Smoke Fire Safety System Using IoT

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This paper has been submitted to the department of Mechanical Engineering of Sonargaon University (SU) in partial fulfillment of the requirement for the degree of Bachelor of Science in Mechanical Engineering**.**

Department Of Mechanical Engineering
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[May 15, 2024]

Letter of Transmittal

May, 2024

To
Nahiyan Chowdhury

Lecturer

Department of ME
Sonargaon University (SU)
147/I, Green Road, Panthapath, Dhaka

Subject: Submission of Project report.

Dear Sir,

Please find enclosed the project report entitled **"Smoke Fire Safety System Using IoT"**. The study has been carried out in partial fulfillment of the requirements for the degree of Bachelor of Science in Mechanical Engineering.

In carrying out the study, we have followed supervisor's advice and collected required information from several text books, reference books, web sites and other sources. I/we think you will find it useful and informative. We would be glad to furnish you further explanations or clarifications if required.

Sincerely yours,

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Declaration

We do hereby solemnly declare that the work presented in this report entitled **"Smoke Fire Safety System Using IoT"** has been carried out by us and has not been previously submitted to any other university, college or organization for an academic qualification, certificate or diploma/degree.

We hereby warrant that the work that has been presented here does not breach any existing copyright. We further undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligations.

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Certificate

This is to certify that the report entitled **"Smoke Fire Safety System Using IoT"** is the valid record of the work done by Md. Omar Faruk , Md. Amjad hossain, Md. Ariful Islam, Md. Rayhan Hossen Dew, Manik Mia for partial fulfillment of the requirement of the degree of B.Sc. in Mechanical Engineering (ME) from Sonargaon University (SU).

This work has been carried out under my guidance and is a bonafide record of valid works carried out successfully.

Faculty Guide

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Next, we would like to thank our family and friends for their valuable support to complete this thesis.

Finally, we would like to express my/our heartiest gratefulness to Almighty Allah for His heavenly blessings. Without his blessings it would not possible to complete my/our work successfully.

Thank you all.

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Executive Summary

Fire plays an important role in our daily life, but it is also a serious threat to human life and properties. Along with the growing science and technology, fire prevention technologies are also constantly innovating. This system is designed to detect the fire and smoke at the early stage and notify with a buzzer. The notification contains the fire and smoke warning and the location information. Whenever a fire occurs, the fire sensor senses the fire at very early stage itself. In case of a gas, the smoke sensor detects it and sends a notification saying there is a chance of fire which helps the fighters to subdue it before the fire causes damage at a greater extend. Node MCU processor is used as the brain of the system. Here also used a MQ2 smoke sensor, flame sensor, GSM, SMPS, Buck Converter, Relay, Pump Motor, LCD Display and a buzzer.

Key Word: Fire Sensor, Smoke Sensor, Alarming System, Fire and Smoke Detection System.

Table of Contents

Letter of Transmittal II

Declaration III

Certificate IV

Acknowledgement V

Executive Summary VI

List of Figures IX

List of Tables X

Chapter 1 Introduction 1

1.1 Introduction 2

1.2 Objective 3

1.3 Methodology 3

1.4 Organization of the Book 3

Chapter 2 Literature Review 4

2.1 Literature Review 5

Chapter 3 Equipment and Software Details 7

3.1 Introduction 8

3.2 Equipment's List 8

3.3 Node MCU 8

3.4 Resistor 11

3.5 Flame Sensor 12

3.6 MQ2 Smoke Sensor 13

3.7 Buzzer 15

3.8 SMPS 15

3.9 LCD Display 20

3.10 Buck Converter 21

3.11 Relay 23

3.12 GSM Module 25

3.13 Pump Motor 28
3.14 Arduino Software 29
3.15 Easy EDA Software 31

Chapter 4 System Design **32**
4.1 Introduction 33
4.2 Block Diagram 33
4.3 Circuit Diagram 33
4.4 Working Principle 34
4.5 Components Rating and Quantity 34
4.6 Real View of Project 35

Chapter 5 Result And Discussion **36**
5.1 Results 37
5.2 Advantages 37
5.3 Applications 37
5.4 Limitations 38
5.5 Discussion 38
Chapter 6 Conclusion **39**
6.1 Conclusion 40
6.2 Future Scope of Work 40

Reference 42
Appendix 44

List of Figures

FIGURE NO.	FIGURE NAME	PAGE
Figure 3.1	Node MCU	9
Figure 3.2	Node MCU Schematic Diagram	9
Figure 3.3	Node MCU Pin Out	10
Figure 3.4	Flame Sensor	13
Figure 3.5	MQ 2 Smoke Sensor	13
Figure 3.6	Buzzer	15
Figure 3.7	SMPS	16
Figure 3.8	SMPS Circuit	17
Figure 3.9	SMPS Circuit Connection	19
Figure 3.10	DC Power supply way	19
Figure 3.11	16*2 LCD Display	20
Figure 3.12	Pin out of 16*2 LCD Display	20
Figure 3.13	16*2 LCD Display interfacing with Arduino	21
Figure 3.14	DC -DC Buck Converter	22
Figure 3.15	Relay	23
Figure 3.16	Relay Module	24
Figure 3.17	Main’s voltage connections	24
Figure 3.18	Voltage connections	25
Figure 3.19	GSM Module	26
Figure 3.20	GSM Module Introducing	26
Figure 3.21	GSM Module Pinout	27
Figure 3.22	Pump Motor	28
Figure 3.23	Arduino Software Interface	30
Figure 3.24	Easy EDA Software Interface	31
Figure 4.1	Block Diagram	33
Figure 4.2	Circuit Diagram	
Figure 4.3	The Complete Prototype of the Project	33

List of Tables

Table 1 Cost of Components with Price 34

Chapter 01
Introduction

1.1 Introduction

In a world where safety is paramount, the integration of advanced technologies becomes imperative to protect lives and property. The "IoT-Based Smoke and Fire Safety System" is a cutting-edge project designed to provide an intelligent and proactive approach to fire prevention and management. This system employs the Internet of Things (IoT) to create a comprehensive and responsive fire safety solution. The primary goal of this project is to detect and respond to potential fire hazards efficiently. The system incorporates a range of components, including smoke and fire detectors, alarming devices, LCD displays, and IoT connectivity, to create a robust and interconnected safety infrastructure.

Utilizing state-of-the-art sensors for early detection of smoke and fire, the system ensures a rapid response to potential hazards. An audible alarm or buzzer is integrated to immediately alert individuals in the vicinity, ensuring swift evacuation in case of a fire. The inclusion of an LCD display offers real-time status updates, providing users with critical information about the system's health and any detected threats. By connecting to the IoT, the system enables remote monitoring and control. It sends instant notifications to designated users through various channels, keeping them informed about the situation, regardless of their physical location. The system is equipped with a Switched-Mode Power Supply (SMPS) to ensure a stable and uninterrupted power source, crucial for the continuous operation of the safety components. Swift detection and notification help in taking immediate action, potentially preventing the escalation of fire incidents.

Users can monitor the system remotely, enhancing overall accessibility and control. Integration capabilities with emergency services improve the efficiency of emergency response. The system logs data, facilitating analysis for continuous improvement and troubleshooting. IoT-Based Smoke and Fire Safety System represents a paradigm shift in fire safety, combining advanced sensor technology with real-time communication to create a reliable, intelligent, and responsive solution. This project aims to set new standards in fire prevention, providing a safer environment for residential, commercial, and industrial spaces.

1.2 Objectives

We have some specific objectives for this project and they are pointed below:

- To study of the **Smoke Fire Safety System Using IoT**.
- To design and construct of a Fire and Smoke Detection, Alarming System and GSM notification system.
- To implement and study of take proper step to reduce the fire incident.
- To take necessary notes from the project for future improvements.

1.3 Methodology

Our methodology for the project:

- Design and construction of a **Smoke Fire Safety System Using IoT** block diagram to know which components need to construct it.
- Collecting the all components and programming for the controller to controlled the system.
- Setting all components in a PCB board & soldering. Then assembling the all block in a board and finally run the system & checking.

