SMS Based LPG gas leakage detection using Arduino UNO and GSM

A
Industrial Oriented Mini Project Report
Submitted in the Partial fulfilment of the
Academic Requirements
for the Award of the Degree of

Bachelor of Technology
in
Electronics and Communication Engineering

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ACE
Engineering College
(NBA ACCREDITED B. TECH COURSES, ECE, EEE, CSE, MECH, CIVIL
(NAAC "A" GRADE)
An Autonomous Institution
Ankushapur (V), Ghatkesar (M), Medchal Dist.-501 301

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CERTIFICATE

This is to certify that the project work entitled "SMS Based LPG gas leakage detection using Arduino UNO and GSM" done by

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Department of Electronics and Communication Engineering, is a record of Bonafede work carried out by them. This mini project is done as partial fulfilment of obtaining Bachelor of Technology degree to be awarded by **JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD** during the academic year 2023-2024.

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ACKNOWLEDGEMENT

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It is with the great pleasure; I Declare that We've completed our project with the help of MR. **R. NARENDER, Assistant professor,** who gave inspiring Guidance, and ever ready for helping us in every manner for every time.

Above all, we are very much thankful to the management of **ACE Engineering College** which was established by the high-profiled intellectuals for the cause of Technical Education in the modern era. We wish that ACE sooner should become a deemed university and produce uncountable young engineers and present them to the modern technical world.

With Regards

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ABSTRACT

The system designed with gas leakage detector is quite useful for the kitchens at domestic side and in the industries at commercial side as well. A gas detector is a device, which detects the presence of various gases within an area, usually as part of a system to warn about gases, which might be harmful to humans. Gas detectors can be used to detect combustible, toxic (poisonous) and CO_2 gases. Here MQ-2 is used as a gas sensor that is capable to detect gas leak and an automated alert message is sent to the authorized mobile through the GSM modem. MQ-2 is a general-purpose sensor, which has good sensitivity characteristics to a wide range of gases. This device is designed to operate at 5V-regulated supply. The most suitable application for the gas sensor is the detection of methane, propane and butane, which makes it an excellent sensor for gas leak detectors.

This sensor output is used to trigger the operational amplifier (op-amp); this device is configured as voltage comparator. With the help of a reference voltage generated at one input of comparator, sensor output is compared, whenever the sensor detects any toxic gasses, it generates a potential, which is more than the reference voltage and there by comparator output will become high. This high signal is fed to the controller; on receipt of this high signal the controller sends this information to the authorized person through GSM i.e., SMS to the number defined in the program. The required power supply for the entire module to operate is directly derived from the mains single phase supply.

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ABBREVIATIONS

1. LPG: Liquefied Petroleum Gas
2. SMS: Short Message Service
3. GSM: Global System for Mobile Communications
4. Arduino UNO: ARDUINO - A Real-time Data Unit Interfaced for Network Operation
5. AT: Attention (used in AT commands for communication with GSM modules)
6. CMGF: Character Mode Text Format (used in AT commands for configuring SMS mode)
7. CMGS: Command Message Send (used in AT commands for sending SMS)
8. BUZ: Buzzer
9. RX: Receive (used in Software Serial for defining the receive pin)
10. TX: Transmit (used in Software Serial for defining the transmit pin)
11. IoT: Internet of Things
12. Ctrl+ Z: Control-Z (ASCII code for indicating end of a message in SMS communication)
13. MQ: Micro Quality (common prefix for gas sensor modules)
14. UI: User Interface
15. SIM: Subscriber Identity Module (used in GSM modules for communication)
16. IoT: Internet of Things

CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW:

The described system is a gas leakage detection system utilizing an MQ-2 gas sensor and GSM modem. The MQ-2 sensor is sensitive to gases such as methane, propane, and butane. When the sensor detects a gas leak, it triggers an operational amplifier configured as a voltage comparator. If the sensor output surpasses a reference voltage, the comparator sends a signal to the controller. The controller, powered by the mains supply, uses a GSM modem to send an alert SMS to an authorized mobile number. This system is versatile, applicable in both domestic kitchens and industrial environments, enhancing safety by providing timely notifications in the event of a gas leak.

1.2 BLOCK DIAGRAM:

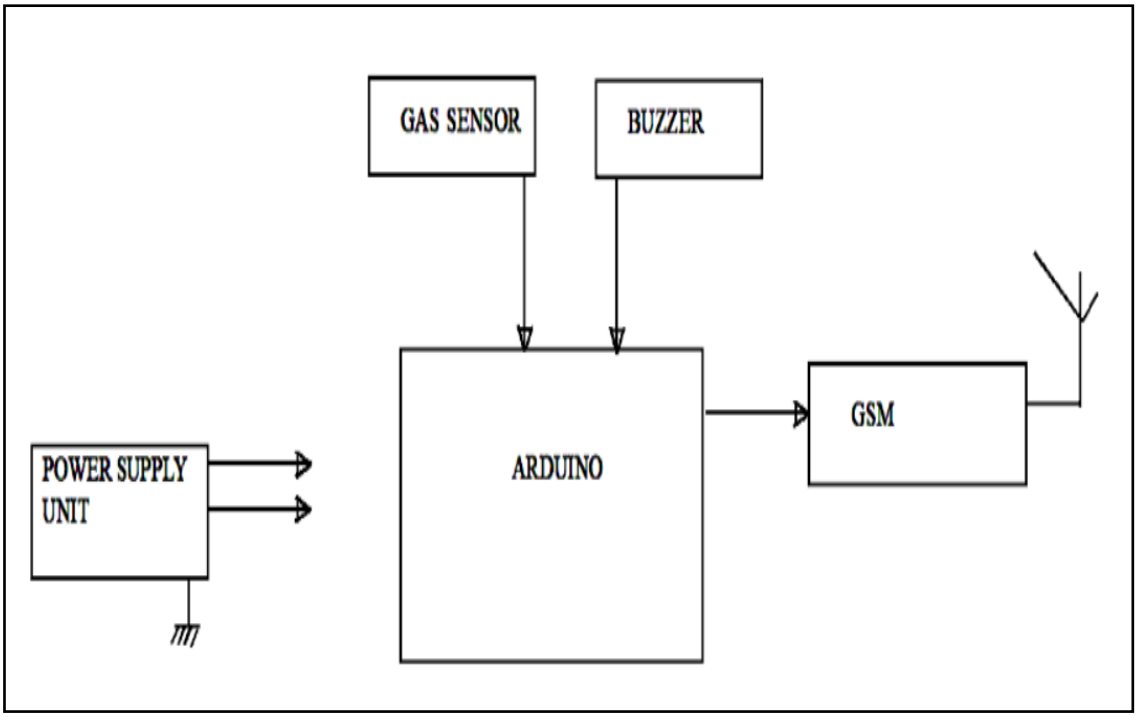


Figure 1.2 Block Diagram of SMS Based LPG gas leakage detection using Arduino UNO and GSM

1.3 BLOCK DIAGRAM DESCRIPTION:

1.3.1 Power Supply Unit:

The power supply unit provides the necessary electrical power to operate the entire system. It is designed to derive power directly from a mains single-phase supply. This unit ensures a stable and continuous power source for the Arduino, gas sensor, buzzer, and GSM module, allowing the system to function reliably and consistently.

In summary, the gas detection system integrates the Arduino as the central controller, a gas sensor for detecting specific gases, a buzzer for audible alerts, a GSM module for remote notifications, and a dedicated power supply unit to ensure uninterrupted operation. Together, these components create a comprehensive solution for detecting and notifying users of potential gas leaks in a given environment.

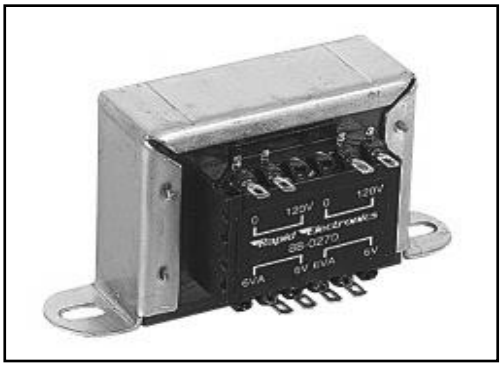


Figure 1.3.1 Step Down Transformer

1.3.2 Arduino:

The Arduino is a microcontroller that serves as the brain of the gas detection system. It processes signals from the gas sensor, activates the buzzer for audible alerts, and interfaces with the GSM module to send notifications. Its programmable nature allows for customization and control of the entire system.

Figure 1.3.2 Arduino UNO

1.3.3 Gas Sensor:

The gas sensor, often an MQ series sensor like MQ-2, is a crucial component responsible for detecting the presence of specific gases in its vicinity. In this context, it is sensitive to gases such as methane, propane, and butane. When these gases are detected, the sensor generates electrical signals that trigger actions in the Arduino.

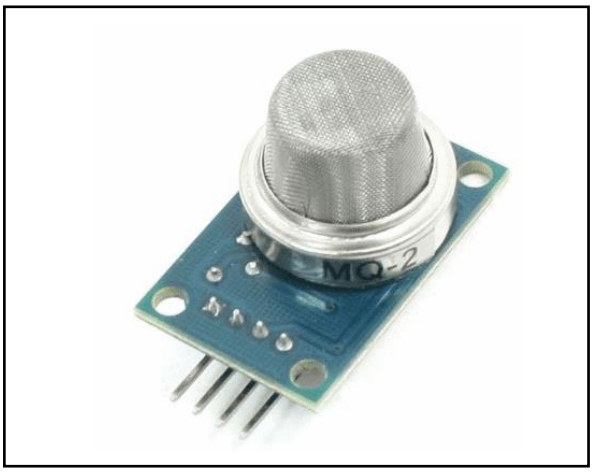


Figure 1.3.3 MQ-2 Sensor

1.3.4 GSM Module:

The GSM (Global System for Mobile Communications) module enables communication between the gas detection system and mobile devices. In the event of a gas leak, the Arduino uses the GSM module to send alert messages, typically via SMS, to predefined mobile numbers. This feature ensures that users receive timely notifications even if they are not in the vicinity of the gas sensor.

Figure 1.3.4 GSM Module

1.3.5 Buzzer:

The buzzer serves as an audible alert mechanism in the gas detection system. When the gas sensor detects a hazardous level of gases, the Arduino activates the buzzer to produce a

sound, providing a local warning signal. This audible alert is an important feature for situations where visual monitoring may not be immediate or practical.

Figure 1.3.5 Buzzer

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

Gas leakage poses significant risks in both domestic and industrial settings, necessitating the development of effective and timely detection systems. This literature survey explores the current state of research and technological advancements in the domain of gas leakage detection, with a specific focus on the integration of Arduino UNO and GSM modules for real-time monitoring and alerting. The project aims to enhance safety measures by leveraging the capabilities of Arduino microcontrollers for gas sensing and GSM technology for immediate communication. Gas detection systems play a crucial role in preventing potential hazards associated with the leakage of LPG (liquefied petroleum gas) and other combustible gases. Understanding the existing technologies and methodologies in this field is essential for designing a robust system that can provide quick and reliable alerts in the event of a gas leak.

