

CHAPTER 1

INTRODUCTION

In this chapter, the introduction of the system and the system overview with the overall block diagram of the system are described. Aim and objectives and outlines of thesis are also explained.

1.1 Introduction of the System

An integral part of any drainage system is the access points into it when it comes to cleaning, clearing, and inspection. If the sewage maintenance is not proper, ground water gets contaminated causing infectious diseases. Blockages in drains during monsoon season, causes problems in the routine of the public. Hence, there should be a facility in the city's corporation, which alerts the officials about blockages in sewers, the exact location. It mainly acknowledges in the field of alerting the people about the gas explosion, increase in the water level and the temperature level. It uses SIM module to make the drainage monitoring system in a highly automotive by using sensor for detecting and sending alerts through GSM module.

When there is a blockage in a particular node, there is variation in the flow of drainage water which when cross the set value will display the alert in the managing

station. Also, other demerits are solved by detecting temperature variations inside the manhole and alerting the same to the managing station. Maintenance of manholes manually is tedious and dangerous due to the poor environmental conditions inside so, the main focus of this system is to provide a system which monitors water level, atmospheric temperature and toxic gases. If drainage gets blocked and sewage water overflows, it is sensed by the sensors and message is sent to the user.

1.2 System Overview

In this system, the proposed method is based on Arduino UNO which processes the signal obtained from the sensors. There are four main sensors, waterproof ultrasonic sensor, temperature and humidity sensor (DHT11) sensor, MQ4 and MQ9 gas sensors

DHT11 sensor is used to detect the temperature and humidity in the drainage. The waterproof ultrasonic sensor is used to detect the water level in the drainage. MQ4 gas sensor is used to detect the amount of methane (CH₄) and MQ9 sensor is detect carbon monoxide (CO) in the drainage. In this system, this sensor helps in detection the CH₄ and CO level in ppm. If the water level and blockage reach in danger level the system will inform the user and required procedure will be done. The overall block diagram of the system is shown in Figure 1.1.

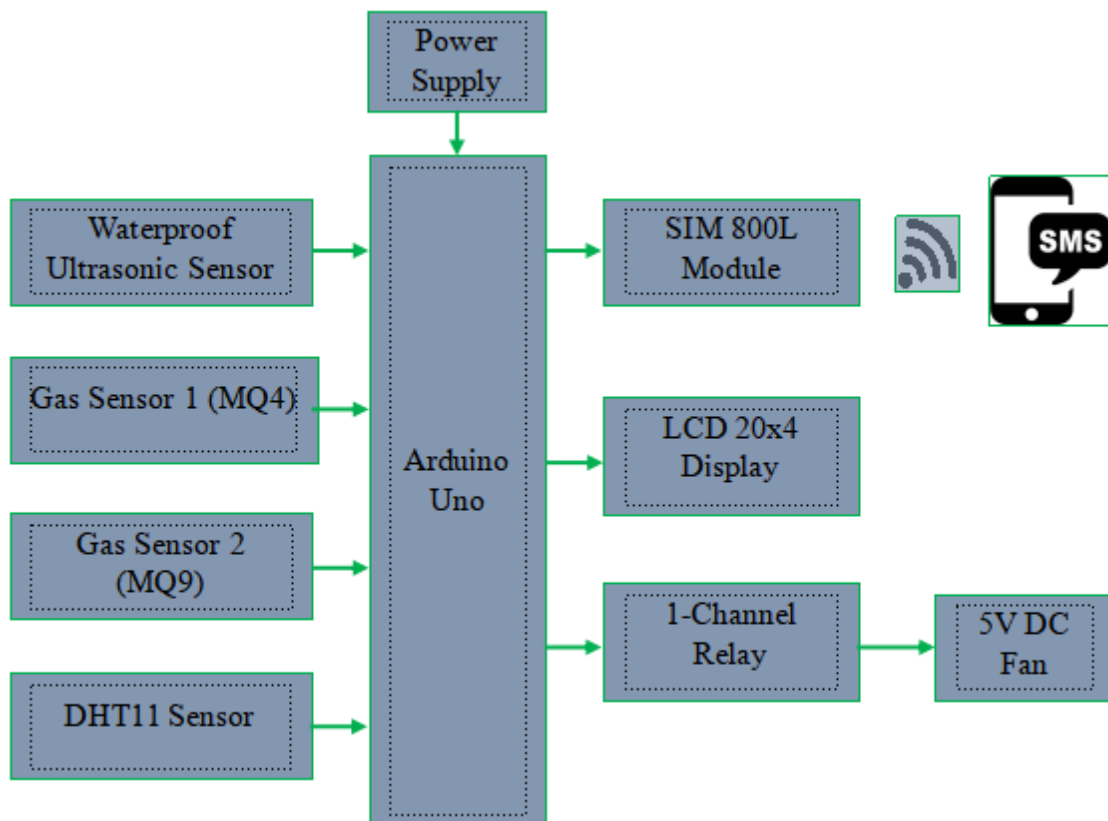


Figure 1.1 Overall Block Diagram of the System

1.3 Aim and Objectives

The aim of the system is to design and implement manhole detection and monitoring system for solving all the problems related to underground sanitation.

