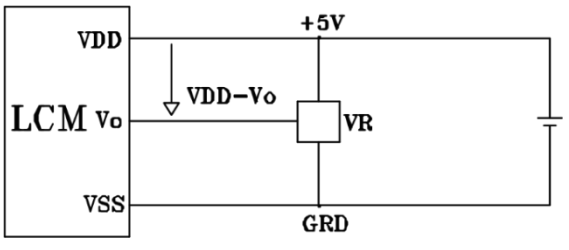
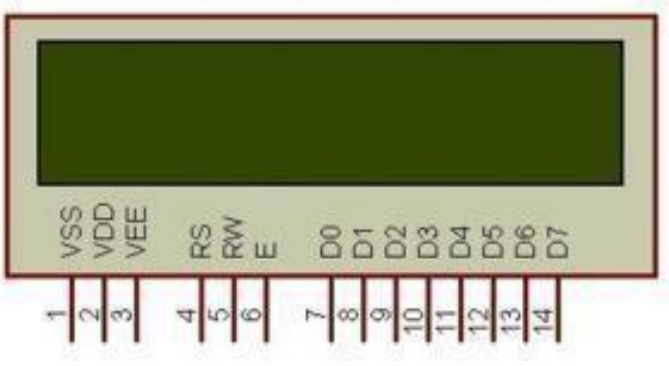


Fig.4.2.10. Block Diagram

VDD-Vo: LCD DRIVING VOLTAGE

VR: 10K-20K.



Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit
Power Voltage	VDD - VSS	0	7.0	V
Input Voltage	V_{in}	V_{SS}	VDD	
Operating Temperature Range	TOP	0	+50	T
Storage Temperature Range	T_{ST}	-20	+60	

Buzzer:

There are many ways to communicate between the user and a product. One of the best ways is audio communication using a buzzer IC. So during the design process, understanding some technologies with configurations is very helpful. So, this article discusses an overview of an audio signaling device like a beeper or a buzzer and its working with applications.

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

Fig.4.2.11. Buzzer Pin Configuration

The pin configuration of the buzzer is shown below. It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '-'symbol or short terminal and it is connected to the GND terminal.

History: The history of an electromechanical buzzer and piezoelectric is discussed below.

Electromechanical: This buzzer was launched in the year 1831 by an American Scientist namely Joseph Henry but, this was used in doorbells until they were eliminated in 1930 in support of musical bells, which had a smooth tone.

Piezoelectric: These buzzers were invented by manufacturers of Japanese & fixed into a broad range of devices during the period of 1970s – 1980s. So, this development primarily came due to cooperative efforts through the manufacturing companies of Japanese. In the year 1951, they recognized the Application Research Committee of Barium Titanate that allows the corporations to be cooperative competitively & bring about numerous piezoelectric creations.

Specifications:

The specifications of the buzzer include the following.

Color is black, The frequency range is 3,300Hz

Operating Temperature ranges from – 20° C to +60°C

CHAPTER 6

CONCLUSION

6.CONCLUSION

The sensors utilized for show of build are general.With utilization of unpretentious sensors, the framework will work with extra exactness continuously. Ongoing natural remaining of underground mines is gathered by the detecting component networks perpetually and it communicates information and is shipped off PC. This will guarantee the well being of diggers who is working underground in each moment of activity. In the event that there's any irksome condition is known, it cautions the administrator inside the room. It screens the significant time values during an efficient presentation. The thoughts of IoT helped in growing low-power and effective arrangements. This paper is declaration that IoT applications will reach so a lot and wide into each side of the globe thus everything can be detected nicely.