This literature survey delves into key areas such as gas detection technologies, the integration of Arduino in gas sensing applications, and the use of GSM modules for remote communication, forming the groundwork for the proposed "SMS Based LPG Gas Leakage Detection using Arduino UNO and GSM" project.

The survey begins by examining the various gas detection technologies commonly employed, shedding light on the working principles of sensors and their limitations. Subsequently, it delves into the role of Arduino microcontrollers in gas detection systems, exploring how these versatile platforms are utilized for interfacing with gas sensors and optimizing power consumption. The integration of GSM modules is then discussed, focusing on communication protocols and the reliability of SMS notifications in alerting systems.

Through this comprehensive review of existing literature, the aim is to identify gaps, trends, and challenges in the current research landscape. By synthesizing knowledge from diverse sources, this literature survey provides a foundation for the subsequent design and implementation phases of the project, contributing to the development of an innovative and efficient solution for LPG gas leakage detection.

2.2 GAS DETECTION TECHNOLOGIES:

Gas detection technologies encompass a variety of sensor types crucial for detecting potential gas leaks. Common technologies include catalytic combustion, infrared, semiconductor, and electrochemical sensors. These sensors operate based on principles such as catalytic oxidation, infrared absorption, semiconductor conductivity changes, and electrochemical reactions. Each technology has its advantages and limitations, influencing factors like sensitivity, selectivity, and response time. Understanding these technologies is vital for designing a robust gas leakage detection system. The subsequent sections will explore the integration of Arduino and GSM technologies to enhance gas detection capabilities.

2.3 ARDUINO INTEGRATION IN GAS DETECTION:

Arduino microcontrollers play a crucial role in gas detection systems, facilitating seamless sensor integration and real-time data processing. The utilization of Arduino in gas detection projects involves connecting sensors, processing data, and implementing control logic for automated responses to gas detection events. This section reviews sensor interfacing techniques, including the use of Analog and digital inputs, communication protocols like I2C or UART, and calibration strategies to ensure accurate measurements. The advantages of Arduino, such as its open-source nature and affordability, make it a popular choice for customization and integration with various sensors. However, challenges, such as power consumption optimization and real-time processing limitations, need consideration for effective gas detection solutions. Understanding the role of Arduino sets the stage for exploring its integration with GSM technology in the subsequent section for enhanced remote monitoring and alerting capabilities.

2.4 GSM-BASED ALERTING SYSTEMS:

GSM technology plays a crucial role in gas detection projects by enabling real-time communication and remote accessibility. Integration of GSM modules ensures immediate transmission of gas detection alerts, providing users with timely information about potential hazards. The communication protocols, particularly SMS notifications, are widely utilized for their reliability and accessibility across various mobile devices. The instantaneous nature of SMS alerts ensures quick response to gas leakage events, contributing to the effectiveness of the alerting system. Understanding the integration of GSM technology establishes the

groundwork for building a responsive and accessible alerting system in the proposed "SMS Based LPG Gas Leakage Detection using Arduino UNO and GSM" project.

CHAPTEP 3

3.1 DESCRIPTION

3.1.1 Technical Description

The block diagram of the present project consists of the ARDUINO microcontroller, Gas sensor MQ-2, alarm and GSM modem for communication. The Arduino microcontroller plays major role in receiving the data from the sensor and to take the required action. The gas sensor is used to detect the presence of smoke or hazardous gases and transmits the information. According to the received data the microcontroller sends the information to the authorized person mobile through the GSM in the form of an SMS. The sensor detects the gas leak and feed the signal to the controller and the controller sends information to the authorized person. The following is the description of individual blocks.

3.1.2 Working

- Continuous monitoring of LPG gas concentrations with the MQ-2 sensor.
- Gas concentration compared to a predefined safety threshold.
- If threshold exceeded, Arduino UNO triggers GSM module for immediate SMS alert.
- Alert notifies a predefined recipient about the detected gas leak.
- Rapid response and timely actions for enhanced safety.
- Users can interact by sending SMS queries for real-time gas concentration information.
- System provides reliable and real-time monitoring for quick detection and response.

3.1.3 Procedure

- Apply power to initiate the system.
- Initialize components, including Arduino UNO, GSM module, and MQ-2 gas sensor.
- MQ-2 sensor continuously monitors LPG gas concentrations.
- Compare real-time gas concentration with safety threshold.
- If threshold exceeded, activate GSM module through Arduino UNO.
- Construct SMS alert message indicating the detected gas leak.
- Use GSM module to connect to the cellular network.
- Instruct GSM module to send SMS alert to predefined recipient's phone number.

- Recipient receives SMS alert, providing immediate information about the gas leak.
- Implement rapid response measures for quick detection and timely actions.
- Allow users to interact by sending SMS queries for real-time gas concentration information.
- System provides reliable and real-time monitoring, enhancing safety by alerting users to potential risks.

3.1.4 Block Diagram

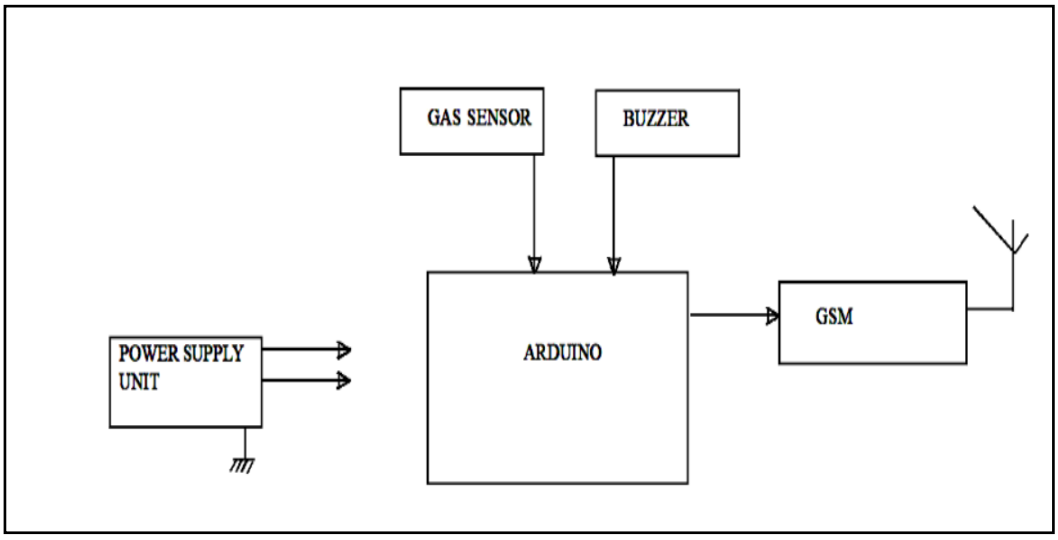


Figure 3.1.4 Block Diagram of SMS Based LPG gas leakage detection using Arduino UNO and GSM

CHAPTER 4

SYSTEM ANALYSIS

4.1 EXISTING MODEL:

4.1.1 Schematic Diagram

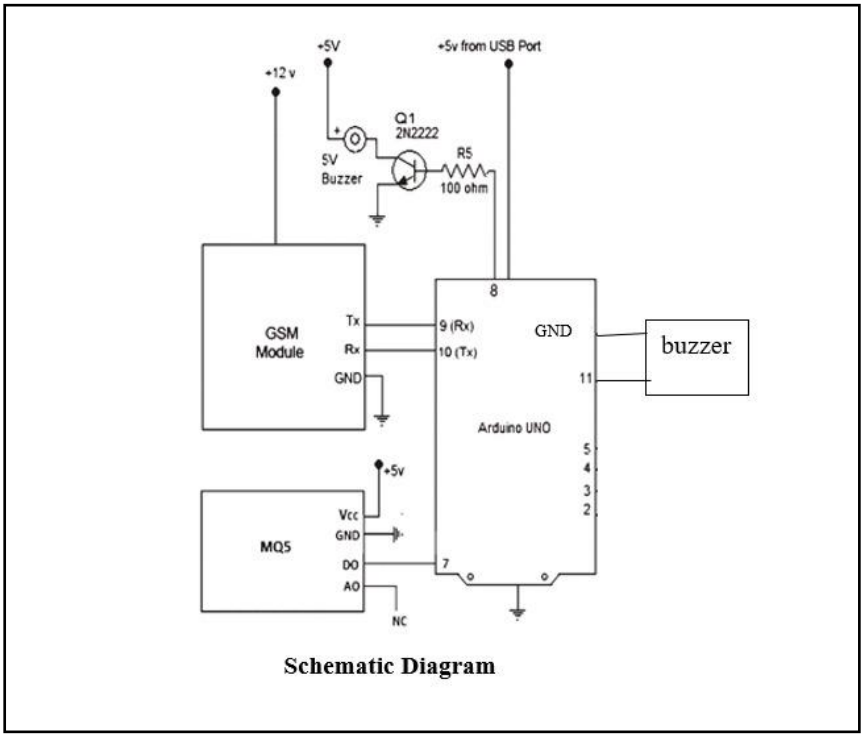


Figure 4.1.1 Schematic Diagram

The system utilizes an Arduino Uno, MQ-2 gas sensor, buzzer, and GSM module to create an SMS-based LPG gas leakage detection system. The MQ-2 sensor, detecting gas concentrations, interfaces with the Arduino, which processes the data. An operational amplifier, configured as a comparator, helps in decision-making based on gas sensor outputs. Upon detecting a hazardous gas level, the Arduino triggers a buzzer for an audible alert. Simultaneously, it commands the GSM module to send an SMS alert to a predefined number, ensuring remote notification. The power supply, derived from an external source, ensures continuous operation. This integrated solution offers a real-time response to potential gas leaks, enhancing safety in both domestic and industrial settings.

4.1.2 Working

The system operates by constantly monitoring the environment for LPG gas using the MQ-2 gas sensor. When the sensor detects a certain threshold of gas concentration, it sends a

signal to the Arduino Uno. The Arduino processes this signal and activates both an audible alert through the buzzer and a remote alert via the GSM module. The operational amplifier, acting as a comparator, aids in decision-making based on the gas sensor's output. The buzzer provides an immediate audible warning locally, while the GSM module sends an SMS alert to a predefined mobile number, ensuring remote notification to authorized personnel. This integrated approach ensures swift and effective response to potential gas leaks, enhancing safety measures in domestic and industrial applications.