Chapter 02

Literature Review

2.1 Literature Review

In this section topics related to A Real Time Fire and Smoke Detection System are included. These provide a sampling of problems appropriate for application of A Real Time Fire and Smoke Detection System. The references are summarized below.

I. Need for Wireless Fire Detection Systems using IOT: The interconnection of physical devices embedded with electronics, software and sensors, which is capable of collecting required data from the surrounding and sent those data over internet is called IOT. The fire detection composed of all of the techniques and processes that ensures the early detection of a fire. There are three main categories Smoke detection, Flame detection and Temperature detection. The automatic fire detection system will do a real-time surveillance. Mainly an automatic fire alarm system is designed for high-rise buildings. To do early extinguishing of a fire disaster, large numbers of detectors are deployed in buildings, which will periodically measure smoke concentration or temperature. There are many techniques we had been already used to detect fire, such as fire detection using sensors, image processing, CC TV technology. (**Reference-01, 02, 03**)

II. Unified Smoke and Flame Detection for Intelligent Surveillance System: This paper explains the way of unification of flame and smoke detection algorithms by merging the common steps into a single processing flow. Smoke detection and flame detection can be done using color probability, boundary roughness, edge density and area variability filtering processes. The obtained preliminary results show that, by processing smoke and flame in parallel, we can reduce the processing time. The results obtained from unified processing part can be used to feed as input for different tasks of intelligent surveillance systems. (**Reference-04**)

III. Design and Implementation of Smoke Early Warning System: In this paper the author proposes a simple hardware design, which consists of different fire sensors that enables every user to use this wireless fire security system. The challenges, while designing the nodes with different types of fire sensors are discussed and the methods to overcome this problem is analyzed. The system is interfaced with the many types of sensors to sense different fire sources like gas leakage, smoke, and heat. This circuit is fully controlled by the PIC micro-controller. All the sensors and detectors are wired to PIC micro-controller. The PIC micro-controller will periodically monitor all the

connected sensors and when it senses any security problem then notification sent to the PC central monitoring station wirelessly. The distance should be in Range of 300m indoor/1500m outdoor using. Also gas, light, smoke, temperature & humidity sensors can be interfaced with this micro-controller to find out abnormal fire conditions in the surroundings in all possible ways. ARM7 based micro-controller can also be used to build such systems. (**Reference-05, 06**)

IV. Development of System for Early Fire Detection using Arduino Pro Mini: The fire alarm system proposed in this paper only uses affordable things. The Fire alarm system monitor real- time, when it detects the presence of fire, it will automatically capture images and display it on a screen. The time when output of the associated sensors such as temperature, humidity, CO2 and fire is increased above the threshold limits, the controller start sending signals module. The main feature of this system is its ability to remotely send an alert whenever a fire and smoke is detected. (**Reference-07**)

Chapter 03
Equipment and Software Details

3.1 Equipment' List

Hardware

- Node MCU
- Smoke Sensor
- Flame Sensor
- SMPS
- Buck Converter
- Relay
- GSM Module
- Pump Motor
- LCD Display
- Buzzer
- Resistor

Software

- Arduino IDE
- Easy EDA

3.2 Node MCU

Node MCU is an open source firmware for which open source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (micro-controller unit). The term "Node MCU" strictly speaking refers to the firmware rather than the associated development kits. Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware 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-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant

for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

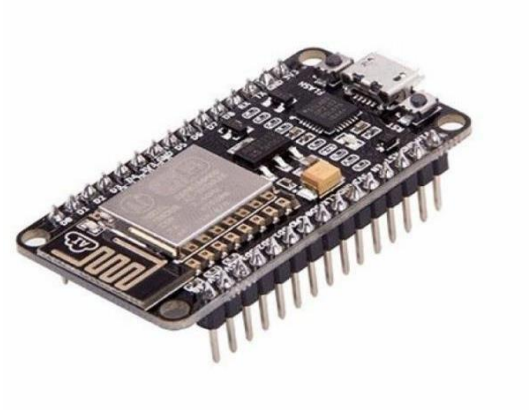


Figure 3.1: Node MCU

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially was based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications. This an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Express if Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the development kits. The firmware uses the Luascripting language. It is based on the eLua project, and built on the Es press if Non-OS SDK for ESP8266. Node MCU was created shortly after the ESP8266 came out.

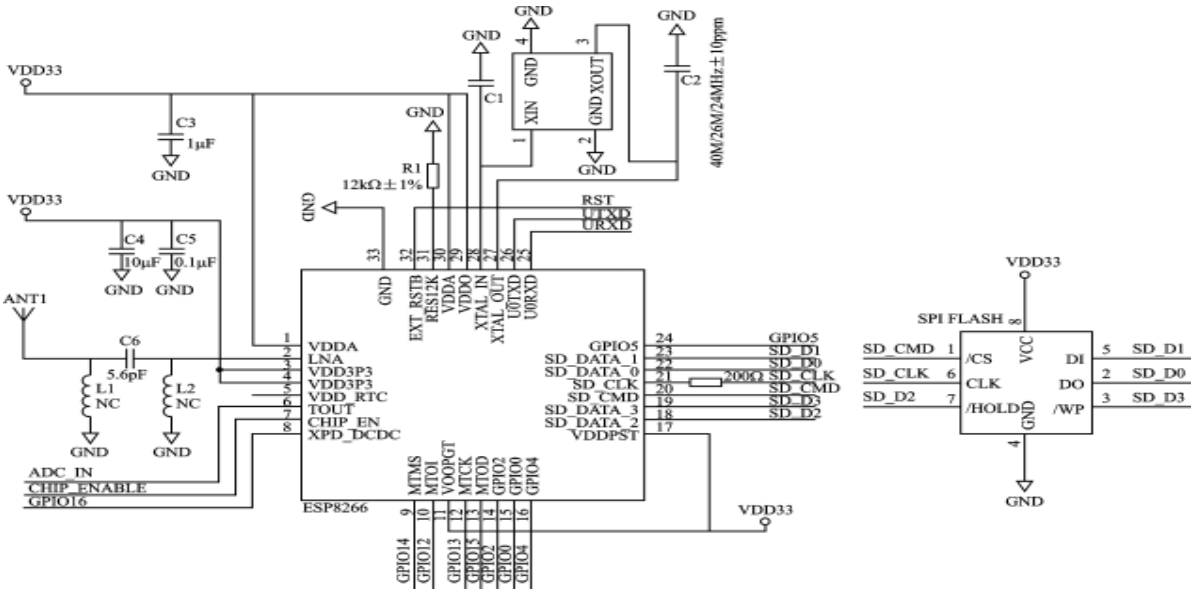


Figure 3.2: Node MCU Schematic Diagram

Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glibto Node MCU project, enabling Node MCU 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 Node MCU 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.

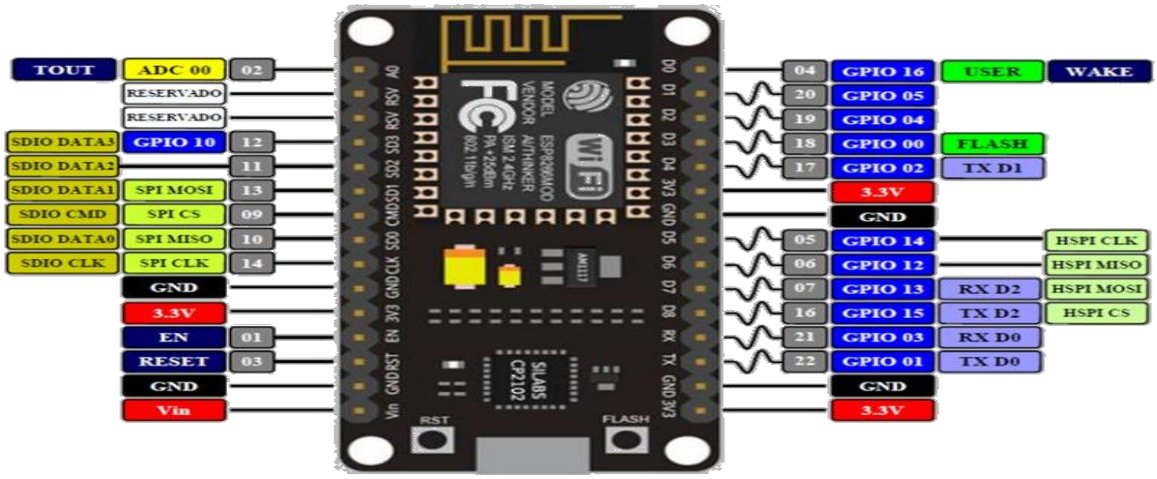


Figure 3.3: Node MCU Pin Out

Node MCU V3 ESP8266 ESP-12E is Wi-Fi development board that helps you to prototype your IoT product with few Lua script lines, or through Arduino IDE. The board is based on ESP8266 ESP-12E variant, unlike other ESP-12E, you won't need to buy a separate breakout board, usb to serial adapter, or even solder it to a PCB to get started, you will only need a usb cable (Micro USB).

