SMOKE DETECTION SYSTEM USING ARDUINO UNO & MQ2 SMOKE SENSOR

Minor Project Report

Submitted in partial fulfillment of the requirement for the award of the degree of

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In

Electronics Engineering

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STUDENT'S DECLARATION

We hereby certify that our minor project report titled "**SMOKE DETECTION SYSTEM USING ARDUINO UNO & MQ2 SMOKE SENSOR**" is an authentic record of our work carried out during our 6th semester of B.Tech. The project was completed under the guidance of **Prof. Tahira Parveen**, Department of Electronics Engineering, Aligarh Muslim University. Our project focuses on the development of a smoke and fire-detecting alarm. We are grateful for the support and guidance we received from our department, faculty, and staff.

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(PROF. TAHIRA PARVEEN MA'AM)
Project Guide
Date: 1 May 2023

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ABSTRACT

The smoke detector project is designed using an Arduino Uno board along with an MQ-2 smoke sensor, a Bluetooth module, a 16x2 LCD display, LEDs, and a buzzer. The project aims to detect smoke in the environment and notify the user via the LCD display, LEDs, and buzzer. In addition, the Bluetooth module allows for remote monitoring and alerts through a mobile device. The system is designed to provide an affordable, user-friendly, and effective solution for detecting and alerting smoke presence in a closed environment. The project is a great example of how microcontrollers and sensors can be used to create simple but effective systems for practical applications.

The LCD display shows the smoke levels in real-time and the LEDs provide instant visual feedback for smoke levels exceeding the threshold. The buzzer emits an alarm sound when the smoke levels reach a dangerous level. Overall, this project offers a simple and effective solution for detecting smoke and hazardous gases in real time with remote monitoring capability.

ACKNOWLEDGEMENTS

We want to convey our sincere gratitude to our supervisor, **Prof. Tahira Parveen** ma'am, for providing the motivation and support necessary for accomplishing this task successfully. Throughout all the highs and lows of our mini-project, she has consistently been friendly, attentive, responsible, and encouraging. She helped us finish the project, offering insightful advice. She has taught us a lot, and we sincerely express our eternal gratitude to her for that. She read and corrected this report with a lot of patience on her part.

We would also like to extend our gratitude to **Mr. Salim** and **Mr**.**Sulaiman**, Lab Assistants for helping us to use the lab facility and provided the technical support for the accomplishment of this project.

Date: 1 MAY 2023

Place: Aligarh, INDIA

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LIST OF FIGURES

Chapter 1

Introduction

The goal of the project is to create a system for smoke detection that can detect the level of smoke and sound an alarm when the smoke level is too high. The system is implemented using an Arduino board, a Bluetooth module, a smoke sensor MQ2, a 16*2 LCD display, LEDs, and a buzzer.

This project is designed to detect smoke and fire and trigger appropriate actions, such as activating an alarm, turning on LEDs, and controlling an exhaust fan to expel the smoke from the environment.

1.1 Problem Statement

With the increasing number of fire incidents reported globally, this project can contribute to enhancing fire safety measures and reducing the risk of fire-related damages.
the user through visual and audio signals. The system uses an MQ2 sensor to detect the smoke level, and the data is displayed on the LCD screen. The user can also monitor the smoke level using a mobile phone via Bluetooth connectivity.

The project addresses the critical issue of fire safety, especially in closed spaces such as homes, offices, and industries. The system provides an efficient and reliable way of detecting smoke, which is an early indicator of fire. By providing real-time data about the smoke level, the system can help prevent potential hazards by alerting the users about the presence of smoke.

1.2 Proposed Solution

The solution to the problem of fire accidents caused by smoke and gas leakage is to build a smoke detector and gas sensor system using an Arduino board, MQ-2 gas sensor, and a Bluetooth module. The system will detect the level of smoke and gas in the air and notify the user through a smartphone application via Bluetooth communication.

The MQ-2 gas sensor will be used to detect smoke, propane, methane, and other flammable gases. The smoke and gas levels will be displayed on an LCD connected to the Arduino board. If the smoke level exceeds the predefined threshold value, the system will sound an alarm, turn on the red LED, and send a notification to the user's smartphone via Bluetooth.

The proposed solution also includes the use of the yellow LED to indicate the smoke level between the normal range and the threshold value. Additionally, a green LED will indicate normal air quality.

The Bluetooth module will establish communication between the Arduino board and a smartphone application. The application will receive notifications from the system and provide real-time monitoring of the smoke and gas levels. The user will receive a notification if the smoke level exceeds the predefined threshold value.

This solution provides an affordable and efficient way to detect smoke and gas leakage in homes, offices, and other indoor environments. It will alert the user of potential fire hazards and provide real-time monitoring for early detection and prevention.

Chapter 2

An Introduction to Arduino Uno

2.1 Arduino Uno Introduction

The Arduino Uno is an open-source microcontroller-board based on the ATmega328P microcontroller. It features 14 digital input/output pins, 6 analog inputs, 16 megahertz quartz crystal oscillator, USB connection, power jack, ICSP header, and reset button. The digital pins can be used as either inputs or outputs and are capable of handling a maximum of 20 mA. The six analog inputs can be used to measure voltage levels ranging from 0 to 5 volts. The microcontroller has 32KB of flash memory for storing the user's code and 2KB of SRAM for storing variables and other temporary data.
The board has a USB connection that allows it to be connected to a computer for programming and serial communication. It also has a power jack that can be used to supply power to the board using an AC-to-DC adapter or a battery. The ICSP header can be used for programming the microcontroller using an external programmer.
The Arduino Uno board can be powered using either a USB cable, an external power supply, or through the Vin pin. It can operate at a voltage range of 5 to 12 volts, and the recommended voltage is 7 to 12 volts.