4.1.3 Advantages and Disadvantages

Advantages

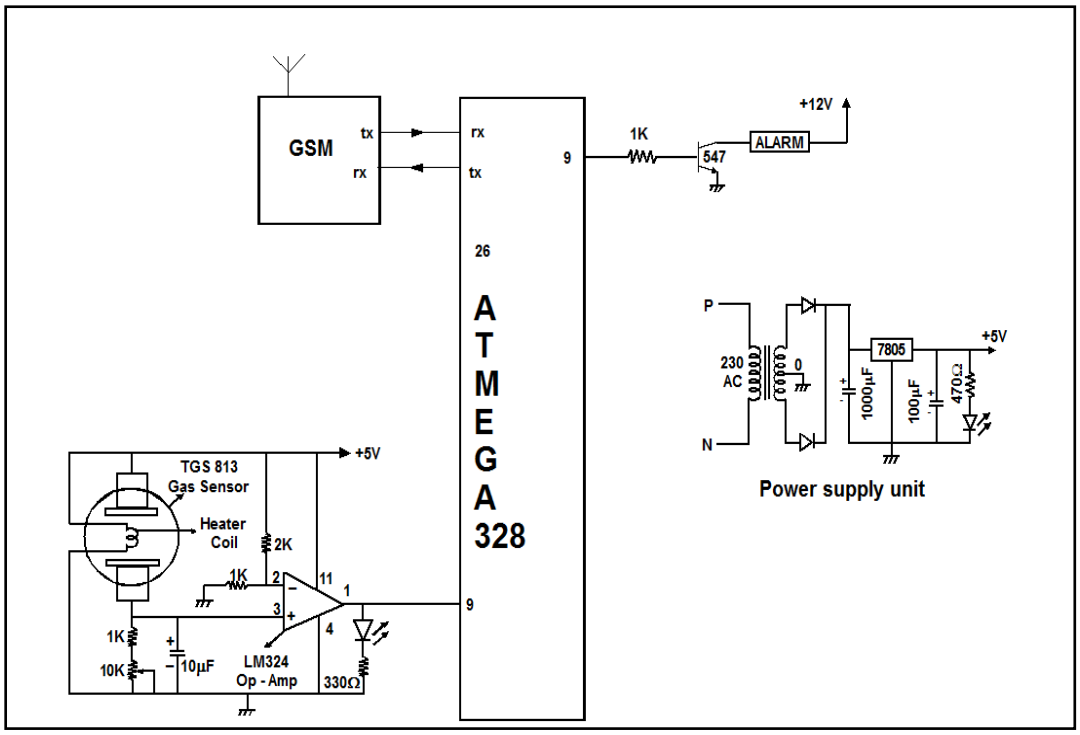
- Early Detection of Gas Leaks
- Remote Notification

Disadvantage

- Dependency on Power Supply
- False Alarms

4.2 PROPOSED MODEL

4.2.1 Circuit Diagram



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4.2.2 Working

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- Gas concentration compared to a predefined safety threshold.
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- Alert notifies a predefined recipient about the detected gas leak.
- Rapid response and timely actions for enhanced safety.
- Users can interact by sending SMS queries for real-time gas concentration information.
- System provides reliable and real-time monitoring for quick detection and response.

CHAPTER 5

THEORETICAL ANALYSIS

5.1 TECHNICAL DESCRIPTION:

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The gas sensor is used to detect the presence of smoke or hazardous gases and transmits the information. According to the received data the microcontroller sends the information to the authorized person mobile through the GSM in the form of an SMS. The sensor detects the gas leak and feed the signal to the controller and the controller sends information to the authorized person. The following is the description of individual blocks.

The main blocks of this project are:

1. Power Supply
2. Arduino UNO
3. Gas Sensor
4. GSM Module
5. Buzzer

5.1.1 Power Supply

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A RPS (Regulated Power Supply) is the Power Supply with Rectification, Filtering and Regulation being done on the AC mains to get a Regulated power supply for Microcontroller and for the other devices being interfaced to it.

A power supply unit can by broken down into a series of blocks, each of which performs a particular function. A DC power supply which maintains the output voltage constant irrespective of AC mains fluctuations or load variations is known as “Regulated D.C Power Supply”.

For example, a 5V regulated power supply system as shown below:

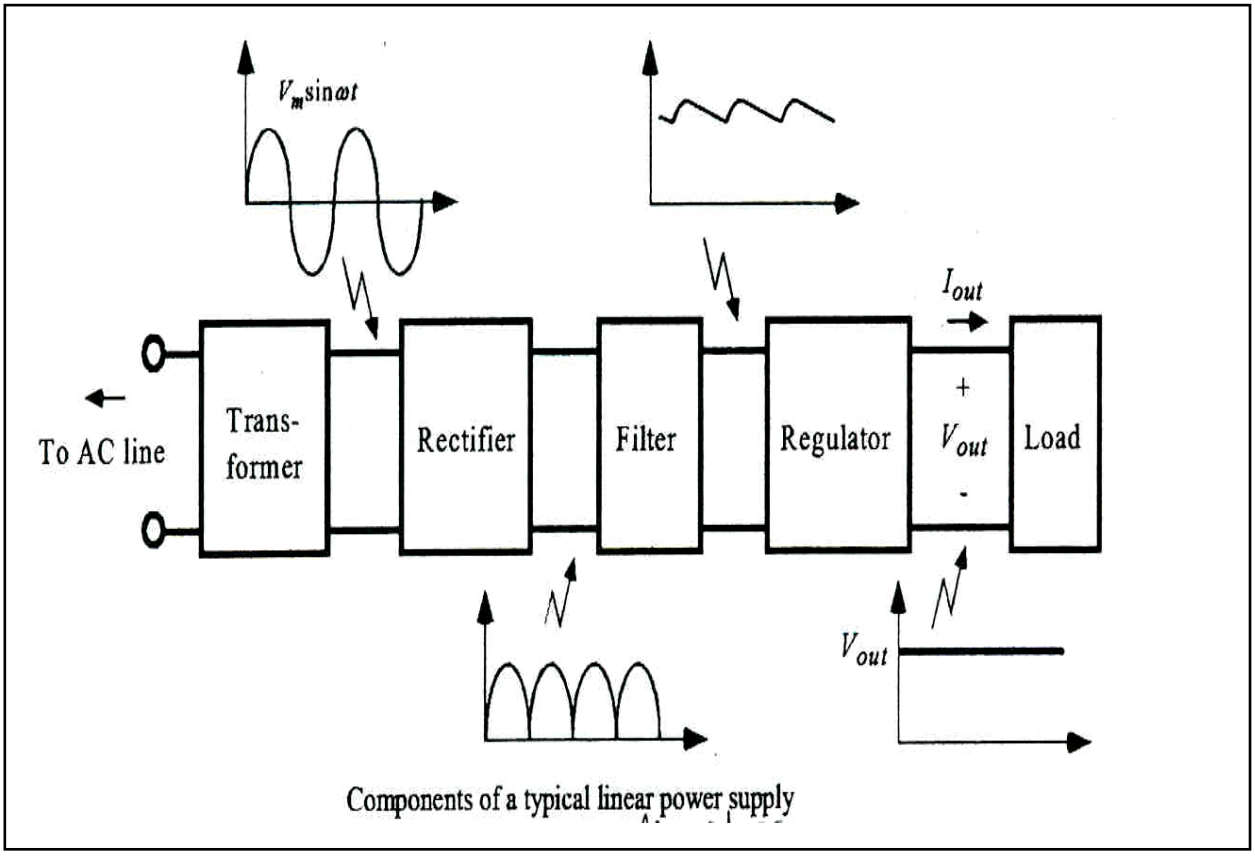

Figure 5.1.1 Block Diagram of Power Supply

1. Transformer
2. Rectifier
3. Filter
4. Regulator

5.1.1.1 TRANSFORMER

A transformer is an electrical device which is used to convert electrical power from one Electrical circuit to another without change in frequency. Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase in output voltage, step-down transformers decrease in output voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead, they are linked by an alternating

magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up. The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

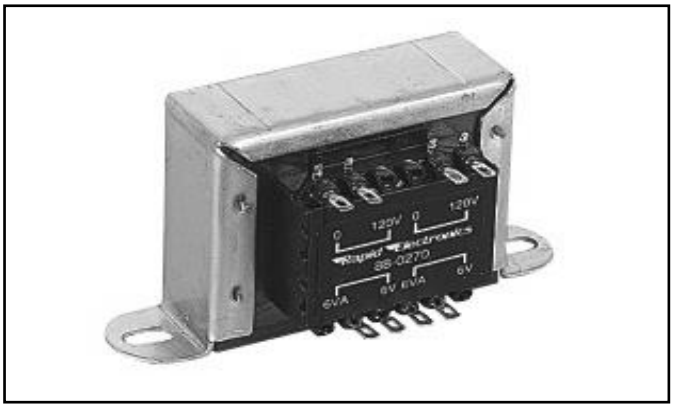

Figure 5.1.1.1 Transformer

Turns ratio = Vp/ V_S = Np/N_S

Power Out= Power In

V_S x I_S=V_P x I_P

Vp = primary (input) voltage

Np = number of turns on primary coil

Ip = primary (input) current

5.1.1.2 RECTIFIER

A circuit which is used to convert a.c to dc is known as RECTIFIER. The process of conversion a.c to d.c is called "rectification".

Types of Rectifiers

1. Half wave Rectifier
2. Full wave Rectifier
   (i). Centre tap full wave rectifier.
   (ii). Bridge type full bridge rectifier.

Parameter	Type of Rectifier		
	Half wave	**Full wave**	**Bridge**
Number of diodes	1	2	4
PIV of diodes	Vm	2Vm	Vm
D.C output voltage	Vm/ $\overline{\pi}$	2Vm/ $\overline{\pi}$	2Vm/ $\overline{\pi}$
Vdc, at no-load	0.318Vm	0.636Vm	0.636Vm
Ripple factor	1.21	0.482	0.482
Ripple frequency	f	2f	2f
Rectification efficiency	0.406	0.812	0.812
Transformer Utilization Factor (TUF)	0.287	0.693	0.812
RMS voltage Vrms	Vm/2	Vm/√2	Vm/√2

Table 5.1.1.2: Comparison of Rectifier Circuits

Full-wave Rectifier

From the above comparison we came to know that full wave bridge rectifier as more advantages than the other two rectifiers. So, in our project we are using full wave rectifier circuit.

5.1.1.3 FILTER

A Filter is a device which removes the a.c component of rectifier output but allows the d.c component to reach the load

Capacitor Filter

We have seen that the ripple content in the rectified output of half wave rectifier is **121%** or that of full-wave or bridge rectifier or bridge rectifier is **48%** such high percentages of ripples is not acceptable for most of the applications.

Ripples can be removed by one of the following methods of filtering.

(a) A capacitor, in parallel to the load, provides an easier by –pass for the ripples voltage though it due to low impedance. At ripple frequency and leave the D.C. to appear at the load.

(b) An inductor, in series with the load, prevents the passage of the ripple current (due to high impedance at ripple frequency) while allowing the d.c (due to low resistance to d.c)

(c) Various combinations of capacitor and inductor, such as L-section filter section filter, multiple section filter etc. which make use of both the properties mentioned in (a) and (b) above. Two cases of capacitor filter, one applied on half wave rectifier and another with full wave rectifier.