Features

1. Communication interface voltage: 3.3V.
2. Antenna type: Built-in PCB antenna is available.
3. Wireless 802.11 b/g/n standard
4. WiFi at 2.4GHz, support WPA / WPA2 security mode
5. Support STA/AP/STA + AP three operating modes
6. Built-in TCP/IP protocol stack to support multiple TCP Client connections (5 MAX)

7. D0 ~ D8, SD1 ~ SD3: used as GPIO, PWM, IIC, etc., port driver capability 15mA
8. AD0: 1 channel ADC
9. Power input: 4.5V ~ 9V (10VMAX), USB-powered
10. Current: continuous transmission: ≈70mA (200mA MAX), Standby: <200uA
11. Transfer rate: 110-460800bps
12. Support UART / GPIO data communication interface
13. Remote firmware upgrade (OTA)

3.3 Resistor

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Two typical **schematic diagram** symbols are as follows:



(a) resistor, (b) rheostat (variable resistor), and (c) potentiometer



IEC resistor symbol

The notation to state a resistor's value in a circuit diagram varies.

One common scheme is the **RKM code** following **IEC 60062**. It avoids using a **decimal separator** and replaces the decimal separator with a letter loosely associated with SI prefixes corresponding with the part's resistance. For example, *8K2* as part **marking code**, in a **circuit**

diagram or in a **bill of materials** (BOM) indicates a resistor value of 8.2 kΩ. Additional zeros imply a tighter tolerance, for example *15M0* for three significant digits. When the value can be expressed without the need for a prefix (that is, multiplicator 1), an "R" is used instead of the decimal separator. For example, *1R2* indicates 1.2 Ω, and *18R* indicates 18 Ω.

Specifications:

- Resistance: 220 Ohms
- Power (Watts): 0.25W, 1/4W
- Temperature Coefficient: 350ppm/Celcius
- Tolerance: +/- 5%
- Case: Axial
- Size: 0.094" Dia x 0.248" L (2.40mm x 6.30mm)

3.4 Flame Sensor

The flame sensor can detect flame and infrared light sources with wavelengths ranging from 760 nm to 1100 nm. It uses the LM393 comparator chip, which gives a clean, stable digital output signal and driving ability of 15 mA. This flame detector that can be used in fire alarms and other fire detecting devices.

Specifications

- LM393 comparator chip
- Detection Range: 760 nm to 1100 nm
- Operating Voltage: 3.3 V to 5 V
- Maximum Output Current: 15 mA
- Digital Outputs: 0 and 1
- Detection Angle: about 60 degrees
- Adjustable sensitivity via potentiometer
- LED lights indicators: power (red) and
- digital switching output (green)
- Fixed bolt holes for easy installation
- PCB Size: 32 x 14 mm

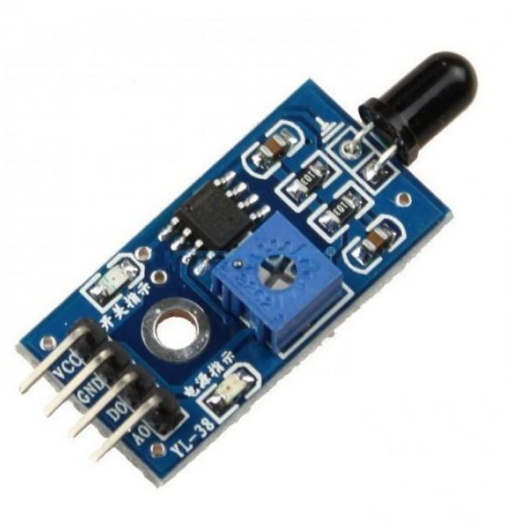


Figure 3.4: Flame Sensor

3.5 MQ 2 Smoke Sensor

The utility model can be used for gas leakage monitoring devices in families and factories, and is suitable for the detection of liquefied petroleum gas, butane, propane, methane, Hydrogen, smoke, etc. This is a very easy to use low cost semiconductor Gas sensor Module with analog and digital output.



Figure 3.5: MQ2 Smoke Sensor

Features:

- Adopt high quality double panel design, with power indication and TTL signal output indication.
- It has DO switch signal (TTL) output and AO analog signal output.
- TTL output valid signal is low level. When the output is low, the signal light is on, and the micro-controller or relay module can be directly connected.

- The analog output voltage increases with the concentration, the higher the voltage.
- It has better sensitivity to liquefied petroleum gas, natural gas, urban gas and smoke.
- MQ-2 MQ2 Smoke Gas LPG Butane Methane Sensor Detector Module
- With four screw holes, easy to locate.
- Product size: 32 (L), *20 (W), *22 (H)
- With long service life and reliable stability.
- Fast response recovery features

Specifications:

- Input voltage: DC5V
- Power dissipation (current): 150mA
- DO output: TTL, numeric quantities 0 and 1 (0.1 and 5V)
- AO output: 0.1-0.3V (relatively pollution-free), the highest concentration of about 4V voltage
- Special reminder: after the sensor is energized, you need to preheat 20S or so, the data to be stable, sensor heating is a normal phenomenon, because the internal heating wire, if hot, it is not normal.

Connection mode:

- VCC: power supply positive (5V)
- GND: power supply negative pole
- DO:TTL switch signal output
- AO: analog signal output
- Functions: This version supporting test procedures
- Using chips: AT89S52
- Crystal oscillator: 11.0592MHZ
- Since this Gas Sensor module is sensitive to smoke it can be used in for fire detection. MQ2 Gas Sensor is also sensitive to flammable/combustible gasses like LPG, Propane & Hydrogen.
- Baud rate: 9600

3.6 Buzzer

Piezo elements are actually one of the coolest crystals you'll play with. Flex them, they generate a voltage (pretty high, actually). Pass power through them, and they'll flex. Do it fast enough, and they'll start to make a sound! So besides making annoying little beep noises, you could use it as a sensor to detect a knock or other similar vibration.

Specifications

- Operating Voltage: 1.0 ~ 20.0V
- Rated Voltage: 3.0V
- Diameter: Ø12.5mm
- Total Height: 6.3mm
- Capacitance: 15,000pF
- Current Consumption: ≤2mA
- Resonance Frequency: 4,000Hz
- Sound Pressure Level at 10cm: ≥75db
- Self Drive: No



Figure 3.6: Buzzer

3.7 Switch Mode Power Supply (SMPS)

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power

supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.

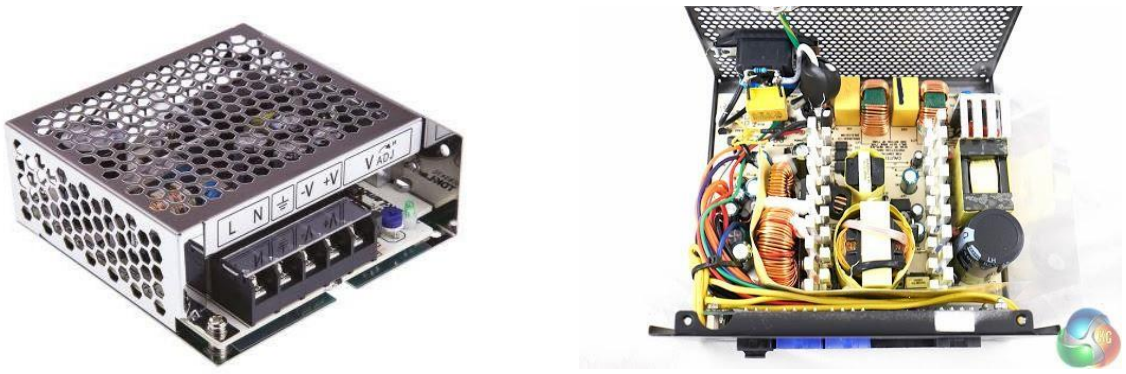


Figure 3.7: SMPS

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor **power factor**.

Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are:

- AC to DC
- DC to DC
- DC to AC
- AC to AC

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter
- Inverter consisting of switching devices such as MOSFETs
- Transformer
- Output rectifier and filter
- Feedback and control circuit

The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC output is rectified and smoothed to produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level.

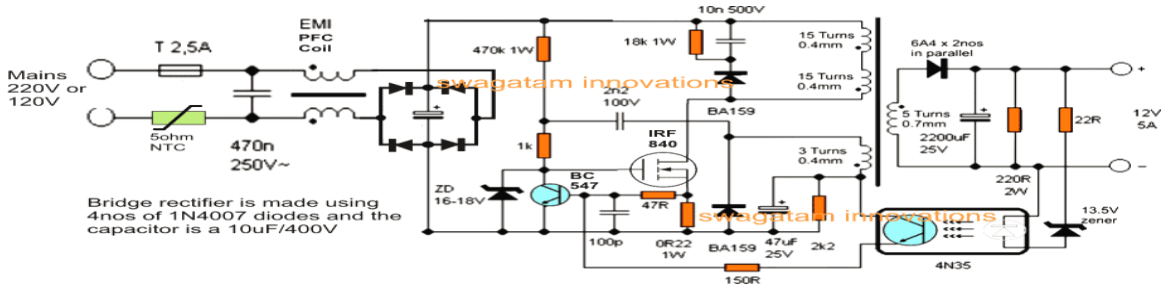


Figure 3.8: SMPS Circuit

Basic working concept of an SMPS

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

Design basics

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electro technical Commission (IEC) style input connector. As for output connectors and pin outs, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up to the manufacturer.

There are different circuit configurations known as topologies, each having unique characteristics, advantages and modes of operation, which determines how the input power is transferred to the output. Most of the commonly used topologies such as flyback, push-pull, half bridge and full bridge, consist of a transformer to provide isolation, voltage scaling, and multiple output voltages. The non-isolated configurations do not have a transformer and the power conversion is provided by the inductive energy transfer.

Advantages of switched-mode power supplies:

- Higher efficiency of 68% to 90%
- Regulated and reliable outputs regardless of variations in input supply voltage
- Small size and lighter
- Flexible technology
- High power density
- Disadvantages:
- Generates electromagnetic interference
- Complex circuit design
- Expensive compared to linear supplies

Switched-mode power supplies are used to power a wide variety of equipment such as computers, sensitive electronics, battery-operated devices and other equipment requiring high efficiency. Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output. Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such a Zener diode and a resistor, or transistors and even op-amps. The most popular linear and fixed output voltage regulator types are by far the 78… positive output voltage series, and the 79… negative output voltage series. These two

types of complementary voltage regulators produce a precise and stable voltage output ranging from about 5 volts up to about 24 volts for use in many electronic circuits. There is a wide range of these three-terminal fixed voltage regulators available each with its own built-in voltage regulation and current limiting circuits. This allows us to create a whole host of different power supply rails and outputs, either single or dual supply, suitable for most electronic circuits and applications. There are even variable voltage linear regulators available as well providing an output voltage which is continually variable from just above zero to a few volts below its maximum voltage output.

Switch Mode Power Supply

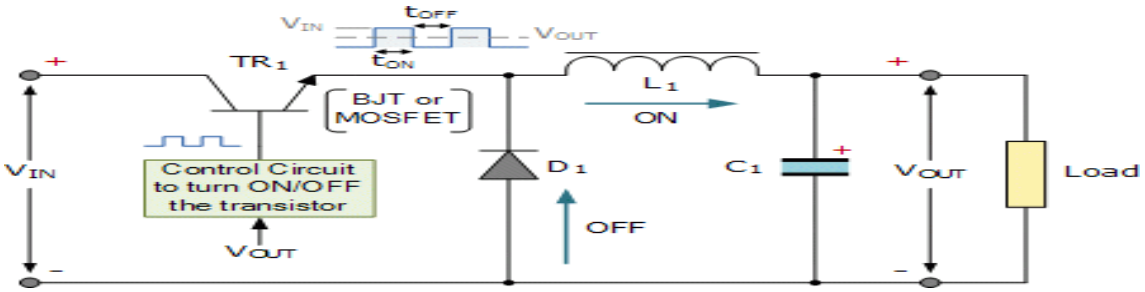


Figure 3.9: SMPS Circuit Connection

Most d.c. power supplies comprise of a large and heavy step-down mains transformer, diode rectification, either full-wave or half-wave, a filter circuit to remove any ripple content from the rectified d.c. producing a suitably smooth d.c. voltage, and some form of voltage regulator or stabilizer circuit, either linear or switching to ensure the correct regulation of the power supplies output voltage under varying load conditions. Then a typical d.c. power supply would look something like this:

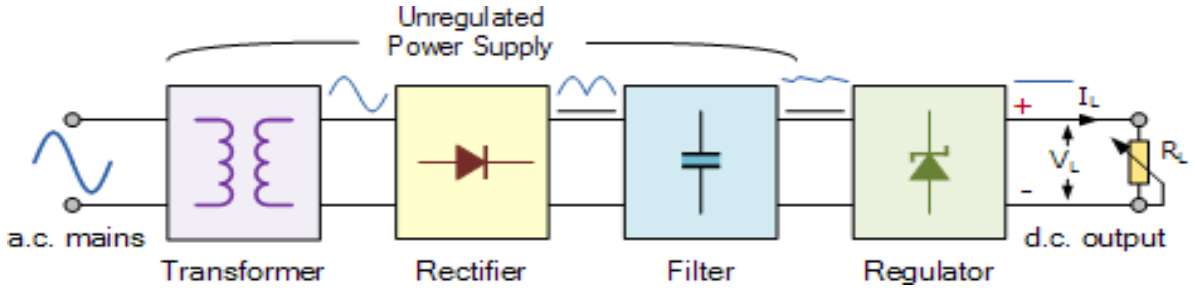


Figure 3.10: DC Power supply way

These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a dissipative series regulator circuit. The regulator circuit could consist of a single Zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

3.8 LCD Display

The LCD (liquid crystal display) screen is an electronic display module and looks for various applications. A 16x2 LCD display is a very basic module and it is very commonly used in various devices and circuits. These modules are preferred over seven sections and many other segments.



Figure 3.11: 16*2 LCD Display

The reasons for having LCD are economic; Easily programmable, special and even custom characters (different in seven sections), there are no restrictions on displaying animations. A 16x2 LCD means it can display 16 characters per line and contains 2 lines. Each character on this LCD is displayed in a 5x7 pixel matrix.

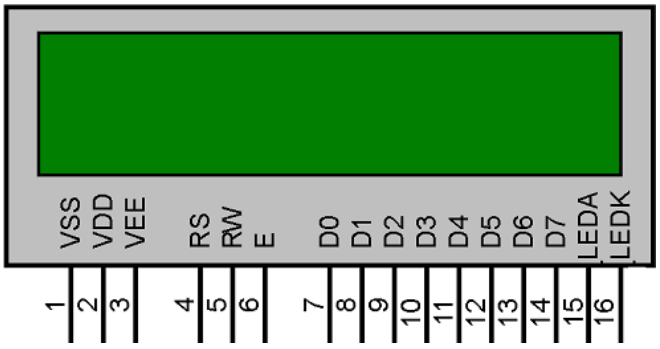


Figure 3.12: Pin out of 16*2 LCD Display

This LCD contains two articles called Command and Data. The command register stores the command instructions on the LCD. The command is a command given to the LCD to perform

a predefined task such as starting it, clearing its screen, locating the cursor, controlling the display, etc.