Overall, the Arduino Uno microcontroller is a versatile and widely-used board in the field of electronics and embedded systems design due to its ease of use, wide range of applications, and extensive community support. This microcontroller is popular in Arduino because of its low power consumption and high processing speed.

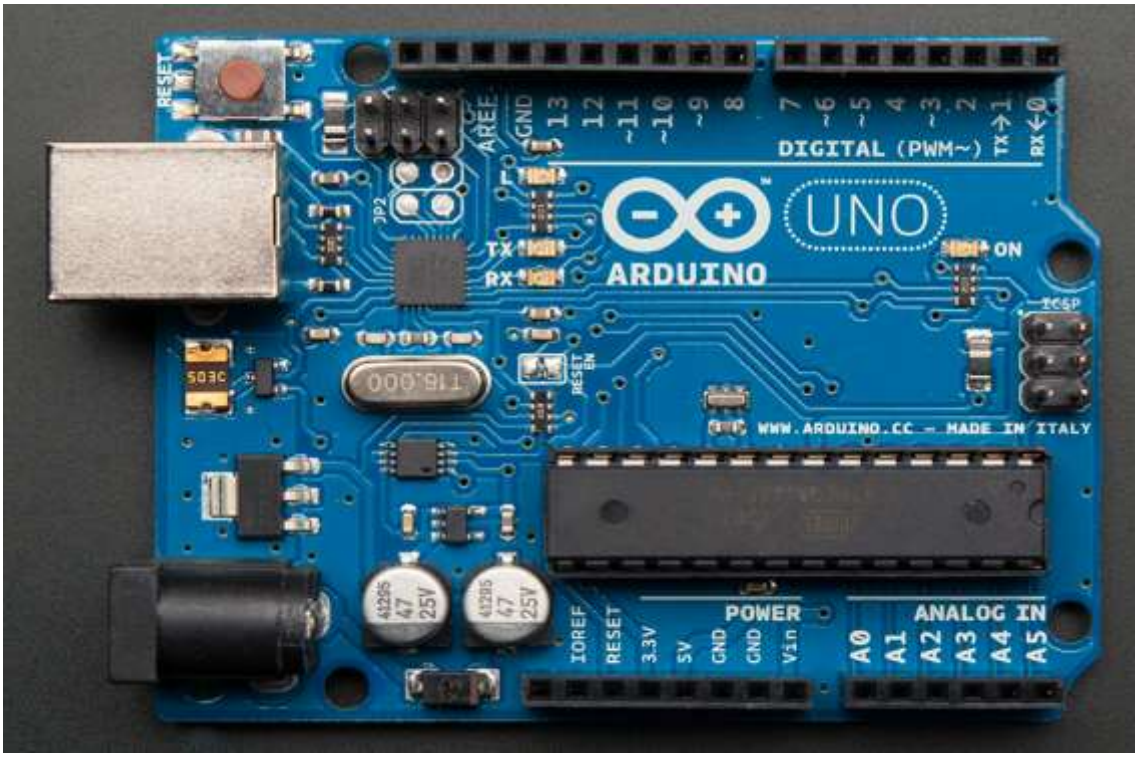


Fig 1. Arduino Uno board

2.2 Pin diagram of Arduino Uno

pin configuration is shown below

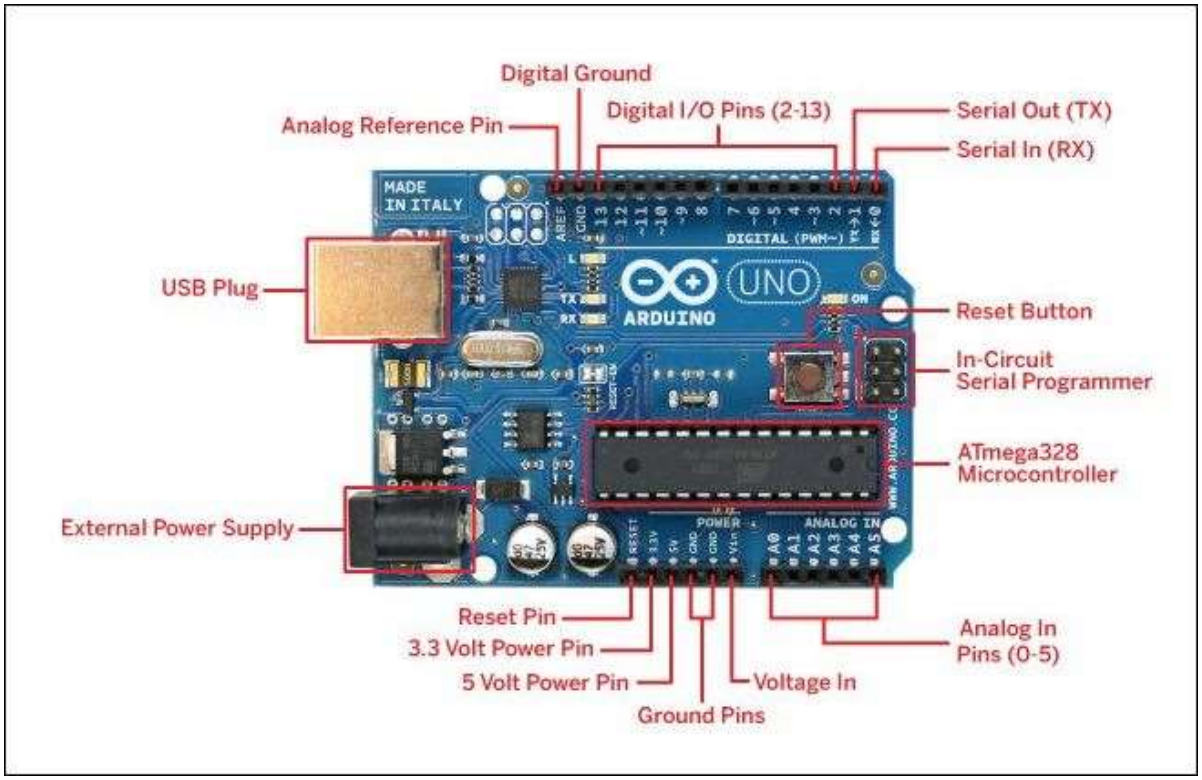


Fig 3. Pin Diagram of arduino uno board

2.3 Application of Arduino Uno

Arduino Uno is a microcontroller-board based on the ATmega328P microcontroller. It is one of the most popular choice among hobbyists, students, and professionals for prototyping, designing, and creating electronic projects. The Arduino Uno is a versatile board and can be used in various applications, including but not limited to:

1. Robotics: Arduino Uno can be utilized in controlling motors, sensors, and actuators, which make it an excellent choice for robotics projects. It can control the movement of the robot, detect obstacles, and perform other tasks.
2. Home automation: Arduino Uno can be used to control home appliances, such as lights, fans, and air conditioners, and create a smart home automation system. It can be connected to various sensors and modules to automate different tasks and make the home more energy-efficient.
3. IoT (Internet of Things): Arduino Uno can be used to create IoT projects that can be connected to the internet and controlled remotely. It can collect data from various sensors and send it to a web server or a mobile application.