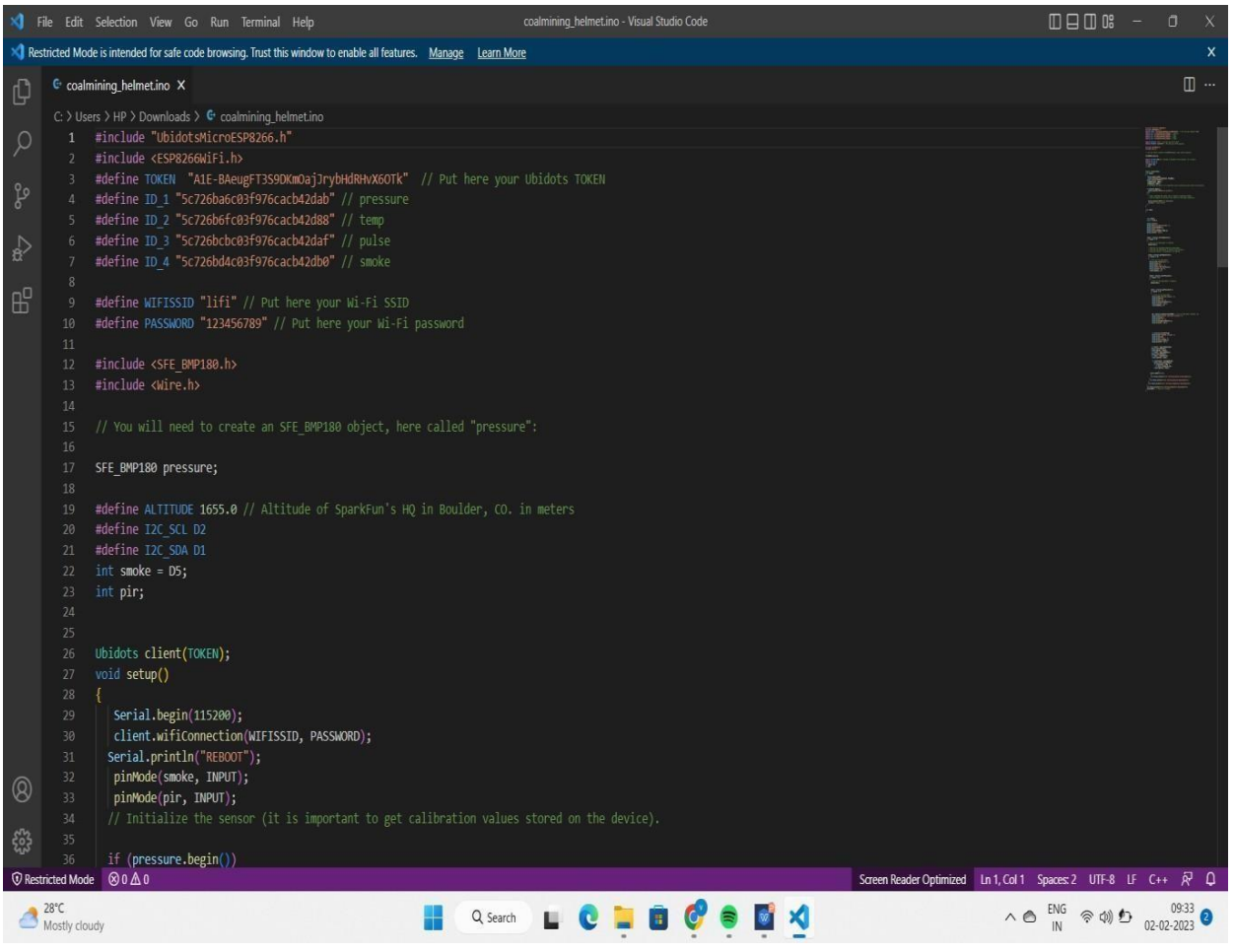
This paper presents a Zigbee-based coal mine monitoring system. The proposed system is used to monitor the subsurface characteristics of a coal mine and will aid in the prevention of mine disasters. ZigBee technology features a simple and adaptable networking concept, is tinyin size, and consumes little power. Additionally, the proposed system addresses all of the problems associated with wired connections. As a result, this is an advancement above the traditional coal mine safety system. Furthermore, a distress signal from the smart helmet is useful in abnormal environmental conditions or when a person needs medical attention. This system has applications in securities of industries as well. It is easy to upgrade and modify further as innovations arise.