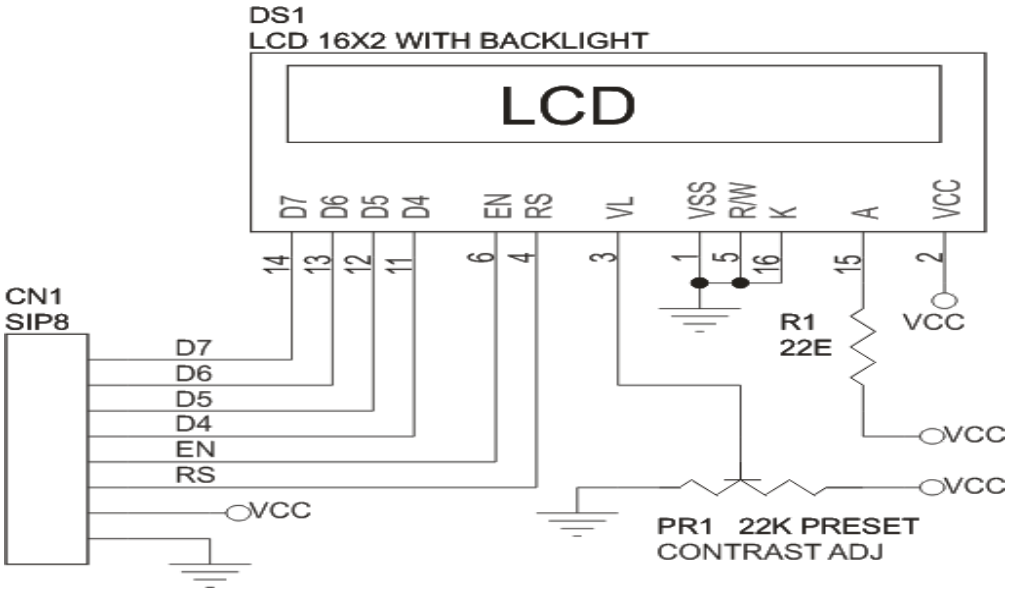


Figure 3.13: 16*2 LCD Display interfacing with Arduino

Feature

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

3.9 Buck Converter

A **buck converter** (**step-down converter**) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). It is called a buck converter because the voltage across the inductor "bucks" or opposes the supply voltage.



Figure 3.14: DC -DC Buck Converter

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

Specifications of DC-DC Buck Converter Step Down Module LM2596 Power Supply :

- Conversion efficiency: 92%(highest)
- Switching frequency: 150KHz
- Output ripple: 30mA9maximum)
- Load Regulation: ± 0.5%
- Voltage Regulation: ± 0.5%
- Dynamic Response speed: 5% 200uS
- Input voltage:4.75-35V
- Output voltage:1.25-26V(Adjustable)
- Output current: Rated current is 2A, maximum 3A (Additional heat sink is required)
- Conversion Efficiency: Up to 92% (output voltage higher, the higher the efficiency)
- Switching Frequency: 150KHz
- Rectifier: Non-Synchronous Rectification
- Module Properties: Non-isolated step-down module (buck)
- Short Circuit Protection: Current limiting, since the recovery
- Operating Temperature: Industrial grade (-40 to +85) (output power 10W or less)

3.10 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

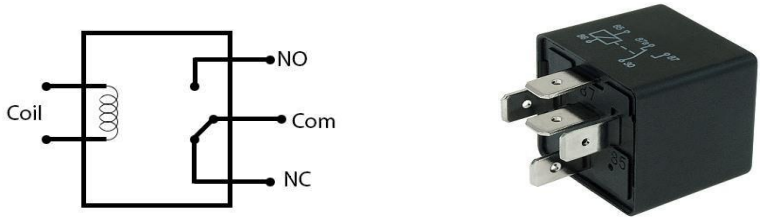


Figure 3.15: Relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts. Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands. The relay module is the one in the figure below.

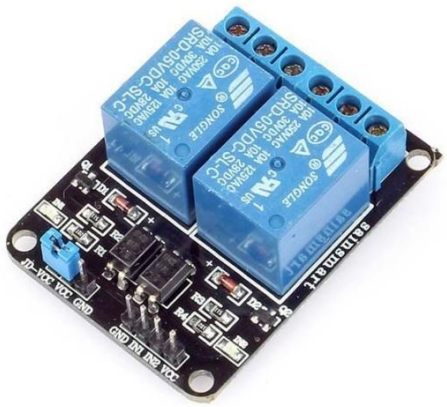


Figure 3.16: Relay Module.

This module has two channels (those blue cubes). There are other varieties with one, four and eight channels.

Main’s voltage connections.
In relation to mains voltage, relays have 3 possible connections:

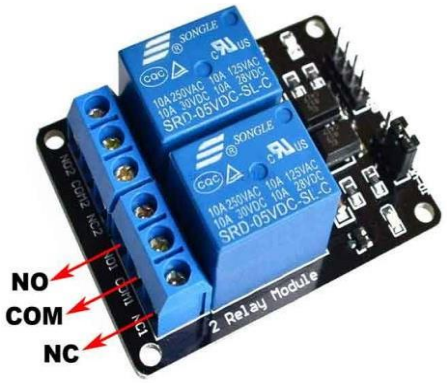


Figure 3.17: Main's voltage connections.

COM: common pin

NO (Normally Open): there is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load

NC (Normally Closed): there is contact between the common pin and the normally closed pin. There is always connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load.

Pin wiring

The connections between the relay module and the Arduino are really simple:

GND: goes to ground

IN: controls the first relay (it will be connected to an Arduino digital pin)

IN2: controls the second relay (it should be connected to an Arduino digital pin if you are using this second relay. Otherwise, you don't need to connect it)

VCC: goes to 5V

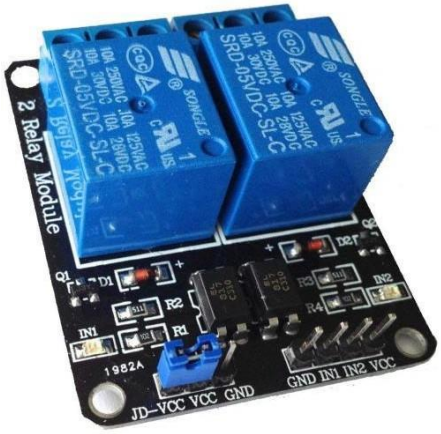


Figure 3.18: Voltage connections

3.11 GSM Module

At the heart of the module is a SIM800L GSM cellular chip from Sim Com. The operating voltage of the chip is from **3.4V to 4.4V**, which makes it an ideal candidate for direct LiPo battery supply. This makes it a good choice for embedding into projects without a lot of space.



Figure 3.19: GSM Module

All the necessary data pins of SIM800L GSM chip are broken out to a 0.1″ pitch headers. This includes pins required for communication with a micro-controller over **UART**. The module supports baud rate from **1200bps** to **115200bps** with Auto-Baud detection.

The module needs an external antenna to connect to a network. The module usually comes with a **Helical Antenna** and solders directly to NET pin on PCB. The board also has a U.FL connector facility in case you want to keep the antenna away from the board.