4. Education: Arduino Uno is widely used in education to teach students about electronics, programming, and robotics. It is a user-friendly platform that can be used by beginners and advanced users alike.

Chapter 3

The MQ2 Sensor: An Overview

3.1 Introduction to MQ2 Sensor

The MQ-2 sensor is a gas sensor that is commonly used for detecting various types of gases such as smoke, methane, propane, alcohol, hydrogen, and more. It is a low-cost sensor that is widely available and can be easily integrated into electronic circuits.

3.2 What is an MQ2 Sensor?

The MQ-2 sensor is a gas sensor used for detecting various types of gases such as smoke, methane, propane, alcohol, hydrogen, and more. It is a low-cost sensor that is widely available and can be easily integrated into electronic circuits.

The sensor works by detecting changes in the electrical conductivity of the metal oxide semiconductor (MOS) when it comes into contact with a specific gas. When the gas interacts with the sensor's surface, the electrical resistance of the MOS changes, which is then measured by the sensor's circuitry.

The MQ-2 sensor is commonly utilized in applications such as gas leak detection systems, fire alarms, and system that monitors air quality. It is also popular among hobbyists and DIY enthusiasts for projects such as building gas detectors and smoke alarms.

It's important to note that the MQ-2 sensor has some limitations, such as sensitivity to humidity and temperature, and it may also give false readings if not calibrated properly. Therefore, it is important to use the sensor in combination with other sensors and technologies to ensure accurate and reliable gas detection.

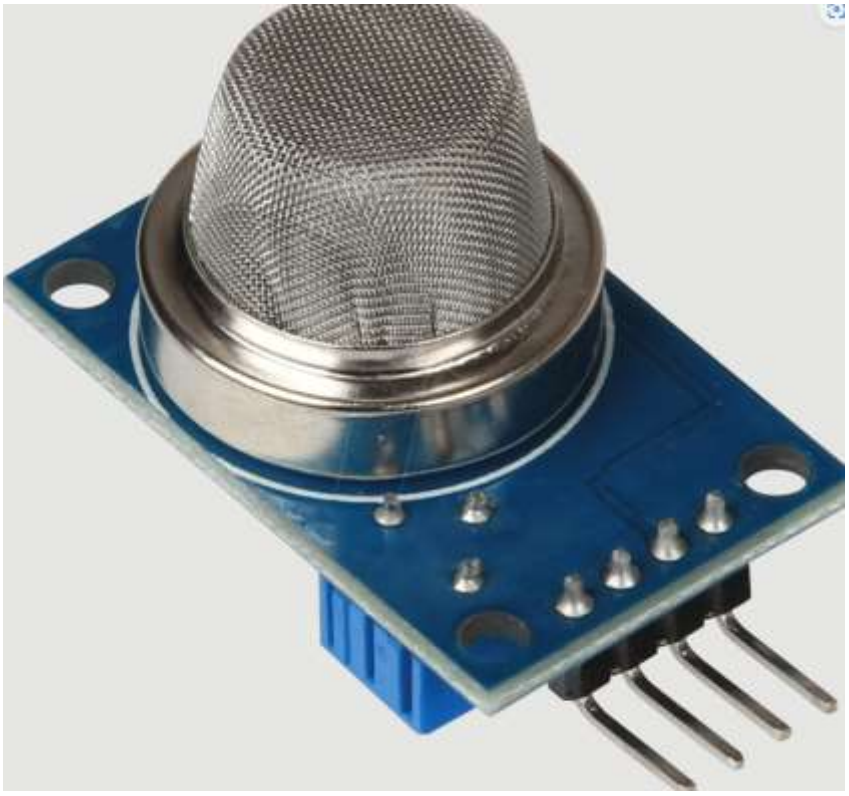


Fig 5. MQ2 **Sensor Diagram**

MQ2 Sensor Features

It has dual signal output (analog output and digital output).