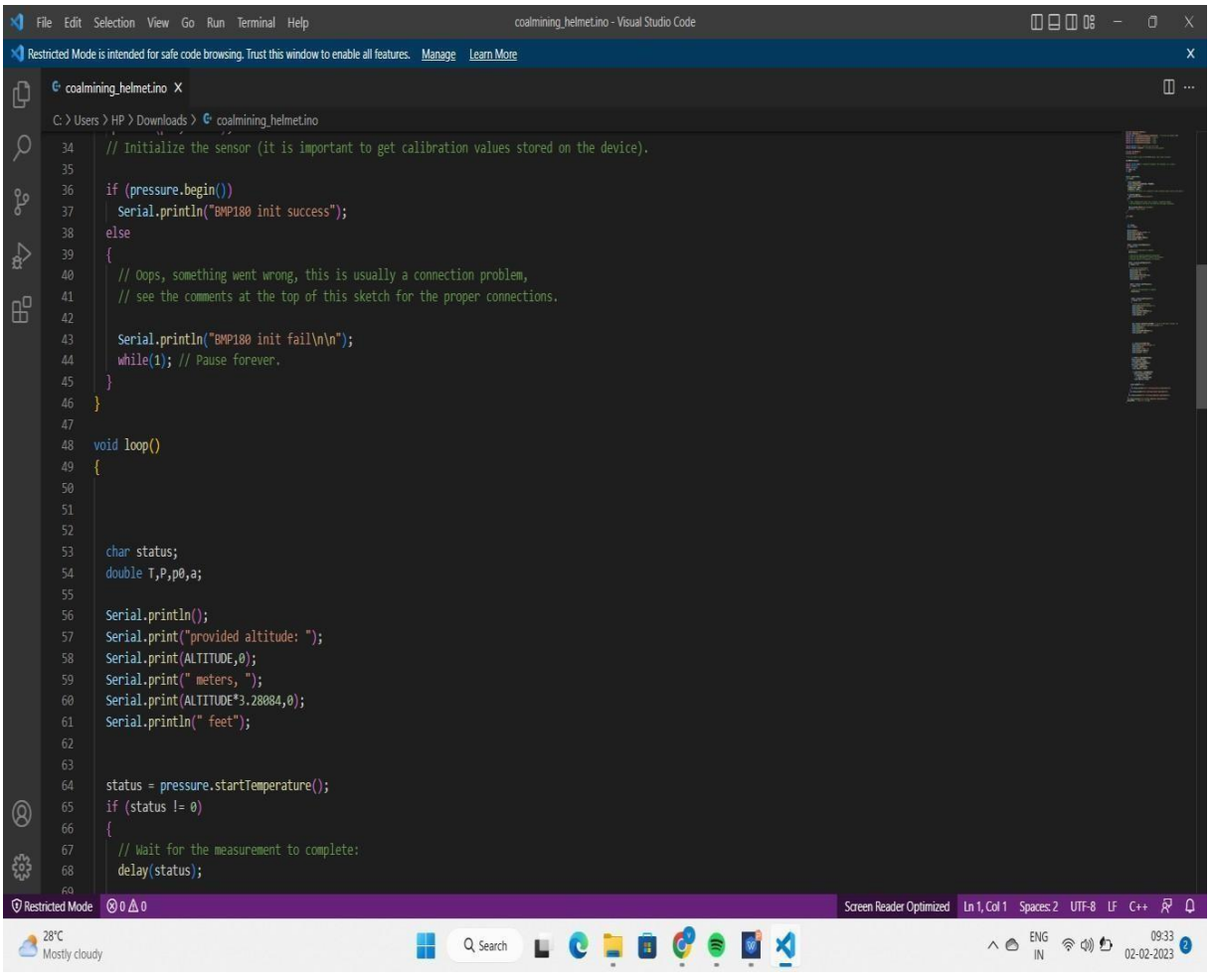
CHAPTER 7

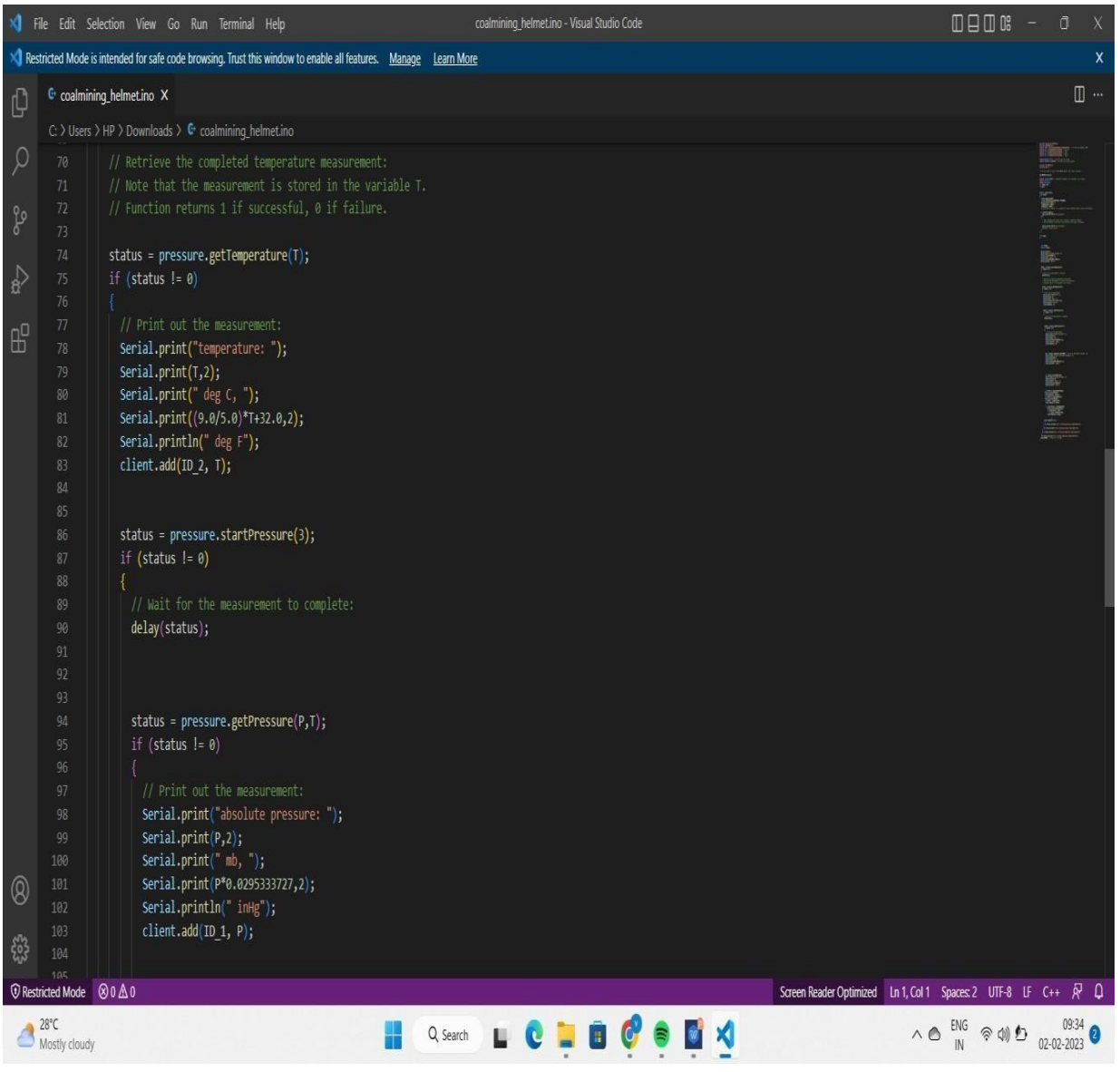
APPENDIX

7.APPENDIX

7.1.SOURCE CODE




File Edit Selection View Go Run Terminal Help
coalmining_helmet.ino - Visual Studio Code
Restricted Mode is intended for safe code browsing. Trust this window to enable all features. Manage Learn More
coalmining_helmet.ino
C: > Users > HP > Downloads > coalmining_helmet.ino
// Initialize the sensor (it is important to get calibration values stored on the device).
if (pressure.begin())
Serial.println("BMP180 init success");
else
{
// Oops, something went wrong, this is usually a connection problem,