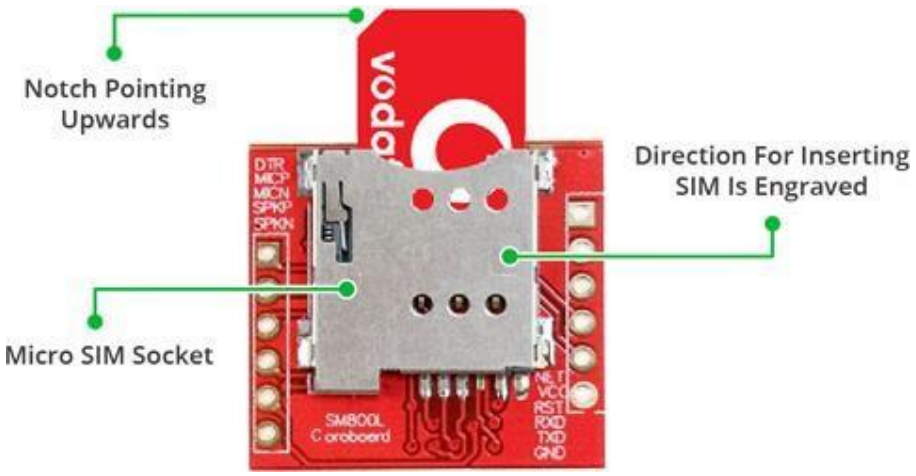


Figure 3.20: GSM Module Introducing

There's a SIM socket on the back! Any activated, **2G micro SIM card** would work perfectly. Correct direction for inserting SIM card is normally engraved on the surface of the SIM socket. This module measures only 1 inch² but packs a surprising amount of features into its little frame. Some of them are listed below:

- Supports Quad-band: GSM850, EGSM900, DCS1800 and PCS1900
- Connect onto any global GSM network with any 2G SIM
- Make and receive voice calls using an external 8Ω speaker & electret microphone
- Send and receive SMS messages
- Send and receive GPRS data (TCP/IP, HTTP, etc.)
- Scan and receive FM radio broadcasts
- Transmit Power:
    - Class 4 (2W) for GSM850
    - Class 1 (1W) for DCS1800
- Serial-based AT Command Set
- FL connectors for cell antennae
- Accepts Micro SIM Card

SIM800L GSM Module Pinout

The SIM800L module has total 12 pins that interface it to the outside world. The connections are as follows:



Figure 3.21: GSM Module Pinout

NET is a pin where you can solder Helical Antenna provided along with the module. VCC supplies power for the module. This can be anywhere from 3.4V to 4.4 volts. Remember connecting it to 5V pin will likely destroy your module! It doesn't even run on 3.3 V! An external power source like Li-Po battery or DC-DC buck converters rated 3.7V 2A would work. RST (Reset) is a hard reset pin. If you absolutely got the module in a bad space, pull this pin low for 100ms to perform a hard reset. RxD (Receiver) pin is used for serial communication.

TxD (Transmitter) pin is used for serial communication.

GND is the Ground Pin and needs to be connected to GND pin on the Arduino.

RING pin acts as a Ring Indicator. It is basically the 'interrupt' out pin from the module. It is by default high and will pulse low for 120ms when a call is received. It can also be configured to pulse when an SMS is received.

DTR pin activates/deactivates sleep mode. Pulling it HIGH will put module in sleep mode, disabling serial communication. Pulling it LOW will wake the module up.

MIC± is a differential microphone input. The two microphone pins can be connected directly to these pins.

SPK± is a differential speaker interface. The two pins of a speaker can be tied directly to these two pins.

3.12 Pump Motor

This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make

sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.

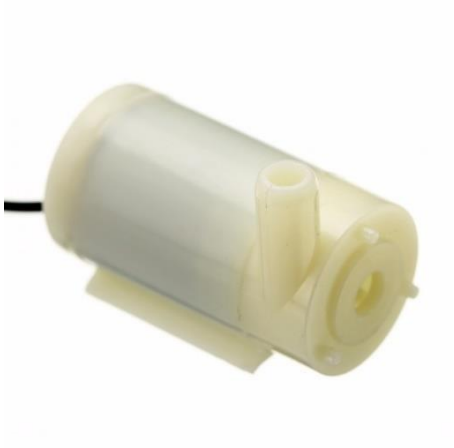


Figure 3.22: Pump Motor

Feature:

- Operating Current : 130 ~ 220mA
- Flow Rate : 80 ~ 120 L/H
- Maximum Lift : 40 ~ 110 mm
- Continuous Working Life : 500 hours
- Driving Mode : DC, Magnetic Driving
- Material : Engineering Plastic
- Outlet Outside Diameter : 7.5 mm
- Outlet Inside Diameter : 5 mm

3.13 Arduino Software

The digital micro-controller unit named as Arduino Nano can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Nano from the Tools, Board menu (according to the micro-controller on our board). The IC used named as ATmega328 on the Arduino Nano comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer.

Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the micro-controller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware

source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

The Arduino Nano is one of the latest digital micro-controller units and has a number of facilities for communicating with a computer, another Arduino, or other micro-controllers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 -(RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs, and for uploading the programs it uses argued. As the Arduino platform uses Atmel micro-controllers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino.

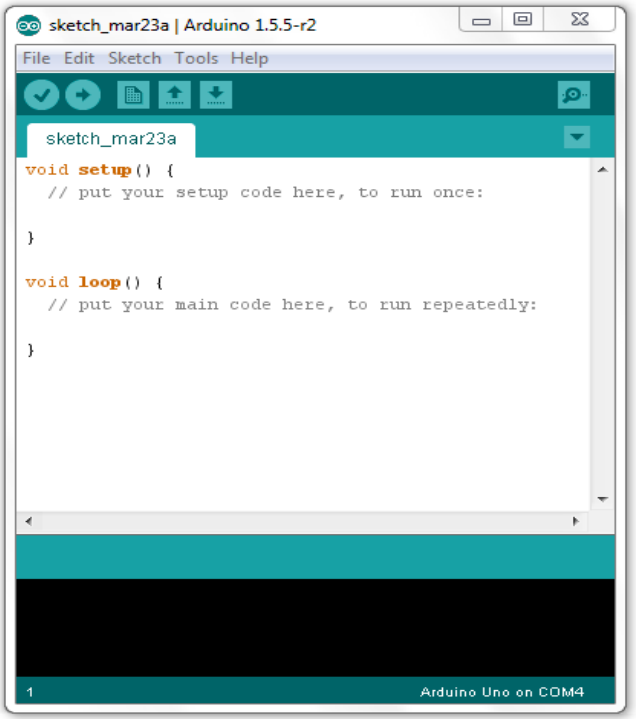


Figure 3.23: Arduino Software Interface IDE

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

3.14 Easy EDA Software

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share - publicly and privately - and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and

the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription.Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

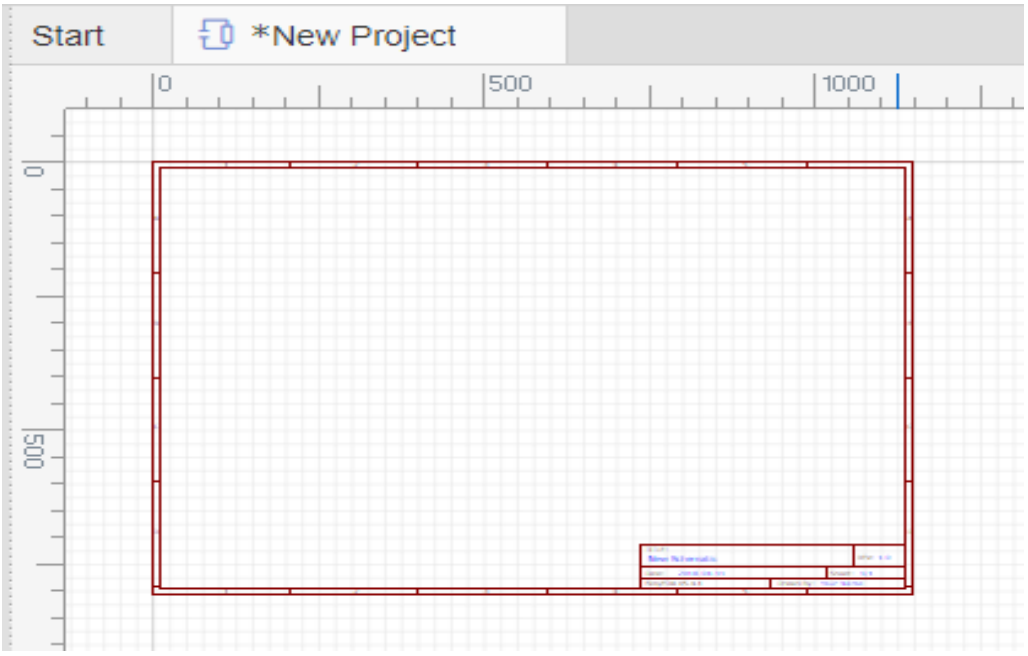


Figure 3.24: Easy EDA Software Interface

Chapter 04
System Design

4.1 Introduction:

In this chapter we describe our project block diagram, circuit diagram, project working principle and final project view.