0~4.1V analog output voltage, the higher the concentration, the higher the voltage.

It has highly sensitive to natural gas, natural gas, and city gas.

Long life, stable and reliable.

Fast and quick response and recovery features.

3.3 Working of MQ2 Sensor

The MQ-2 sensor detect changes in the electrical conductivity of the metal oxide semiconductor (MOS) when it comes in contact with a specific gas. The sensor consists of a small ceramic chip with a heating element and a sensing element.

When the sensor is powered up, the heating element is activated, and the sensing element starts to heat up. The heating element is necessary to maintain a constant temperature of the sensing element. Once the sensing element reaches a stable temperature, it is ready to detect gases.

When the sensing element comes into contact with a gas, the gas molecules are adsorbed on the surface of the sensing element, which therefore changes the electrical conductivity of the MOS. The change in conductivity is then measured by the sensor's circuitry, which generates a voltage output signal that is proportional to the concentration of the gas in the air.

The output signal is then processed by a microcontroller or a dedicated gas detection circuit, which converts it into a readable value such as parts per million (ppm) or a gas concentration level. The reading is then displayed on a screen or communicated to other devices in the system.

It's important to note that the MQ-2 sensor has a specific sensitivity to different types of gases and can detect multiple gases simultaneously. However, it can also give false readings if exposed to certain environmental conditions such as high humidity or temperature, which can affect its accuracy. Therefore, it is important to calibrate the sensor regularly and use it in conjunction with other sensors and technologies to ensure accurate and reliable gas detection.

Chapter 4

LCD Display Module

4.1 Introduction to 16*2 LCD Display Module

There are several electronic uses for liquid crystal displays (LCDs). It is mostly used in many systems to display various statuses and parameters. LCD 16x2 features two lines, each with 16 characters. The pixel matrix for each character is 5x8 (column by row).

Due to its low cost and simplicity of usage, the 16x2 alphanumeric LCD Display Module is equally popular with professionals and hobbyists. The 16x2 Alphanumeric LCD, as its name implies, can display 16 Columns and 2 Rows for a total of (16x2) 32 characters. An alphabet, a number, or even a unique character can be used for each character. The LCD in question has green backlight, but you also can acquire one with a backlight of blue color to give your projects more visual appeal. Other than the colour of the backlight, both LCDs have the identical characteristics, so they may use the same circuit and code.