Filtering is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output. Filtering significantly increases the average DC voltage to almost the peak value (1.4 × RMS value).

To calculate the value of capacitor(C),

$$C = ¼ * \sqrt{3} * f * r * Rl$$

Where

f = supply frequency,

r = ripple factor,

Rl = load resistance

Note: In our circuit we are using 1000µF hence large value of capacitor is placed to reduce ripples and to improve the DC component.

5.1.1.4 REGULATOR:

Voltage regulator ICs is available with fixed (typically 5, 12 and 15V) or variable output voltages. The maximum current they can pass also rates them. Negative voltage regulators are available, mainly for use in dual supplies.

Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection'). Many of the fixed voltage regulators ICs have 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. The LM7805 is simple to use. You simply connect the positive lead of your unregulated DC power supply (anything from 9VDC to 24VDC) to the Input pin, connect the negative lead to the Common pin and then when you turn on the power, you get a 5 volt supply from the output pin.

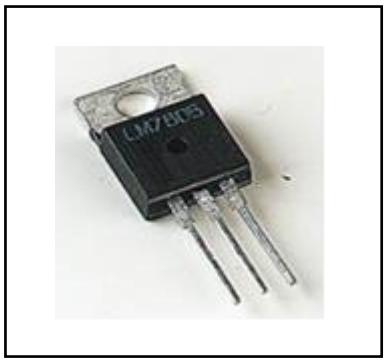

Figure 5.1.1.4 Three Terminal Voltage Regulator

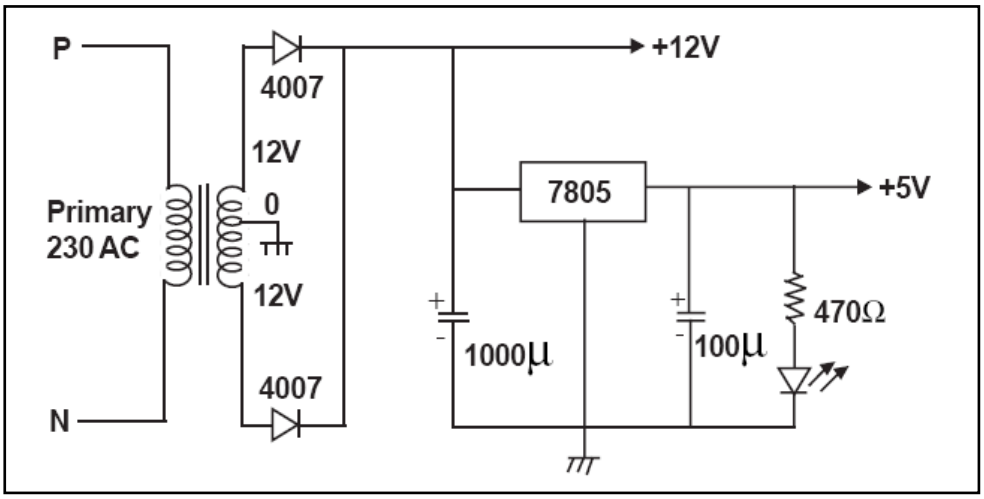

Figure 5.1.1 Power Supply

5.1.2 ARDUINO UNO

The Arduino Uno is a microcontroller board which has ATmega328 from the AVR family. There are 14 digital input/output pins, 6 Analog pins and 16MHz ceramic resonator. USB connection, power jack and also a reset button is used. Its software is supported by a number of libraries that makes the programming easier.

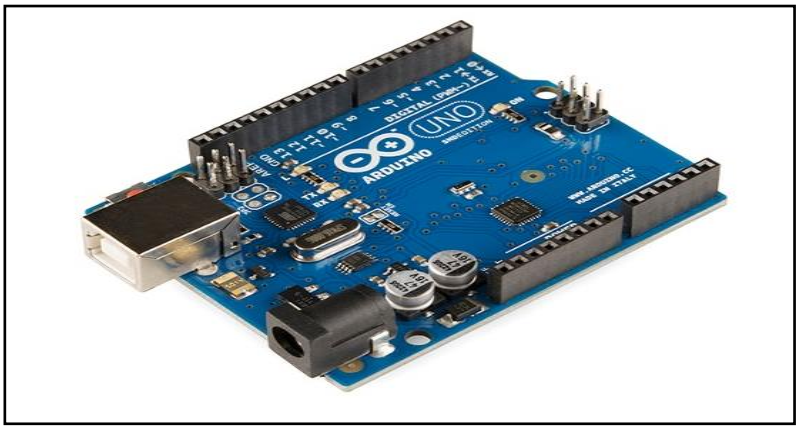

Figure 5.1.2 Arduino UNO

5.1.2.1 Technical specifications

- IC: Microchip ATmega328P (8-bit AVR core)
- Clock Speed: 16 MHz on Uno board, though IC is capable of 20 MHz maximum at 5 Volts
- Flash Memory: 32 KB, of which 0.5 KB used by the bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- USART peripherals: 1 (Arduino software default configures USART as a 8N1 UART)
- SPI peripherals: 1
- I²C peripherals: 1
- Operating Voltage: 5 Volts
- Digital I/O Pins: 14
- PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11) [13]
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Size: 68.6 mm x 53.4 mm
- Weight: 25 g
- ICSP Header: Yes
- USB connector. USB bus specification has a voltage range of 4.75 to 5.25 volts. The official Uno boards have a USB-B connector, but 3rd party boards may have a mini-USB / micro-USB / USB-C connector.
- 5.5mm/2.1mm barrel jack connector. Official Uno boards support 6 to 20 volts, though 7 to 12 volts is recommended. The maximum voltage for 3rd party Uno boards varies between board manufactures because various voltage regulators are used, each having a different maximum input rating
- VIN pin on shield header. It has a similar voltage range of the barrel jack. Since this pin doesn't have reverse voltage protection, power can be injected or pulled from this pin. When supplying power into VIN pin, an external series diode is required in case barrel jack is used. When board is powered by barrel jack, power can be pulled out of this pin.

5.1.2.2 Pin Description

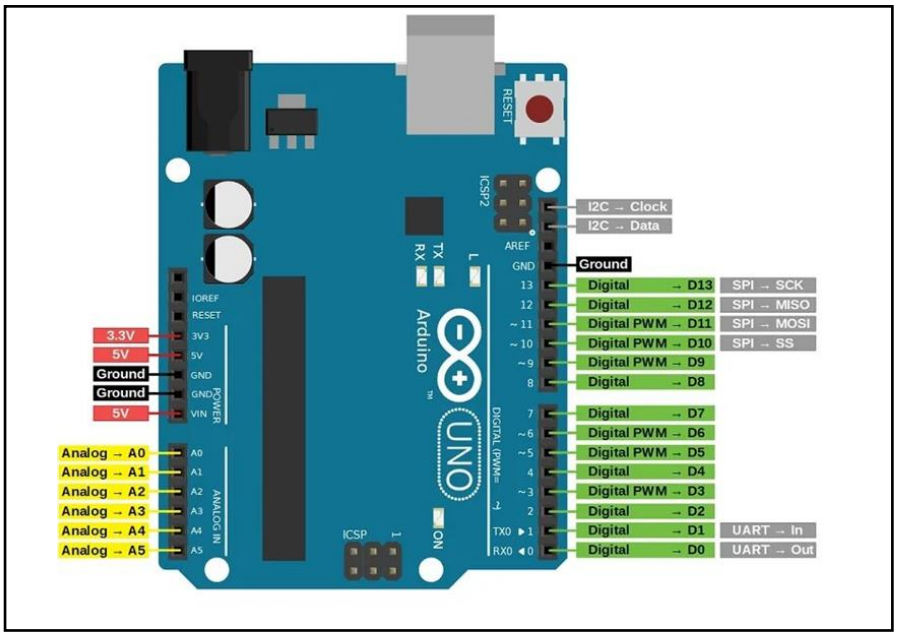

Figure 5.1.2.2 Arduino UNO Pin Description

- **Power Pins**: There are three power pins. **VIN** pin, **5V** and **3.3V** pins.
  - **VIN** This is the input voltage pin of the Arduino board used to provide input supply from an external power source.
  - **5V**: This pin of the Arduino board is used as a regulated power supply voltage and it is used to give supply to the board as well as onboard components.
  - **3.3V**: This pin of the board is used to provide a supply of 3.3V which is generated from a voltage regulator on the board.
- **GND** are the ground pins of ARDUINO.
- **Reset**: This pin of the board is used to reset the microcontroller. It is used to Reset the microcontroller.
- **Analog Pins**: The pins A0 to A5 are used as an Analog input and it is in the range of 0-5V.
- **Digital Pins**: The pins 0 to 13 are used as a digital input or output for the Arduino board.
- **Serial Pins**: These pins are also known as a UART pin. It is used for communication between the Arduino board and a computer or other devices. The transmitter pin number 1 and receiver pin number 0 is used to transmit and receive the data respectively.

- **External Interrupt Pins**: This pin of the Arduino board is used to produce the External interrupt and it is done by pin numbers 2 and 3.
- **LED Pin**: The board has an inbuilt LED using digital pin-13. The LED glows only when the digital pin becomes high.
- **AREF Pin**: This is an Analog reference pin of the Arduino board. It is used to provide a reference
- voltage from an external power supply
- **PWM Pins**: These pins of the board are used to convert the digital signal into an Analog by varying the width of the Pulse. The pin numbers 3,5,6,9,10 and 11 are used as a PWM pins.
    - SS: Pin number 10 is used as a Slave Select
    - MOSI: Pin number 11 is used as a Master Out Slave In
    - MISO: Pin number 12 is used as a Master in Slave Out
    - SCK: Pin number 13 is used as a Serial Clock

5.1.2.3 Arduino Communications

The ARDUINO supports all three of the main serial communication protocols found on the Arduino. These are:

1. **UART (Universal Asynchronous Receiver/ Transmitter)**: UART, or Universal Asynchronous Receiver/Transmitter, is a form of serial communication that relies on just one wire going in either direction. Since the format is asynchronous, there's no need for a clock signal to be sent along a separate cable: the data is simply transmitted at a predetermined rate (the 'baud' rate), with the connected devices unpacking the data as it arrives on the other end. On the ARDUINO, UART is done via pins Rx and Tx, which are respectively used to receive and transmit.
2. **I2C (Inter-integrated Circuit)**: Inter- Integrated circuit does have a separate clock signal, but uses just one wire for data transmission. It's great for connecting a single master device to multiple slaves, each of which has a separate address. I2C is also called 'TWI', or 'two wire interfaces. The SCL and SDA pins are on digital pins D1 and D2. As the name implies, I2C is great for connecting integrated circuits to one another.