// see the comments at the top of this sketch for the proper connections.
Serial.println("BMP180 init fail\n\n");
while(1); // Pause forever.
}
}
void loop()
{
char status;
double T,P,p0,a;
Serial.println();
Serial.print("provided altitude: ");
Serial.print(ALTITUDE,0);
Serial.print(" meters, ");
Serial.print(ALTITUDE*3.28084,0);
Serial.println(" feet");
status = pressure.startTemperature();
if (status != 0)
{
// Wait for the measurement to complete:
delay(status);
Restricted Mode
0 0
Screen Reader Optimized
Ln 1, Col 1
Spaces: 2
UTF-8
LF
C++
28°C
Mostly cloudy
Search
ENG
IN
09:33
02-02-2023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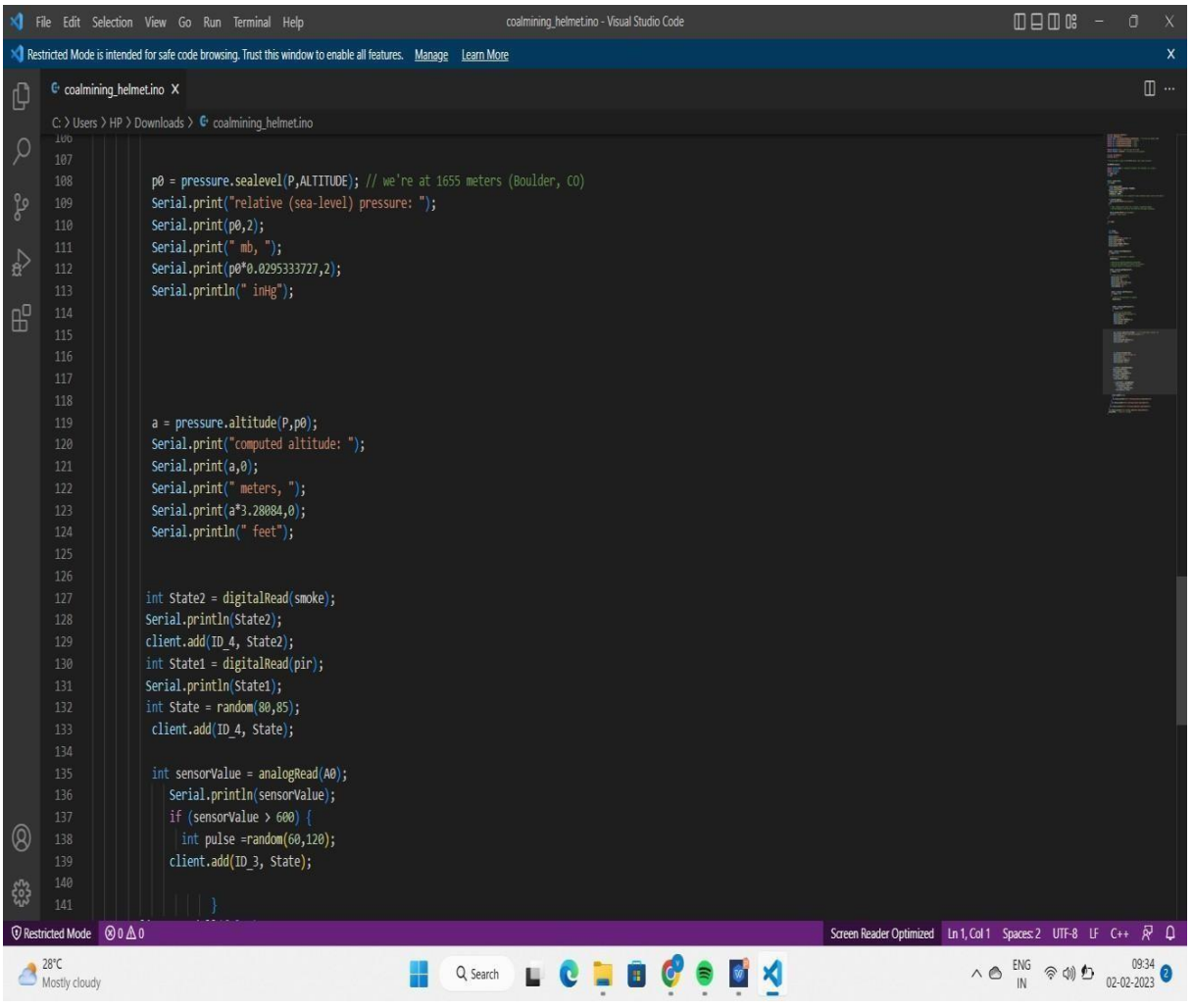
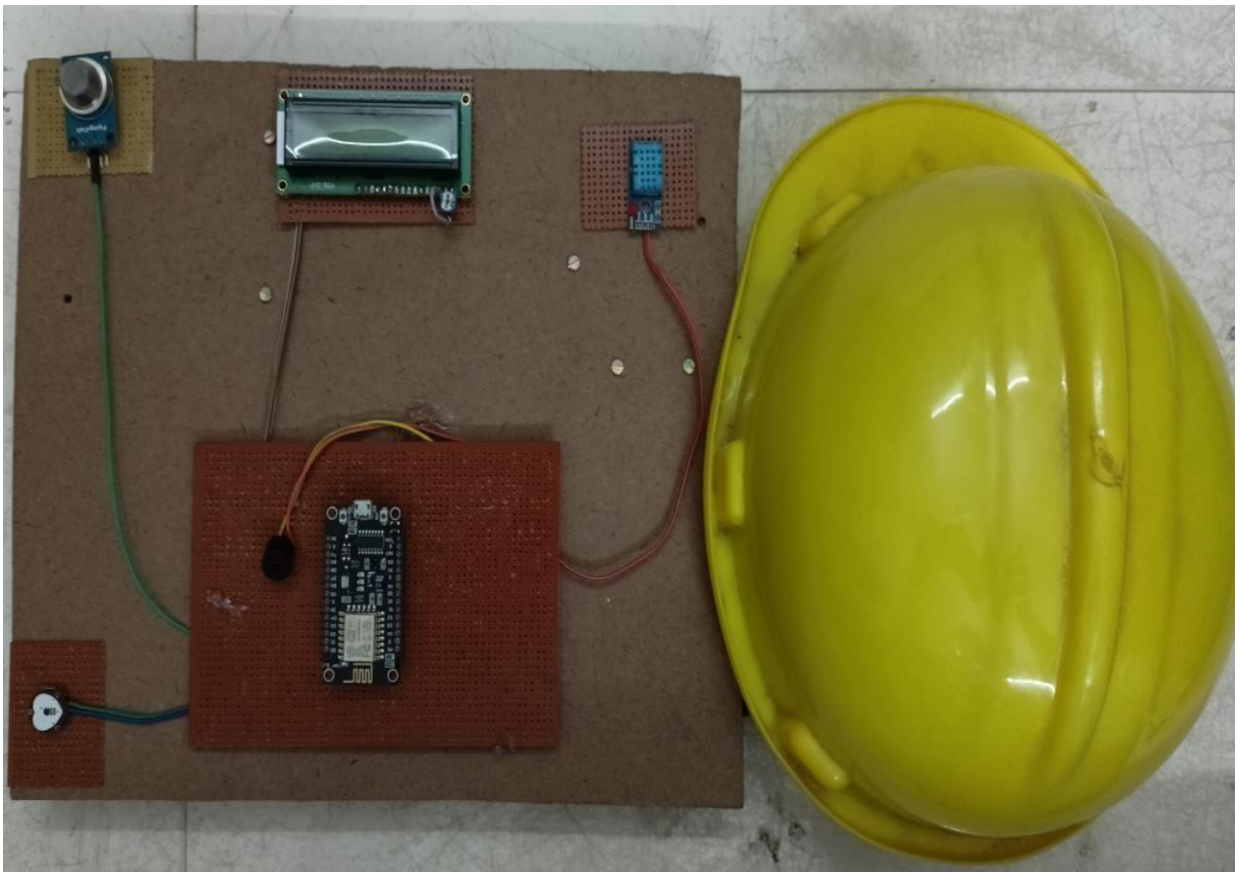
coalmining_helmet.ino - Visual Studio Code
Restricted Mode is intended for safe code browsing. Trust this window to enable all features. Manage Learn More
coalmining_helmet.ino
C: > Users > HP > Downloads > coalmining_helmet.ino
// Retrieve the completed temperature measurement:
// Note that the measurement is stored in the variable T.
// Function returns 1 if successful, 0 if failure.
status = pressure.getTemperature(T);
if (status != 0)
{
// Print out the measurement:
Serial.print("temperature: ");
Serial.print(T,2);
Serial.print(" deg C, ");
Serial.print((9.0/5.0)*T+32.0,2);
Serial.println(" deg F");
client.add(ID_2, T);
status = pressure.startPressure(3);
if (status != 0)
{
// Wait for the measurement to complete:
delay(status);
status = pressure.getPressure(P,T);
if (status != 0)
{
// Print out the measurement:
Serial.print("absolute pressure: ");
Serial.print(P,2);
Serial.print(" mb, ");
Serial.print(P*0.0295333727,2);
Serial.println(" inHg");
client.add(ID_1, P);
Restricted Mode
Screen Reader Optimized
Ln 1, Col 1
Spaces: 2
UTF-8
LF
C++
28°C
Mostly cloudy
Search
ENG
IN
09:34
02-02-2023