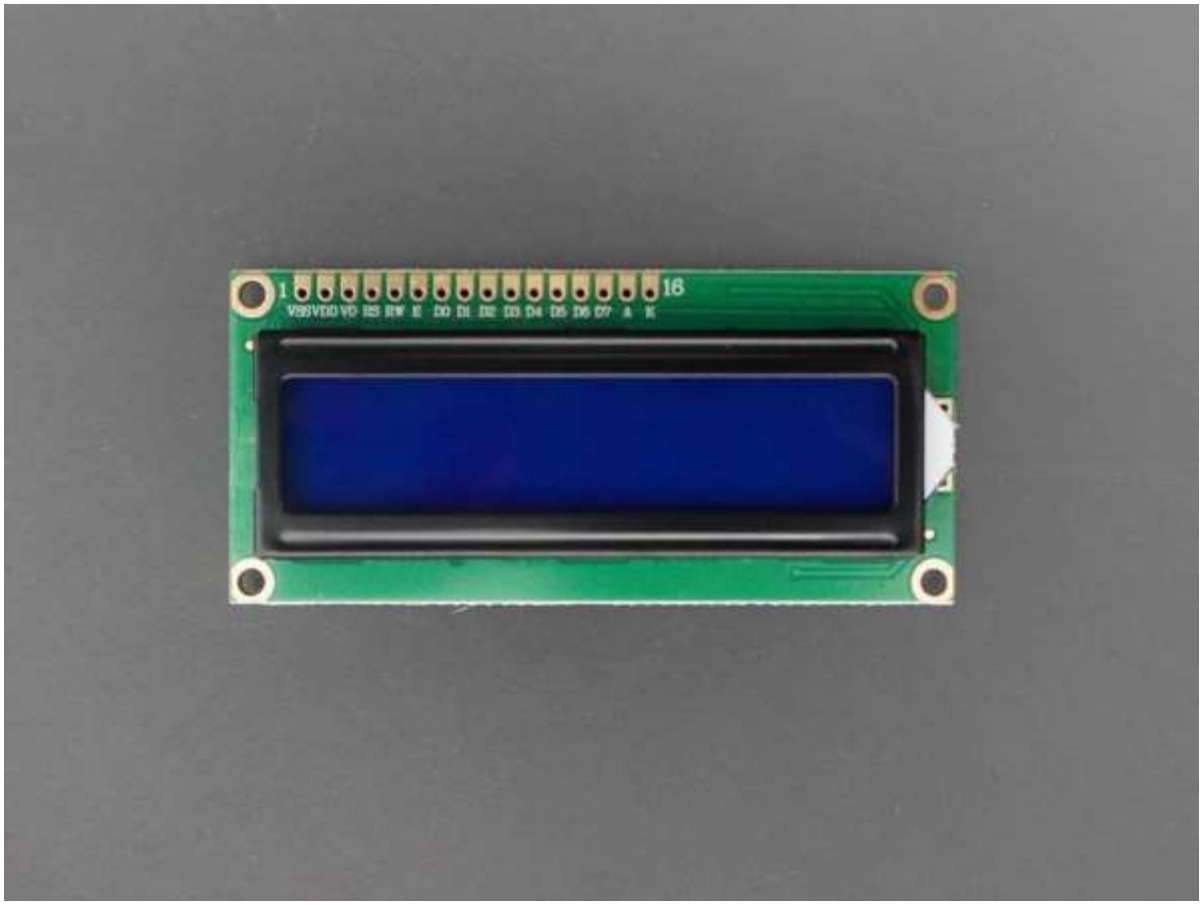


Fig 10. 16*2 LCD Display Module

4.2 16*2 LCD Display Pin description

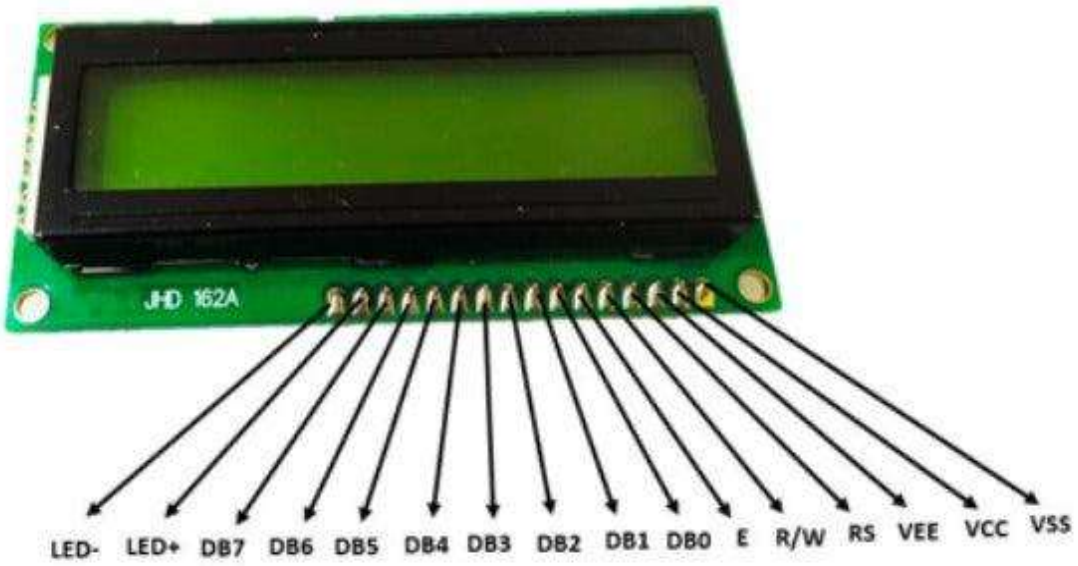


Fig 11. 16*2 LCD Display Pin Diagram

The diagram of the 16x2 LCD pinout is provided in Fig 11. As you see that, the module contains two power pins to power LCD, labeled Vss and Vcc (from right to left). The LCD can run from voltage between 4.7V and 5.3V, although typically Vss should be connected to the ground and Vcc to 5V. The control pins, which are Contrast (VEE), Register Select (RS), Read/Write (R/W), and Enable (E), are the following. The contrast (visibility) of the characters is set via the contrast pin, which is often coupled to a 10k potentiometer so that the contrast can be changed. Most of the time, we will just be writing characters to the LCD and not reading anything from it, hence the Read/Write pin will be grounded.

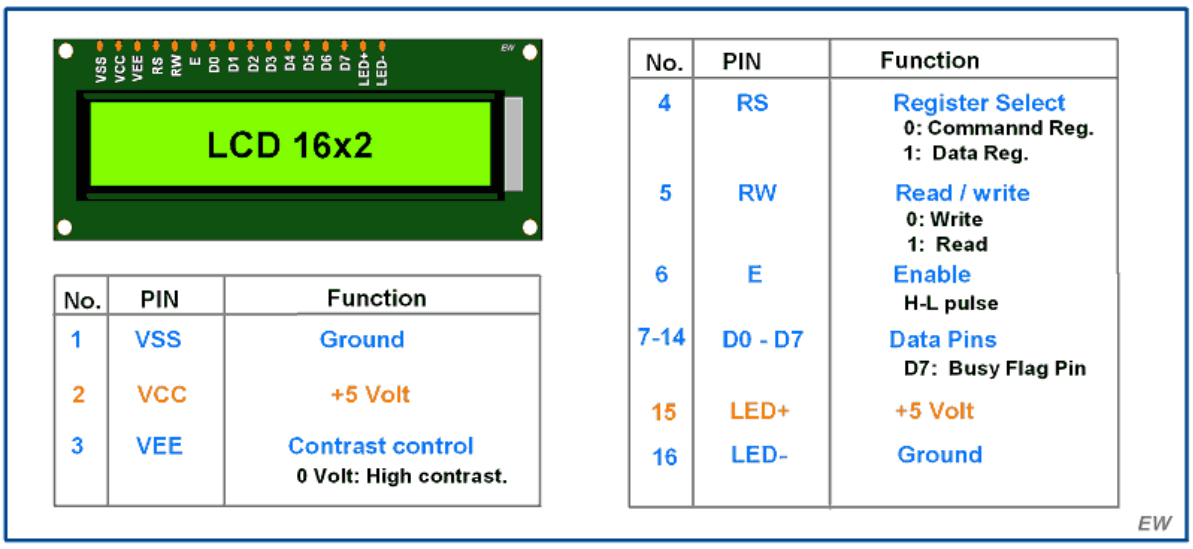


Fig 12. 16*2 LCD Pin description

The LCD16x2's first two pins are utilized for power (+5 V) and ground.