3. **SPI (Serial Peripheral Interface)**: Our third variety of serial communication is SPI, or 'serial peripheral interface'. It's commonly used to connect microcontrollers and other

integrated circuits, much like I2C –but it uses three pins rather than just two. It is also full-duplex, which means that every read operation is able to coincide with a write operation travelling in the other direction. Unlike I2C, only the master device in an SPI chain is able to modify the clock speed. On the ARDUINO, SPI uses three pins: D5 is the CLK; D6 is the Master In Slave Out (or MISO); D7 is the Master Out Slave In (MOSI).

4. **ARDUINO PWM Pins**: Some of the digital pins come with Pulse Width Modulation, or PWM, functionality. This provides us with a means of simulating an Analog signal using a rapid series of digital pulses. The longer the 'on' portion of these cycles, the stronger the signal will appear to be. So, if you're turning an LED on and off rapidly, the longer the 'on' cycle is, the brighter the LED will appear to be.

5.1.2.4 ATMEGA328P

The ATmega328 is a single-chip microcontroller created by Atmel in the megaAVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC processor core. The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general-purpose I/O lines, 32 general-purpose working registers, 3 flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8 channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and 5 software-selectable power-saving modes. The device operates between 1.8 and 5.5 volts. The device achieves throughput approaching 1 MIPS/MHz. A common alternative to the ATmega328 is the "Pico Power" ATmega328P. A comprehensive list of all other members of the megaAVR series can be found on the Atmel website.

ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the popular Arduino development platform, namely the Arduino Uno, Arduino Pro Mini and Arduino Nano models.

- **VCC**: Digital supply voltage.
- **GND:** Ground.
- **Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2**: Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).

Depending on the clock selection fuse settings, PB6 can be used as input to the inverting oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting oscillator amplifier. If the internal calibrated RC oscillator is used as chip clock source, PB7:6 is used as TOSC2..1 input for the asynchronous.

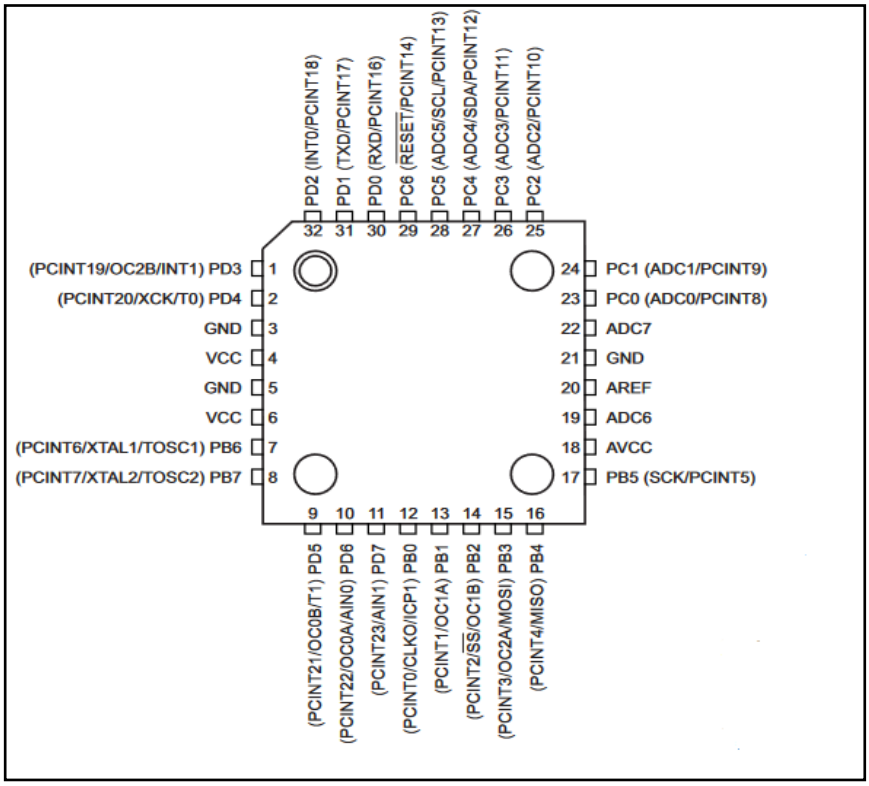

Figure 4.1.2.4(a) Pin Description of ATMEGA328P

- **Port C (PC5:0)**: Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5:0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.
- **PC6/RESET**: If the RSTDISBL fuse is programmed, PC6 is used as an input pin. If the RSTDISBL fuse is unprogrammed, PC6 is used as a reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.
- **Port D (PD7:0)**: Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port D pins that are externally

pulled low will source current if the pull-up resistors are activated. The port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- **AVCC**: AVCC is the supply voltage pin for the A/D converter, PC3:0, and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC6..4 use digital supply voltage, VCC.
- **AREF**: AREF is the Analog reference pin for the A/D converter.
- **ADC7:6 (TQFP and QFN/MLF Package Only)**: In the TQFP and QFN/MLF package, ADC7:6 serve as Analog inputs to the A/D converter. These pins are powered from the Analog supply and serve as 10-bit ADC channels.

➢ **Block Diagram of ATMEGA328P**

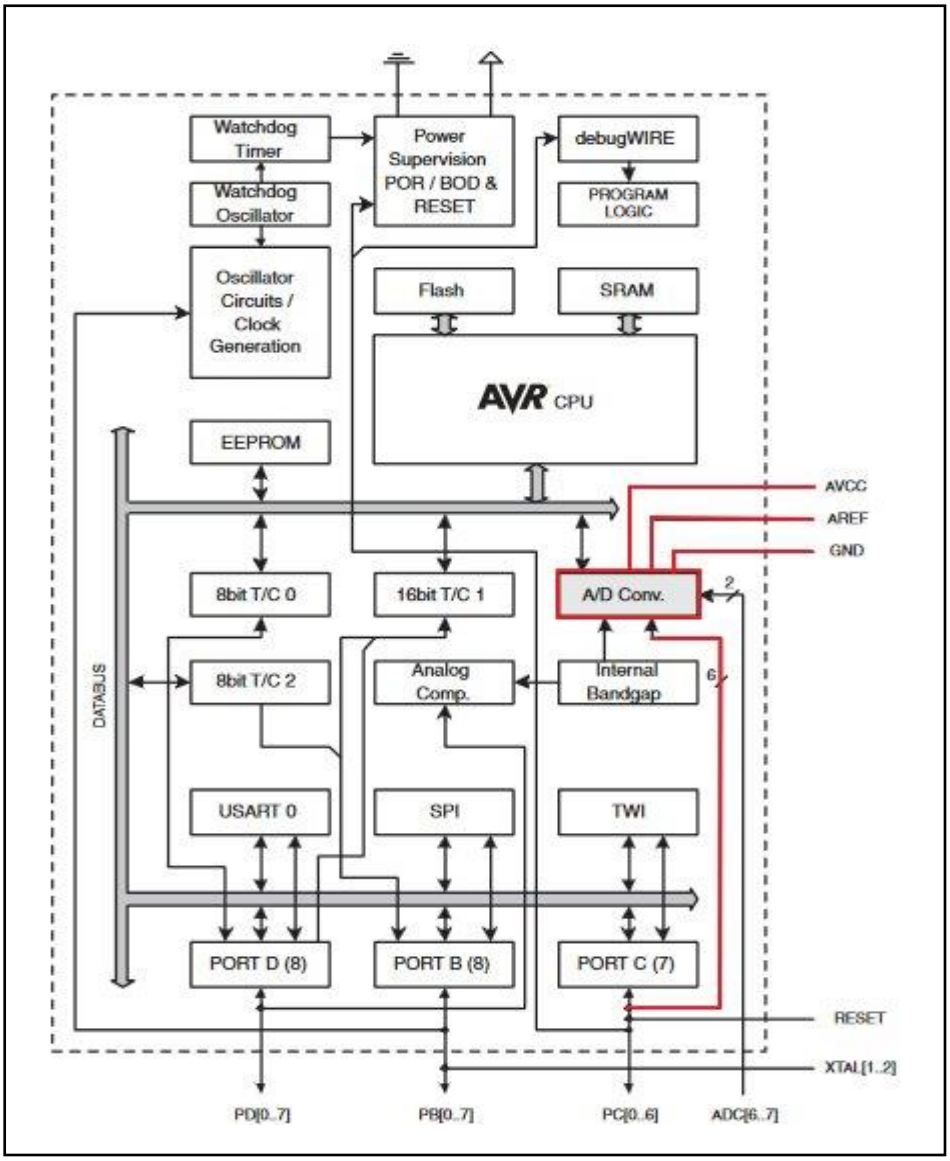

Figure 5.1.2.4(a) Block Diagram of ATMEGA328P

5.1.3 Gas Sensor

The MQ-2 sensor is a popular gas sensor module widely used for detecting various gases such as methane, propane, butane, LPG, alcohol, smoke, and carbon monoxide. It is widely employed in applications like gas leakage detection, fire detection, and air quality monitoring. Let's delve into a deeper explanation of the MQ-2 sensor:

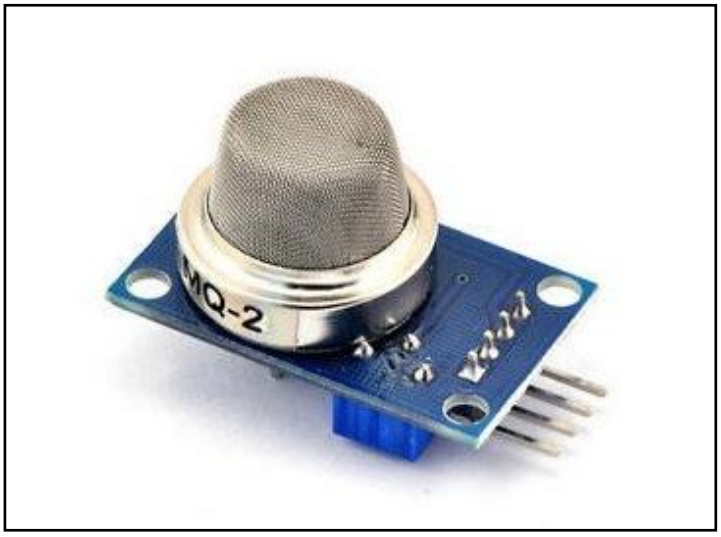

Figure 5.1.3 GAS Sensor MQ-2

5.1.3.1 Gas leak detection

Gas leak detection is the process of identifying potentially hazardous gas leaks by means of various sensors. These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Common sensors used today include Infrared Point Sensors, Ultrasonic Sensors, Electrochemical Sensors, and Semiconductor Sensors. These sensors are used for a wide range of applications, and can be found in industrial plants, refineries, wastewater treatment facilities, vehicles, and around the home.

1.Gas Sensitive Material:

The MQ-2 sensor comprises a gas-sensitive semiconductor material that undergoes changes in its electrical conductivity when exposed to specific gases. Tin dioxide (SnO2) is commonly used as the sensing material in the MQ-2.