File Edit Selection View Go Run Terminal Help
coalmining_helmet.ino - Visual Studio Code
Restricted Mode is intended for safe code browsing. Trust this window to enable all features. Manage Learn More
coalmining_helmet.ino
C: > Users > HP > Downloads > coalmining_helmet.ino
p0 = pressure.sealevel(P,ALTITUDE); // we're at 1655 meters (Boulder, CO)
Serial.print("relative (sea-level) pressure: ");
Serial.print(p0,2);
Serial.print(" mb, ");
Serial.print(p0*0.0295333727,2);
Serial.println(" inHg");
a = pressure.altitude(P,p0);
Serial.print("computed altitude: ");
Serial.print(a,0);
Serial.print(" meters, ");
Serial.print(a*3.28084,0);
Serial.println(" feet");
int State2 = digitalRead(smoke);
Serial.println(State2);
client.add(ID_4, State2);
int State1 = digitalRead(pir);
Serial.println(State1);
int State = random(80,85);
client.add(ID_4, State);
int sensorValue = analogRead(A0);
Serial.println(sensorValue);
if (sensorValue > 600) {
int pulse =random(60,120);
client.add(ID_3, State);
}
Restricted Mode
Screen Reader Optimized
Ln 1, Col 1
Spaces: 2
UTF-8
LF
C++
28°C
Mostly cloudy
Search
ENG
IN
09:34
02-02-2023

7.2.SCREENSHOT



CHAPTER 8

REFERENCES

REFERENCES

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