3. The VEE pin.

The display's contrast can be changed via this pin. Low voltage increases contrast on the display; higher voltage decreases contrast. For maximum contrast, simply connect this pin to the ground or a 4.7 k pot for contrast adjustment.

Register Select pin, pin 4, is

RS = 0: Information on pins D0 through D7 is regarded as a command.

RS = 1: Data on the D0 through D7 pins is taken into account for LCD 16x2 display.

Pin 5 is a read-write pin.

Write data to the LCD with RW = 0.

RW = 1: Check the LCD for data.

Pin 6 -E: Activate

The data contained on data pins D0 to D7 is latched using this pin. To latch the data to the display, a high-to-low pulse with minimum width of around 449 ns is necessary.

Pins 7:14 are the DATA pins D0 to D7.

Data and commands are sent to the LCD16x2 as parallel 8 data bits using data pins.

LED + and LED - pin 15:16

Unlike seven-segment displays, liquid crystal displays do not have their own light. Consequently, the module has an LED backlight. Through these pins, this LED receives power.

Chapter 5

Bluetooth Module

5.1 What is a Bluetooth Module?

A Bluetooth sensor is a device that can detect and communicate with other devices using Bluetooth wireless technology. Bluetooth sensors come in various forms and can be used in wide range of applications, which includes monitoring environmental conditions, tracking movement, and detecting proximity to other devices.

Some examples of Bluetooth sensors include:

1. Environmental sensors: These sensors can measure temperature, humidity, air quality, and other environmental parameters.
2. Motion sensors: These sensors can detect movement and acceleration and are commonly used in fitness trackers and wearable devices.
3. Proximity sensors: These sensors can detect the presence of nearby Bluetooth devices and can be used for location tracking, indoor positioning, and other applications.
4. Medical sensors: These sensors can be used for monitoring health-related parameters such as heart rate, blood pressure, and oxygen saturation.

Bluetooth sensors typically communicate wirelessly with other devices using the Bluetooth protocol, which allows them to send and receive data over short distances. They can be powered by batteries or other power sources and can be designed to be very small and portable, making them suitable for a wider range of applications.

Fig 14. Bluetooth Module Diagram

Chapter 6

Relay Module

6.1 What is a Relay Module?

A relay module is an electronic device that allows us to control high-voltage or high-current circuits using a low-voltage signal. It consists of one or more relays (electromechanical switches) and associated circuitry mounted on a small PCB (Printed Circuit Board).

Relay modules are used to interface between low-voltage control circuits, such as those used in microcontrollers and other electronic circuits, and high-voltage or high-current loads, such as motors, lights, solenoids, and other electrical devices. They are often used in automation and control systems, robotics, and industrial applications where it is necessary to switch high-power loads with low-power control signals.

When a low-voltage signal is applied to the input of a relay module, the relay switches on, allowing current to flow through the high-voltage or high-current circuit it controls. When the input signal is removed, the relay switches off, and the circuit is disconnected.

Relay modules are available in a variety of configurations, with different numbers of relays, contact ratings, and input voltages. They are typically easy to use, requiring only a few connections to interface with a microcontroller or other control circuit.

Fig 15. Diagram of Relay Module

Chapter 7

Brushless DC Exhaust Fan

7.1 What is a Brushless DC Exhaust Fan?

A Brushless DC (BLDC) Exhaust Fan is a type of fan that is used to expel air from an enclosed space. Unlike traditional fans that use a brush-type DC motor, a BLDC exhaust fan uses a brushless DC motor, which offers several advantages.

First, a BLDC motor is more efficient than a brush-type DC motor because it has no brushes to wear out, reducing friction and minimizing energy loss. This translates into lower power consumption and longer motor life.

Second, a BLDC motor operates more quietly and with less vibration than a brush-type DC motor, making it ideal for applications where noise and vibration are a concern, such as in residential and commercial buildings.

A BLDC exhaust fan typically consists of a motor and a fan blade mounted in a housing. The motor is connected to a controller that regulates its speed based on input signals, such as temperature or humidity. This allows the fan to operate at variable speeds, adjusting its output to match the changing conditions in the space it serves.

BLDC exhaust fans are commonly used in a wider range of applications, which includes bathrooms, kitchens, garages, and other areas where ventilation is required. They are available in various sizes and airflow capacities, allowing them to be tailored to specific applications.

Fig 16. Diagram of Brushless DC Exhaust Fan

Chapter 8

Servo Motor

8.1 What is a Servo Motor?

A servo motor is an electric motor which is commonly used in robotics and other precision control applications. Unlike a conventional motor that rotates continuously, a servo motor can rotate to a precise angle and hold its position, making it ideal for applications where precise control is required.