2.Heater Element:

To operate effectively, the sensor includes a heater element. This heater is responsible for maintaining a constant temperature of the sensing element. The heat helps to enhance the sensitivity of the sensor to target gases.

3.Interconnecting Electrodes:

The sensor has interconnecting electrodes that measure the resistance changes in the sensing material. The resistance varies with the concentration of the target gas in the environment.

5.1.3.2 GENERAL CHARACTERISTICS OF MQ-2 GAS SENSOR

The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gasses and are used indoors at room temperature. The output is an Analog signal and can be read through ADC or through an Op-Amp. The MQ-2 Gas Sensor module is useful for gas leakage detecting in home and industry. It can detect LPG, i-butane, propane, methane, alcohol, hydrogen and smoke. Some modules have a built-in variable resistor to adjust the sensitivity of the sensor.

MQ-2 is a general-purpose Sensor that has good sensitivity characteristics to a wide range of gases. This device is designed to operate with a stabilized 5V heater supply and a circuit voltage depends up the design. The most suitable application for the sensor is the detection of methane, propane and butane, which makes it an excellent Sensor for domestic gas, leak detectors.

The initial stabilization time of the sensor is very short and the relative and elapsed characteristics are very good over a long period of Operation. sensor has a very low sensitivity to 'noise-gases', which considerably reduces the Problem of nuisance alarming. The sensor is most practically employed in a circuit design, which maintains circuit voltages at fixed value of 5V. This voltage rating is very practical when determining design specifications because of the wide range of available components. This makes the use of the sensor an especially economical way to design low-cost, highly reliable gas detection circuits.

Because of its especially high sensitivity to methane, propane and butane, the MQ-2 is very practical for Town Gas and LPG monitoring. With the added features of a short-initial stabilization period and highly reliable elapsed characteristics, the MQ-2 represents a new generation of gas Sensors from Figaro. These sensors are molded with Resin.

5.1.3.3 BASIC MEASURING CIRCUIT WITH MQ-2 SENSOR:

The Variation in resistance of the sensors measured indirectly as a Change in voltage appearing across the load resistor RL.

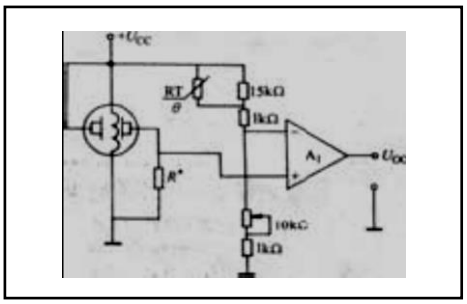

Figure 5.1.3.3 MQ-2 Circuit

In fresh air the current passing through the Sensor and RL in series is steady, but when a combustible gas such as propane, methane etc. comes in contact with the Sensor surface, the Sensor resistance decreases in accordance with the gas concentration present. The voltage Change across RL is the same when VC and VH are supplied from AC or DC sources. One can feel that this circuit is most suitable for evaluating the MQ-2 performance because of the ease in measuring the output signal.

5.1.4 GSM Module

GSM (Global System for Mobile Communications*)* is a digital cellular communications system. It was developed in order to create a common European mobile telephone standard but it has been rapidly accepted worldwide. GSM is designed to provide a comprehensive range of services and features to the users not available on Analogue cellular networks and in many cases very much in advance of the old public switched telephone network (PSTN). In addition to digital transmission, GSM incorporates many advanced services and features like worldwide roaming in other GSM networks.

5.1.4.1 Architecture of the GSM Network

The GSM mobile telephony service is based on a series of contiguous radio cells which provide complete coverage of the service area and allow the subscriber operation anywhere within it. Prior to this cellular concept, radiophones were limited to just the one transmitter covering the whole service area. Cellular telephony differs from the radiophone service because instead of one large transmitter, many small ones are used to cover the same area. The basic problem is to handle the situation where a person using the phone in one cell moves out of range of that cell. In the radiophone service there was no solution and the call was lost, which is why the service area was so large. In cellular telephony, handing the call over to the next cell solves the problem. This process is

totally automatic and requires no special intervention by the user, but it is a complex technical function requiring significant processing power to achieve a quick reaction.

5.1.4.2 Mobile Station

The Mobile Station (MS) represents the only equipment the GSM user ever sees from the whole system. It actually consists of two distinct entities. The actual hardware is the Mobile Equipment (ME), which is anonymous and consists of the physical equipment, such as the radio transceiver, display and digital signal processors. The subscriber information is stored in the Subscriber Identity Module (SIM), implemented as a Smart Card. The mobile equipment is uniquely identified by the International Mobile Equipment Identity (IMEI). The SIM card contains the International Mobile Subscriber Identity (IMSI), identifying the subscriber, a secret key for authentication, and other user information. The IMEI and the IMSI are independent, thereby providing personal mobility. Thus the SIM provides personal mobility, so that the user can have access to all subscribed services irrespective of both the location of the terminal and the use of a specific terminal. By inserting the SIM card into another GSM cellular phone, the user is able to receive calls at that phone, make calls from that phone, or receive other subscribed services. The SIM card may be protected against unauthorized use by a password or personal identity number.

- The ME provides generic radio and processing functions to access the network through the radio interface as well as an interface to the user (microphone loudspeaker, display and keyboard) together with an interface to some other terminal equipment (fax machine, PC).
- The SIM contain all the subscriber-related information stored on the user's side of the radio interface.
- The MS is operational only when a valid SIM is placed in a ME.

5.1.4.3 Base Station Subsystem

The Base Station Subsystem is composed of two parts, the Base Transceiver Station (BTS) and the Base Station Controller (BSC). The BTS houses the radio transceivers that define a cell and transmits and receives signals on the cells' allocated frequencies with the mobile station.

A BSC operates with a group of BTSs and manages the radio resources for one or more of them. The BSC is the connection between the MS and the Network Subsystem. It manages the radio channel (setup, tear down, frequency hopping, etc.) as well as handovers and the transmission power

levels and frequency translations of the voice channel used over the radio link to the standard channel used by the Public Switched Telephone Network or ISDN.

5.1.4.4 Network Subsystem

The central component of the Network Subsystem is the Mobile services Switching Center (MSC). It acts like a normal switching node of the normal telephones of the land lines and in addition provides all the functionality needed to handle a mobile subscriber, including registration, authentication, location updating and inter-MSC handovers. These services are provided in conjunction with several functional entities, which together form the Network Subsystem. The MSC provides the connection to the public fixed network (PSTN or ISDN) and is the interface between the GSM and the PSTN networks for both telephony and data.

Thus the MSC is primarily responsible for:

- Traffic management
- Call set-up
- Call Routing to a roaming subscriber
- Termination
- Charging and accounting information

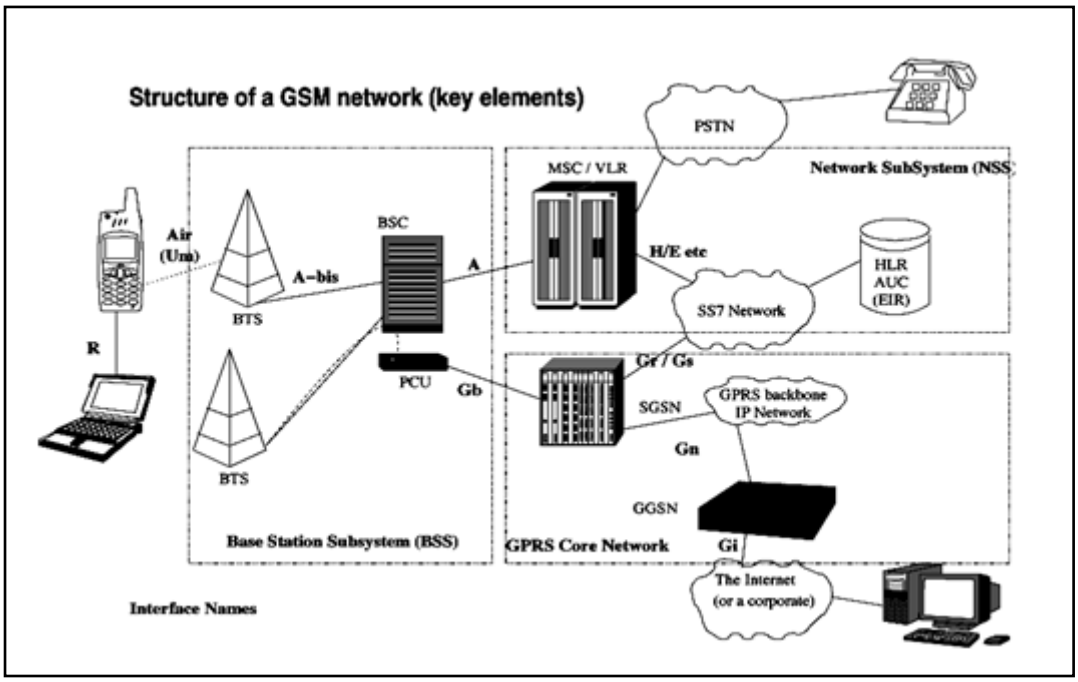

Figure 5.1.4 Structure of a GSM Network

5.1.5 Buzzer

In the SMS-based LPG gas leakage detection system, the buzzer plays a critical role in providing an audible alert when the MQ-2 sensor detects a potentially hazardous level of gas. The integration of a buzzer enhances the system's ability to communicate the presence of a gas leak to individuals in the vicinity. Here's a breakdown of the buzzer integration:

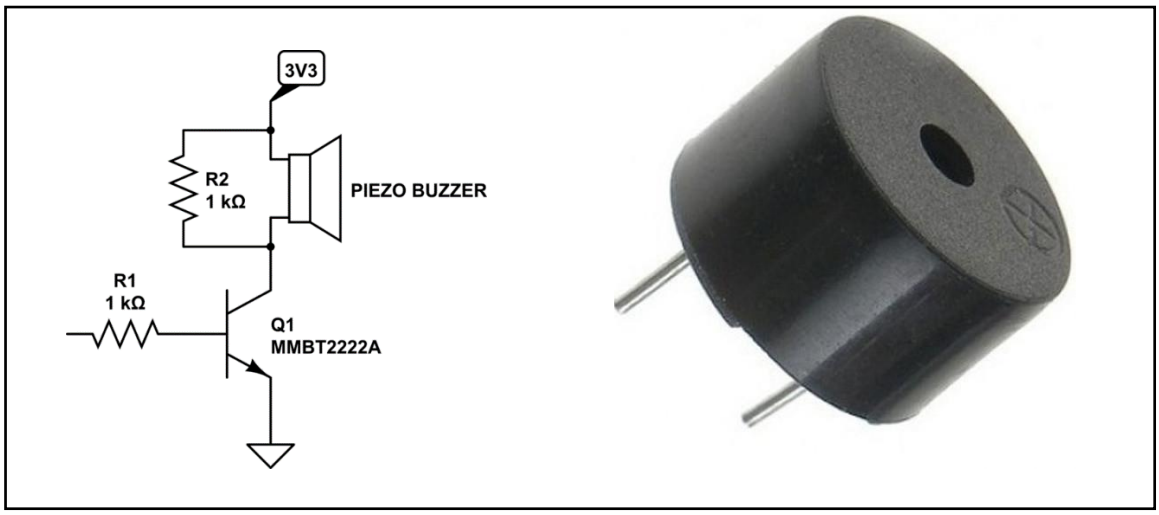

Figure 5.1.5 Structure of Buzzer

5.1.5.1 Alert Signaling:

The buzzer serves as an audible indicator, signaling an alert when the MQ-2 sensor detects a concentration of LPG or other gases beyond the predefined safety threshold. This audible alert is essential for immediate notification, especially in scenarios where visual monitoring may not be constant.