4.2 Block Diagram of our proposed model:

In our project we have set up a **Smoke Fire Safety System Using IoT**, fire sensor and smoke sensor detect the fire and the smoke. Here the main power supply is a SMPS. In this circuit we have used an Node MCU micro-controller for controlling this system.

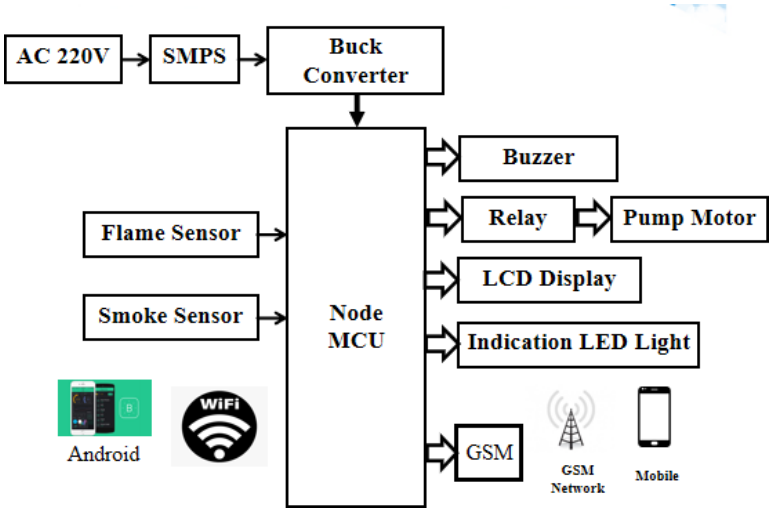


Figure 4.1: Block diagram

4.3 Circuit Diagram of proposed Model

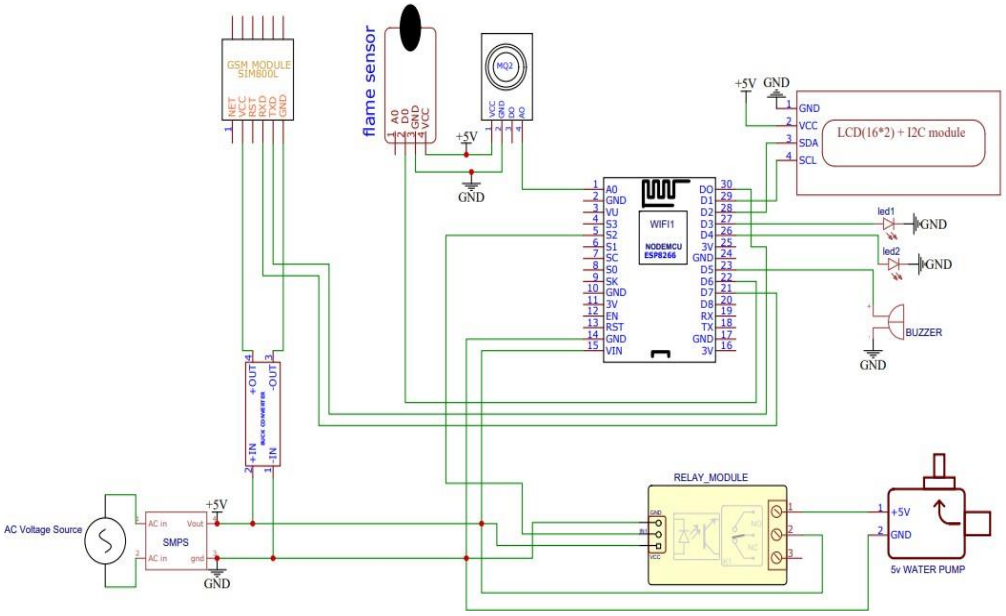


Figure 4.2: Circuit Diagram

4.4 Working Principle

Our main power supply for this system is AC 220 voltage. This power is connected to the SMPS. The main function of SMPS is to convert AC to DC. This SMPS will be supply fixed 5V DC, 5Amp in this system. In this project we have used an Node MCU for operate this system. This is a Fire and Smoke Detection and Alarming System. The main brain of our system is the Node MCU micro-controller. A flame sensor was used for detect the fire, MQ2 sensor is detect the smoke. When there creates a fire then firstly detect it by flame sensor, after that when there creates some smoke then it will detect by the MQ2 sensor. Then it will ring a buzzer for alerting system and pump motor is on. GSM Module send the notification of mobile phone. This is the main procedure of our system.

4.5 Components Rating and Quantity

Table 01: Component's name and quantity

Serial No	Components Name	Rating	Quantity	Price (Taka)
01	Node MCU	ESP8266	1	490
02	Smoke Sensor	MQ2	1	260
03	Flame Sensor	3.3V-5V	1	140
04	SMPS	5V	1	480
05	Buck Converter	LM2596	1	220
06	Relay	5V	1	140
07	GSM Module	SIM800L	1	590
08	Pump Motor	6V	1	160
09	LCD Display	16*2	1	280
10	Buzzer		1	50
11	Indication LED		2	15
12	Others			1850/=
			Total =	4645/=

4.5 Real View of project

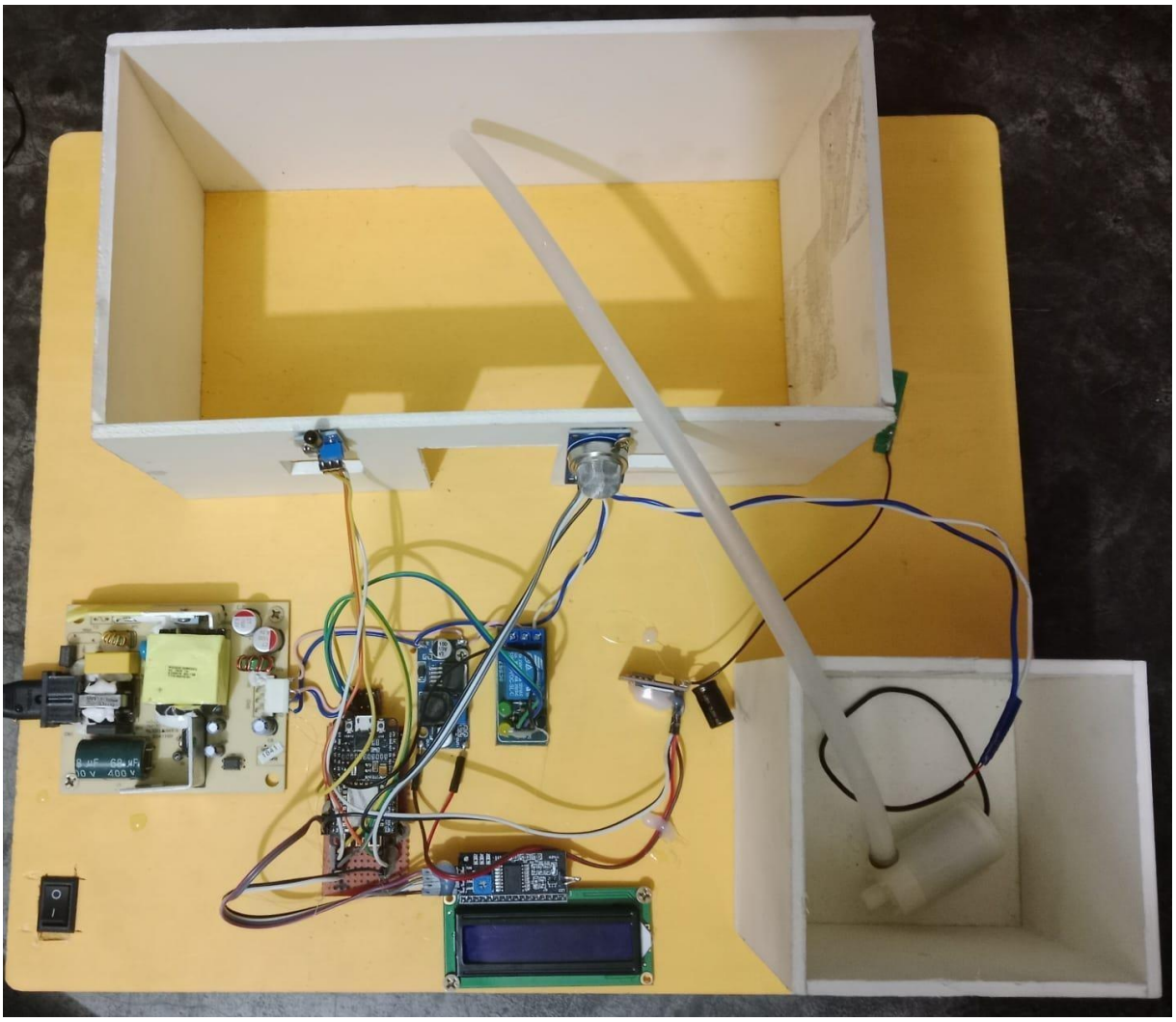


Figure 4.3: Our Project Prototype

Chapter 05
Result and Discussion

5.1 Results

After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it work and we get perfect output from this project.