A servo motor consists of a DC motor, gear train, and a feedback control system. The feedback control system, known as a closed-loop control system, uses a sensor, such as an encoder or potentiometer, to monitor the position of the motor shaft and send feedback signals to the motor controller. The controller adjusts the motor's power supply to maintain the desired position, speed, and torque.

Servo motors are commonly used in robotics, CNC machines, industrial automation, and other applications that requires precise control of position, velocity, and acceleration. They come in a variety of sizes, torque ratings, and speed ranges, allowing them to be tailored to specific applications.

One advantage of servo motors is their ability to produce high torque at low speeds, which makes them ideal for tasks that require high precision and accuracy, such as robotic arms, pick-and-place machines, and camera gimbals. They can also operate at high speeds, making them suitable for applications that require quick response times, such as drones and quadcopters.

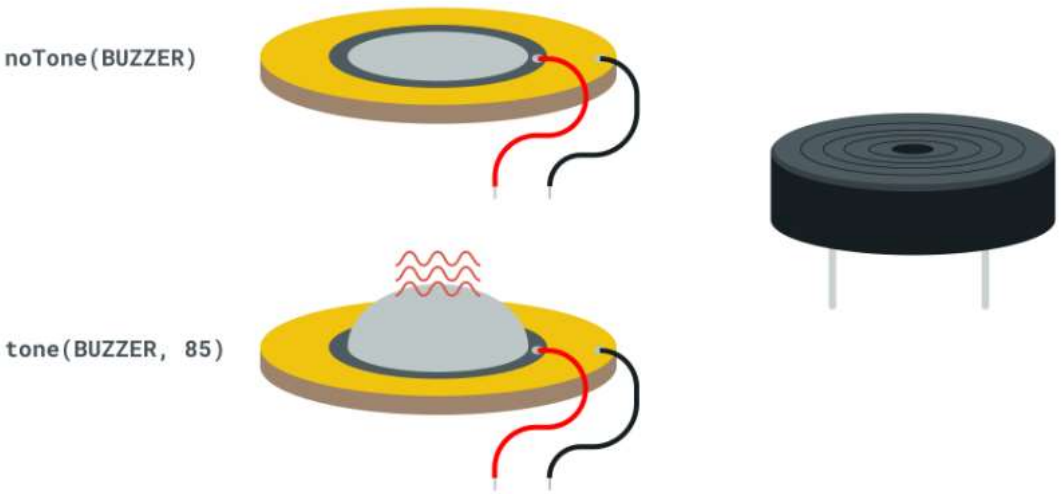
Fig 17. Servo Motor Diagram

Chapter 9

Buzzer

8.1 What is a Buzzer?

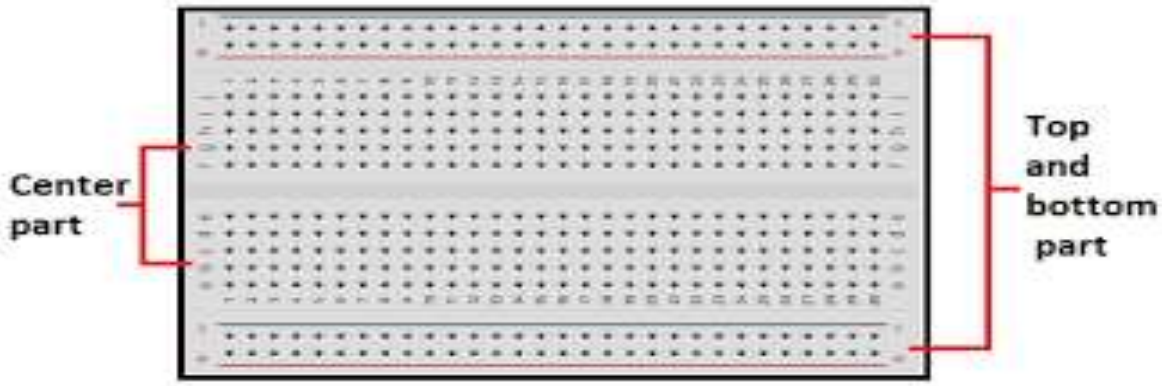
The piezo (buzzer) is a component that is used for generating sound. It is a digital component that can be connected to digital outputs and emits a tone when the output is HIGH. It can be connected to an analog pulse-width modulation output to generate various tones and effects. The Grove Buzzer operates at both 3.3V and 5V with a sound output of 85 decibels.



BreadBoard

What is a breadboard?

A breadboard is a plastic board in a rectangular shape which has small holes that allows for easy insertion of electronic components to create and test preliminary versions of electronic circuits. For instance, one can build and test a basic circuit that includes a battery, switch, resistor, and LED (light-emitting diode) using a breadboard.