5.1.5.2 Buzzer Control via Arduino:

The Arduino UNO, acting as the central controller, triggers the buzzer when the gas concentration surpasses the predefined safety threshold. This control is achieved by programming the Arduino to activate the buzzer through one of its digital output pins.

5.1.5.3 Pulse Width Modulation (PWM):

Depending on the urgency and severity of the gas leak, the Arduino can implement Pulse Width Modulation (PWM) to control the intensity and pattern of the buzzer sound. For instance, a higher duty cycle or a rapid pulsing pattern could indicate a more critical situation.

5.1.5.4 Integration with SMS Alert System:

The buzzer can complement the SMS alert system by providing immediate local notification. While the SMS alerts ensure remote communication, the buzzer addresses the need for on-the-spot awareness within the physical vicinity of the gas leakage.

CHAPTER 6

6.1 Software Description

This Arduino code is designed for a gas leakage detection system using a gas sensor and a GSM module for SMS alerts. Here's a breakdown of the key elements:

1.Libraries and Serial Communication:

The code uses the Software Serial library to create a secondary serial port for communication with the GSM module. This is necessary because the Arduino Uno has only one hardware serial port, and it's often used for debugging.

2.Pin Definitions:

Pin assignments for the gas sensor input (GAS) and the buzzer output (BUZ) are defined. Adjust these pins based on your hardware connections.

3.Setup Function:

The setup function initializes pin modes, sets the initial state of the buzzer, and starts serial communication for both debugging (Serial) and communication with the GSM module (my Serial).

4.Loop Function:

The loop function continuously monitors the gas sensor. If gas leakage is detected, it activates the buzzer, sends an SMS alert using the GSM module, and sets a flag to indicate that an alert has been sent. If no leakage is detected, it deactivates the buzzer and resets the flag.

5.Alert Sending Mechanism:

The GSM module is configured using AT commands, and the alert message is sent to a specified phone number when gas leakage is detected. The system is designed to send the alert only once until the gas level returns to normal.

6.Delay: A short delay is introduced at the end of the loop to prevent rapid sensor readings.

6.2 ARDUINO IDE:

6.2.1 Introduction:

Arduino IDE (Integrated Development Environment) is the software for Arduino. It is a text editor like a notepad with different features. It is used for writing code, compiling the code to check if any errors are there and uploading the code to the Arduino. It is a cross-platform software which is available for every Operating System like Windows, Linux, macOS.

It supports C/C++ language.

Figure 6.2.1 Arduino IDE LOGO

It is open-source software, where the user can use the software as they want it to. They can also make their own modules/functions and add them to the software. It supports every available Arduino board including Arduino mega, Arduino Leonardo, Arduino Ethernet and more Word file is called a Document similarly, Arduino file is called a Sketch where the user writes code. The format of Arduino is saved as .ino.

6.2.2 How Arduino IDE works:

When a user writes code and compiles, the IDE will generate a Hex file for the code**.** (Hex file are Hexadecimal files which are understood by Arduino) and then sent to the board using a USB cable. Every Arduino board is integrated with a microcontroller, the microcontroller will receive the hex file and runs as per the code written.

6.2.3Functions of Arduino IDE:

Arduino IDE consists of different sections

a) Window Bar
b) Menu Bar
c) Shortcut Buttons
d) Text Editor
e) Output Panel

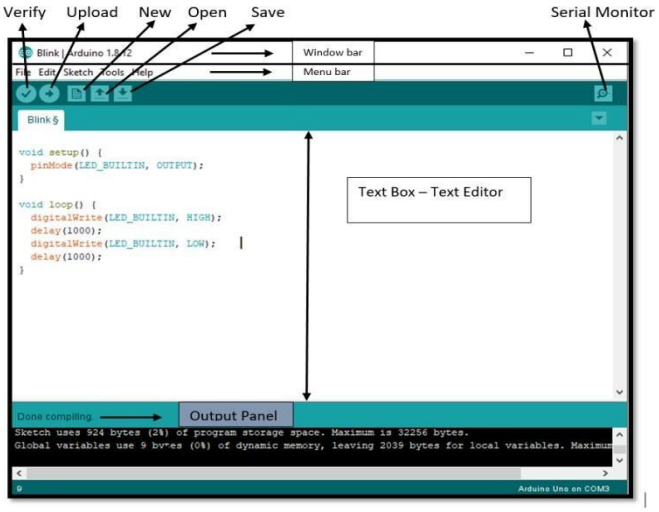

Figure 6.2.3 (a) Arduino IDEA

1. Window Bar:

The window bar consists the name of File and the Arduino IDE software version **Menu Bar:**

The menu bar consists of

1. File

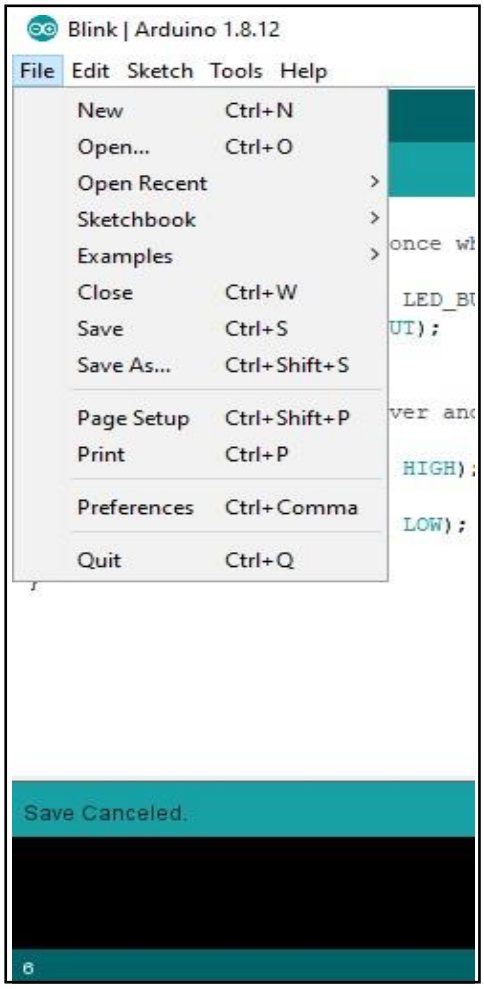

Figure 6.2.3 (b) File Section

- **New**

It creates a new File. **(Ctrl+N)**

- **Open**

It is used to open the file which was saved before. **(Ctrl+O)**

- **Open Recent**

It shows the shortlist of Recently opened programs.

- **Sketchbook**

Shows the current sketches which you have used for your project

- **Examples**

Examples of a few basic problems for reference.

- **Close**

Closes the main screen window. **(Ctrl+W)**

- **Save**

It is used to save the current sketch. **(Ctrl+S)**

- **Save as…**

Allows saving the current sketch with a different name. **(Ctrl+Shift+S)**

- **Page Setup**

Page settings for modifying the page (Text). **(Ctrl+Shift+P)**

- **Print**

Used to print the current program. **(Ctrl+P)**

- P**references**

Settings of the IDE software can be changed here. **(Ctrl+,)**

- **Quit**

Closes all IDE windows. **(Ctrl+Q)**

2. Edit:

- Undo/Redo

Goes back of one or more steps you did while editing.

- Cut

Cuts the selected text from the editor.

- **Copy**

Copies the selected text from the editor

- **Copy for Forum**

It copies and changes the style of code suitable for the forum.

- **Copy as HTML**

It copies and changes the style of code suitable for the Html.

- **Paste**

It pastes the text from the copied text.

- **Select All**

Select's all the content from the editor.

- **Comment/Uncomment**

It is used to comment and uncomment selected lines of code.

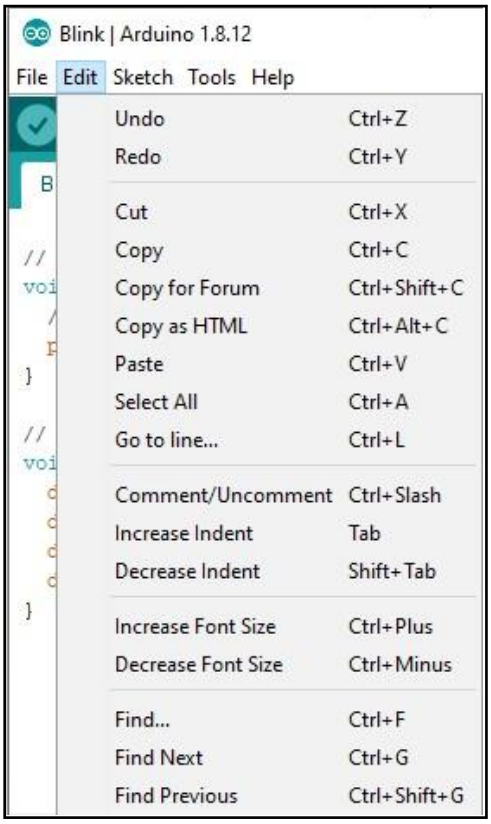

Figure 6.2.3 (c) Edit Section

- **Increase/Decrease Indent**

Adds or removes a space at the beginning of each selected line

- **Find**

Finds the typed text in the editor

- Find Next

Finds the next position of the searching word.

- Find Previous

Finds the previous position of the searching word.

3. Sketch:

- Verify/Compile

Checks or verifies your program if any error is there, and displays in the output panel.

- Upload

It compiles and also uploads the code to the Arduino board.

- Upload Using Programmer

Uploads code using Programmer which is available in Tools Tab.

- Export Compiled Binary

Saves a .hex file in the System

- Show Sketch Folder

Opens the current sketch folder.

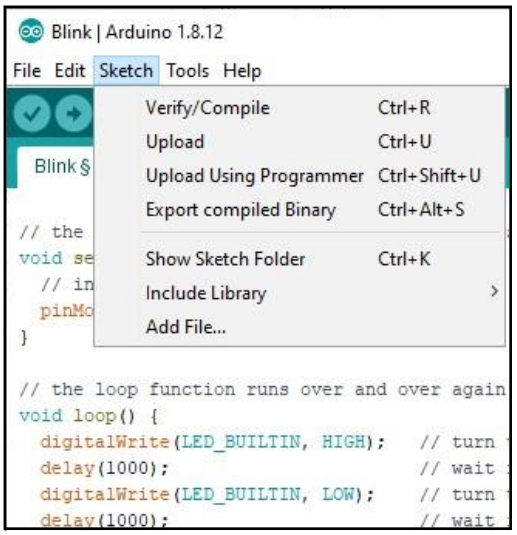

Figure 6.2.3 (d) Sketch Section

- Include Library

Adds a library to your sketch by inserting #include statements at the start of your code

- Add File…

Adds a file to the sketch and the new file appears in a new tab in the window.