- ❑ At first, we start our system.
- ❑ Then if there create any fire and smoke then it will sense and ring a buzzer for alert and pump motor is on.
- ❑ Then GSM Module send the notification of mobile phone.
- ❑ All data show in Blynk Mobile Apps and LCD Display.

5.2 Advantage

There are certainly many advantages of our project and some of the major ones have been given below:

- This project is easy to use
- Cost effective
- User-friendly
- Automatic and requires less human interaction
- People with physical disabilities can use this system with ease
- Can be operated virtually from anywhere in the world
- The whole system consumes very little energy.

5.3 Application

Some of the application areas of the project have been pointed out below:

- It can be used in any educational institutions.
- It can be used in any industry or corporate offices.
- It can be used in Hospitals.
- It can be used to identify authentic or fake person.
- It can be used to collect evidences against people with bad intentions.
- It can be used in residential areas.

5.4 Limitations

No project is without its limitations and ours is no exception from that but the final output we received from our project is quite satisfactory. Listed below, are some of the limitations we have:

- Used cheap Chinese products for the prototype so there's some processing delay present in the circuit
- This project can now be only used for small scale purposes

5.5 Discussion

Smoke Fire Safety System Using IoT is really needed for country right now because it can very well save people from unwanted harms. This project lets the user control the unwanted fire or gas related incident. Our project is simple to use but very smart. It doesn't require much energy to run as well. The components that were used to build the system is cheap and available so maintenance is not issue. This type of machine reduces human efforts and also provides accurate results. While doing our project, we did face some difficulties such as faulty wires, coding problem, structure building problems etc. But at the end, the results we came up with were up to the mark. As we have some limitations in our project, so it means that there are lots of things that we can do with this project in the future and we are already focusing on that.

Chapter 06
Conclusion

6.1 Conclusion

We are now in the digital era and with the improvements of technology. We don't feel that much safe as well due to having too many people around with ill intensions. That's we have built this project to tackle the issues. This project firstly, able to detect fire and smoke inside the home or industry. Secondly, it lets the user know by ringing buzzer. This kind of project is also available in outside countries but in ours we don't have much but as we can realize now, it has become really necessary for us. The project doesn't cost that much to build and it's very easy to use. It was built with the intension that everyone should be able to use it for their safety and home automation. Our project is in its pilot phase and now we doing practical tests with it to validate our work and taking notes for future improvements as well. At last we can say that this project is necessary for our country and we hope we can succeed on our mission of making our homes and offices more security.

6.2 Future Scope of Work

As we have already discussed about the limitations of our project so definitely there's room for improvement and thus we have lots of future scope of work available to us for this project. Some of these are listed below:

- In future development this project can be develop by more sensor.
- In future we will add cc TV camera monitoring system.

Reference

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[6] W. Krüll, R. Tobera, I. Willms, H. Essen, and N. Von Wahl, “Early forest fire detection and verification using optical smoke, gas and microwave sensors,” in *Procedia Engineering*, 2012, doi: 10.1016/j.proeng.2012.08.208.

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Appendix

Programming Code:

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);  // I2C address 0x3F, 16 column and 2 rows 27or3F
#include <Wire.h>
#include <SoftwareSerial.h>
SoftwareSerial gsmSerial(D0, D7);

int mq=A0;
int air;

int led1=D3;
int led2=D4;

int buzzer=D5;

int flame=D6;
int fire;

int pump=10;

#define BLYNK_TEMPLATE_ID "TMPL6CVUBr-Jk"
#define BLYNK_TEMPLATE_NAME "Smoke and Fire Safety System Using IoT"
#define BLYNK_AUTH_TOKEN "bzivcLEAJ_qLFbva1SUjicXpFdrNgyTY"
/* Comment this out to disable prints and save space */
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

// Your WiFi credentials.
// Set password to "" for open networks.


char ssid[] = "abcde";
char pass[] = "123456789"
BlynkTimer timer;
```

```
void setup()
{
  Serial.begin(115200);
  pinMode(mq,INPUT);
  pinMode(flame,INPUT);
  pinMode(buzzer,OUTPUT);
  pinMode(led1,OUTPUT);
  pinMode(led2,OUTPUT);
  pinMode(pump,OUTPUT);
  gsmSerial.begin(9600);

   lcd.init();      // initialize the lcd
  lcd.backlight(); // open the backlight
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
  // You can also specify server:
  //Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass, "blynk.cloud", 80);
  //Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass, IPAddress(192,168,1,100), 8080);

  delay(2000);

}

void loop()
{
  Blynk.run();
  timer.run();

  air=analogRead(mq);
 int  air1=air/10.24;
    Serial.println(air1);

  heat();
 Blynk.virtualWrite(V4, air1);
```

```
 if( air1<=30){
  Blynk.virtualWrite(V2, LOW);
  Blynk.virtualWrite(V3, LOW);
  digitalWrite(led1,LOW);

  lcd.setCursor(0, 1);  // start to print at the first row
  lcd.print("Air Quality Ok        ");
   }
  if(air1>30 && air1<80){
  Blynk.virtualWrite(V3, HIGH);
  Blynk.virtualWrite(V2, LOW);
   lcd.setCursor(0, 1);  // start to print at the first row
  lcd.print("Gas Detected       ");
  //sendSMS("Gas Detected!");
  digitalWrite(buzzer,HIGH);
  digitalWrite(led1,HIGH);
  delay(2000);
  digitalWrite(buzzer,LOW);


}
   if(air1>80 ){
    Blynk.virtualWrite(V2, HIGH);
       Blynk.virtualWrite(V3, LOW);
 lcd.setCursor(0, 1);  // start to print at the first row
 lcd.print("Gas Increased      ");
 digitalWrite(led1,HIGH);
       sendSMS("High quantity Gas Detected!");


   digitalWrite(buzzer,HIGH);
  delay(2000);
  digitalWrite(buzzer,LOW);
```

```
 delay(1000);
 digitalWrite(buzzer,HIGH);
 delay(2000);
 digitalWrite(buzzer,LOW);

  }

}
void heat(){
  fire=digitalRead(flame);
  Serial.println(fire);

  if( fire==0){
  Blynk.virtualWrite(V1, HIGH);
  sendSMS("Fire Detected!");
  digitalWrite(led2,HIGH);
  digitalWrite(pump,HIGH);
    lcd.setCursor(0, 0);  // start to print at the first row
 lcd.print("Fire Detected  ");

   digitalWrite(buzzer,HIGH);
 delay(2000);
 digitalWrite(buzzer,LOW);
 delay(1000);
 digitalWrite(buzzer,HIGH);
 delay(2000);
   }
 if( fire==1){
 Blynk.virtualWrite(V1, LOW);
 digitalWrite(buzzer,LOW);
 digitalWrite(led2,LOW);
 digitalWrite(pump,LOW);
```

```
 lcd.setCursor(0, 0);  // start to print at the first row
 lcd.print("                ");
  }
  }
  void sendSMS(String message) {
  gsmSerial.println("AT+CMGF=1"); // Set SMS mode to text
  delay(100);
  gsmSerial.print("AT+CMGS=\"+01820944103\""); // Replace with the recipient's phone
number
  gsmSerial.write(0x0D); // Enter
  delay(100);
  gsmSerial.println(message);

  delay(100);
  gsmSerial.write(0x1A);
  delay(100);
}
```