Bread Board

Chapter 10

Construction and Working of the Device

In the construction of the smoke detection device, we have used various components which include Arduino Uno, MQ2 Sensor, I2C LCD Display Module, a buzzer, a Single channel relay module, a Bluetooth module. Using and assembling all these components we have designed the device with the interface as shown in below figure

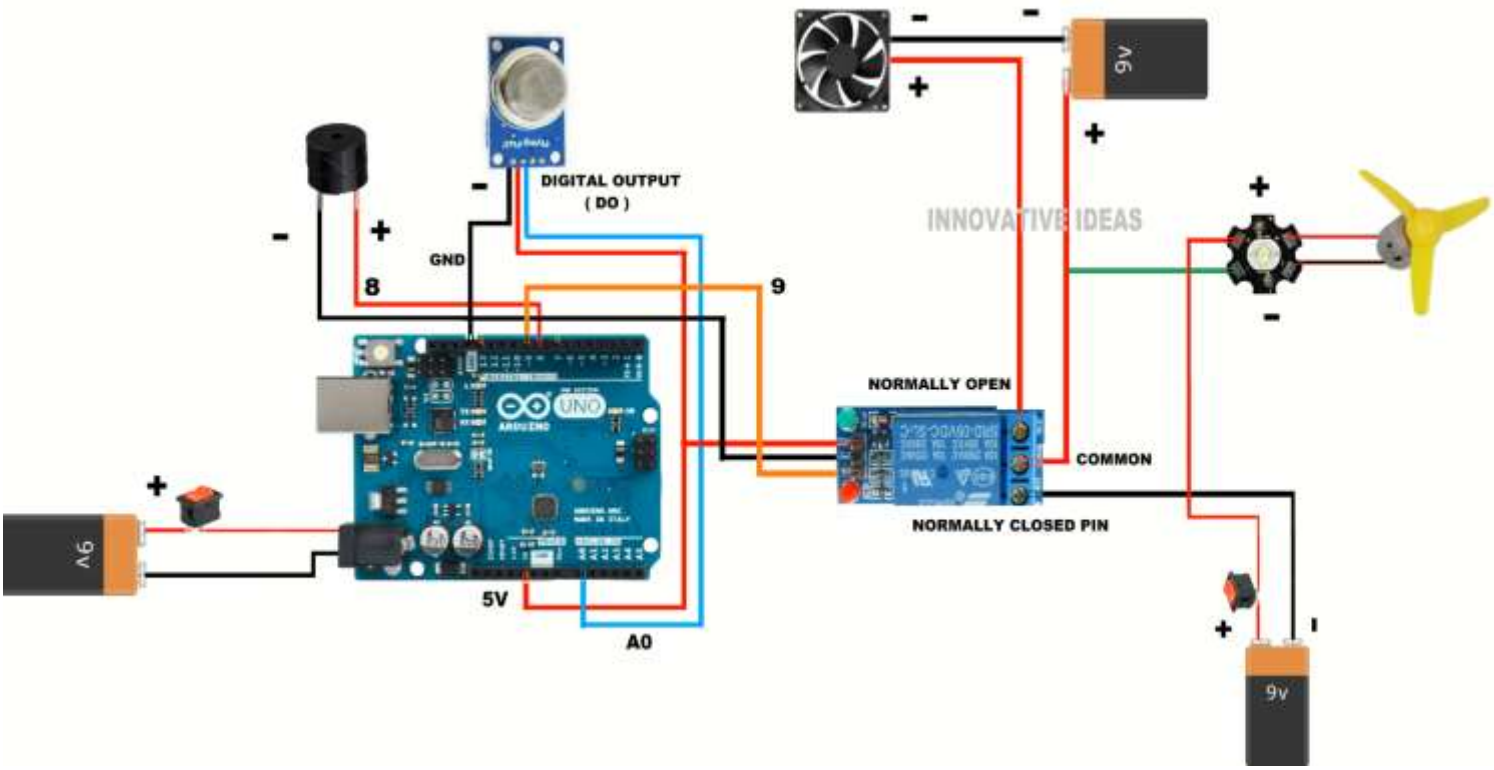


Fig 18. Circuit Diagram

Chapter 11

Working of the device

1.1 Smoke Detection:

The MQ-2 Smoke Sensor detects the presence of smoke or combustible gases in the air. It works by measuring the resistance changes in its sensor when it comes in contact with smoke or gas. The sensor’s analog output is fed to the input analog pin of the Arduino.

The Arduino continuously read the sensor’s analog input and compares it with a threshold value. If the sensor value exceeds the threshold value, the Arduino triggers an alarm by turning on the Red LED, Buzzer, and Exhaust Fan.

The Red LED indicates the presence of smoke or gas, and the Buzzer produces a loud sound to alert the occupants of the building. The Exhaust Fan is turned on to extract the smoke or gas from the room.

The Green LED indicates that the system is working properly.

1.2 Display and Notification:

The LCD display shows the current value of the smoke or gas level in the air and the status of the system components. It also displays warning messages if the system encounters any errors.

The Bluetooth module sends the smoke or gas level and component status to a mobile app or any Bluetooth-enabled device. This provides the occupants with remote access to the system's status and alerts them in case of any smoke or gas detection.

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Chapter 12

Conclusions

11.1 Conclusions

In conclusion, the project successfully demonstrated the implementation of a smoke detection system using an MQ2 gas sensor, a relay module, a Bluetooth module, a brushless DC exhaust fan, and an LED. The system was able to detect smoke in real-time and trigger the exhaust fan and LED alarm to alert users of potential danger.

The use of a relay module allowed for the control of high-voltage devices with a low-voltage signal, while the brushless DC exhaust fan provided a quieter and more efficient method of smoke removal. The Bluetooth module enabled the system to be remotely monitored and controlled using a smartphone, enhancing its convenience and accessibility.

The project showcased the practical application of several electronic components and provided valuable insights into their functioning and integration. Further development and improvements to the system could be made, such as incorporating additional sensors or integrating the system with a home automation network.

Overall, the project demonstrated the potential of electronic devices in providing solutions to real-world problems and highlighted the importance of innovation and experimentation in the field of electronics.

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