4. Tools:

- Auto Format

This option formats your code to a nice format so everyone can understand.

- Archive Sketch

Copies the code into winrar format(.zip)

- Fix Encoding & Reload

Fixes possible discrepancies between the editor char map encoding and other operating systems char maps.

- Serial Monitor

Serial monitor shows the visual communication by sending and receiving data

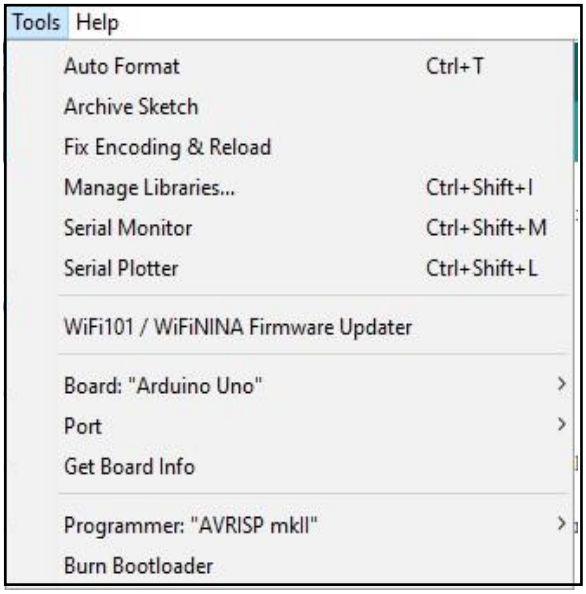

Figure 6.2.4 (e) Tools

- Board
- To select the type of Arduino Board
- Section **Port**

To select the port where you have connected the Arduino

- Programmer

For selecting a hardware programmer when programming a board or chip and not using the USB type of communication.

- Burn Bootloader

It is used to burn bootloader to the Arduino board

5. Help

Output Panel:

This output panel is used to give comments about the code If the code is successfully compiled or any error occurs.

If the code has been successfully uploaded to the board. How much space the board has occupied.

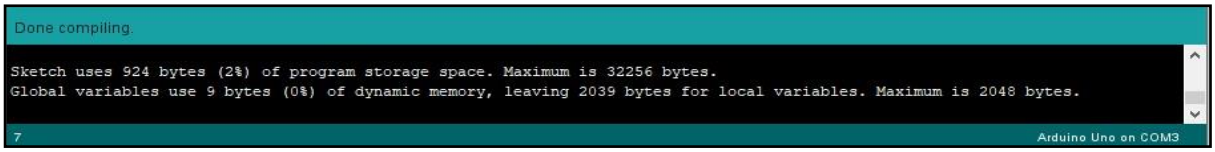

Figure 6.2.3 (f) Output Panel

CHAPTER 7

RESULTS

7.1 Circuit Diagram:

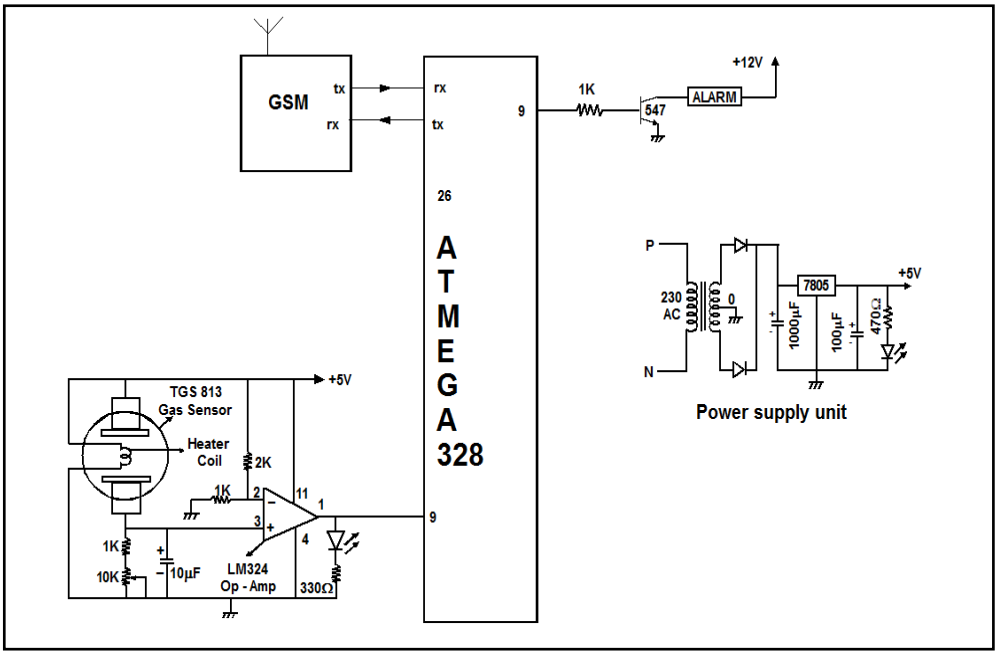

Figure 7.1 Circuit Diagram

7.2 Result:

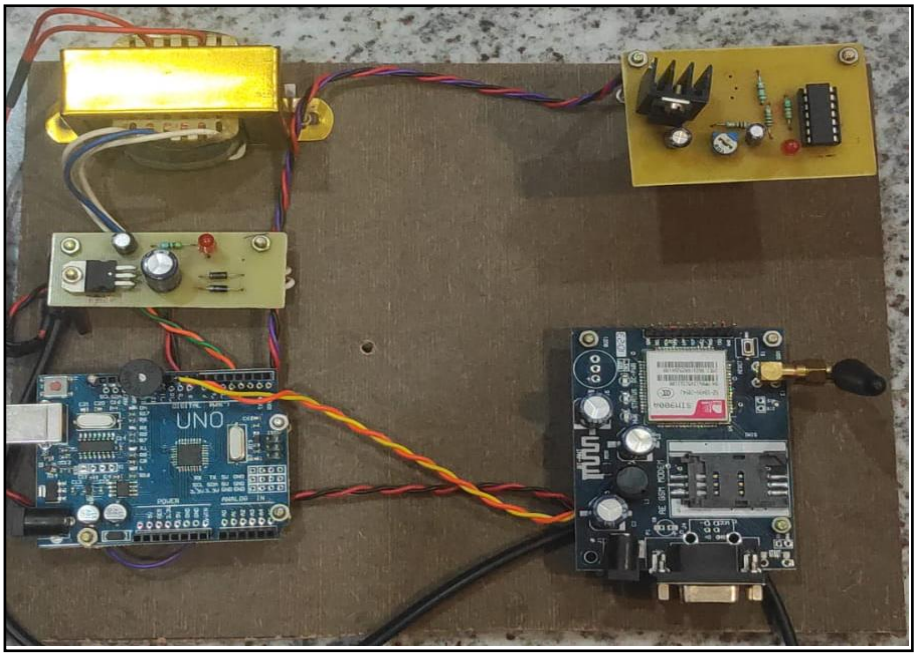

Figure 7.2 Result

7.3 Working

- Continuous monitoring of LPG gas concentrations with the MQ-2 sensor.
- Gas concentration compared to a predefined safety threshold.
- If threshold exceeded, Arduino UNO triggers GSM module for immediate SMS alert.
- Alert notifies a predefined recipient about the detected gas leak.
- Rapid response and timely actions for enhanced safety.
- Users can interact by sending SMS queries for real-time gas concentration information.
- System provides reliable and real-time monitoring for quick detection and response.

7.4 ADVANTAGES

1. Timely Alerts via SMS:
2. Remote Monitoring and Notification:
3. Cost-Effective Implementation:
4. Simple and Portable Design:

7.5 DISADVANTAGES

1. Dependency on GSM Network
2. Limited Automation

7.6 APPLICATIONS

1. Residential Gas Safety
2. Commercial Kitchens
3. Industrial Facilities
4. Educational Institutions
5. Hotels and Hospitality
6. Remote Monitoring Stations

CHAPTER 8

CONCLUSION & FUTURE SCOPE

8.1 CONCLUSION

The SMS-based LPG gas leakage detection system using Arduino UNO and GSM is a valuable solution for enhancing safety in environments where LPG is used. The system effectively detects gas leaks and promptly sends SMS alerts to designated recipients, enabling quick response and mitigation of potential risks. The combination of Arduino's simplicity, gas sensor accuracy, and GSM communication facilitates a cost-effective and accessible solution for a variety of applications, including residential, commercial and industrial settings.

Through the implementation of this system, users can benefit from timely notifications, allowing them to take immediate action in the event of a gas leak. The integration of GSM technology provides a reliable means of communication, ensuring that alerts reach users regardless of their location

8.2 FUTURE SCOPE

The SMS-based LPG gas leakage detection system can be further enhanced and expanded in various ways to improve functionality and address specific needs. Some potential areas for future development include.

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2. https://how2electronics.com/gas-leakage-detector-gsm-arduino-sms-alert

3. https://www.researchgate.net/publication/347495607_Gas_leakage_detection_and_alerting_system_using_Arduino_Uno

4. https://en.wikipedia.org/wiki/GSM_modem

APPENDIX:

Source Code (Arduino)

```
#include <SoftwareSerial.h>
SoftwareSerial mySerial(8,9); // RX, TX
const int GAS=2;
const int BUZ=11;
int flag=0;
void setup()
{

  pinMode(BUZ,OUTPUT);

  pinMode(GAS,INPUT);
  digitalWrite(BUZ,LOW);

  Serial.begin(9600);
  Serial.println("WELCOME");
  mySerial.begin(9600);

  }
void loop()
{
  if(digitalRead(GAS)==HIGH)
  {

  digitalWrite(BUZ,HIGH);

    Serial.println("GAS LEAK");
    if(flag==0)
    {
    mySerial.println("AT"); //Handshaking with SIM900
    delay(500);
```

```
    mySerial.println("AT+CMGF=1"); // Configuring TEXT mode
    delay(1000);

    mySerial.println("AT+CMGS=\"+91XXXXXXXXXX\"");//change ZZ with country code and xxxxxxxxxx with phone number to sms
    delay(500);

    mySerial.print("ALERT!GAS LEAK DETECTED"); //text content

    delay(500);

    mySerial.write(26);
    delay(500);
    flag=1;
    }
  }
  else
  {

  digitalWrite(BUZ,LOW);

  Serial.println("NO LEAK");
  flag=0;
  }
  delay(100);
}
```