The objectives of this system are:

- ❖ To obtain cleaner cities and intelligent management of drainage in the city
- ❖ To detect of drainage water level and blockages in the drainage
- ❖ To Check water flow rate, temperature, leakage of gas and send SMS
- ❖ To obtain an effective low-cost and flexible solution for condition monitoring and infrastructure management in the city

1.4 Outlines of the Thesis

In this thesis, five chapters will be discussed. Firstly, chapter one consists of the introduction of the system, system overview, aim and objectives and outlines of thesis. In chapter two, background theory of the thesis is explained. Chapter three describes the implementation of this system. Chapter four includes test and results of the overall system that has been testified and successfully operated. Finally, conclusion and discussion of this system are expressed in chapter five.

CHAPTER 2

BACKGROUND THEORY

This chapter describes details of each system requirements with it related specifications, system operation and how hardware components work to provide microcontroller. Moreover, background theory of the system is described.

2.1 Background Theory of the System

A manhole, or inspection chamber, is an access point for maintenance workers to inspect underground utilities such as sewer systems, storm drains, and utility conduits. Typically circular for structural strength, manholes are made from materials like precast concrete, brick and polymer composites to meet various load-bearing and environmental resistance needs. The safety features include built-in steps or ladders, fall protection equipment and gas detectors to test for hazardous gases.

Manhole covers are heavy to prevent unauthorized access and withstand traffic loads but are designed to be removable by maintenance workers. Strategically placed at flow direction changes, pipe junctions, and regular intervals, manholes help manage flow and facilitate maintenance. Proper sealing prevents groundwater infiltration and surface water inflow, protecting the system from overloads. Historically, manholes date back to ancient civilizations like Rome, with modern designs incorporating advanced materials and engineering techniques for improved functionality and durability [1].

2.2 Hardware Requirements of the System

This system is designed with Arduino(microcontroller) and Arduino are increasingly being used to implemented control system. controller in each and every application. The purpose of this system is an integration of sensor devices, wireless communication which enables the user to remotely access the various parameter on GSM module.

To complete this system, the following components are needed:

- ❖ Arduino Uno Microcontroller

- ❖ DHT11 Humidity and Temperature sensor
- ❖ Waterproof Ultrasonic Sensor
- ❖ Gas Sensor (MQ2, MQ4)
- ❖ SIM800L GSM Module
- ❖ 20x4 LCD Display
- ❖ One Channel Relay
- ❖ 5V DC Fan
- ❖ Jumper Wire

2.3 Introduction to Arduino Uno Microcontroller

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often reference to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on computer, used to wire and upload computer code to the physical board. Arduino Uno is a microcontroller board based on 8-bit ATmega328 microcontroller. It consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the controller. The Arduino Uno is one kind of microcontroller board based on ATmega328, and Uno is an Italian term which means one.

Arduino Uno is named for marking the upcoming release of microcontroller board namely Arduino Uno Board 1.0. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, ceramic resonators- A16 MHz, a USB connection, a power barrel jack, an ICSP header and a reset button.

All these can support the microcontroller for further operation by connecting this board to the computer. The power supply of this board can be done with the help of an AC to DC adapter, a USB cable, otherwise a battery. This article discusses what is an Arduino Uno microcontroller, pin configuration, Arduino Uno specifications or features, and applications.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware in order to load new code into the board and the user can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Arduino provides a standard form factor that breaks out the functions of the microcontroller into

a more accessible package. Arduino Uno board shown in Figure 2.1.



Figure 2.1 Arduino Uno Board[2]

The ATmega328 is one kind of single-chip microcontroller formed with Atmel within the megaAVR family. The architecture of this Arduino Uno is a customized Harvard architecture with 8-bit RISC processor core. Other boards of Arduino Uno include Arduino Pro Mini, Arduino Nano, Arduino Due, Arduino Mega, and Arduino Leonardo.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Net media's BX-24, Phidgets, MIT's Handy board, and many others offer similar functionality. All of these tools take the messy details of the microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontroller, but it

offers some advantages for teachers, students, and interested amateurs over other systems:

- ❖ Inexpensive - Arduino boards are relatively inexpensive compared to the other microcontroller. The least expensive version of the Arduino module can be assembled by hand.
- ❖ Cross platform - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- ❖ Simple, clear programming environment - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.
- ❖ Open source and extensible software - The Arduino software is published as open-source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, the user can add AVR-C code directly into the Arduino programs if the user wants to.
- ❖ Open source and extensible hardware – The plans of the Arduino boards are published under creative common license, so experienced circuit designers can make their own version of the module, extending it and improving it.

Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

- ❖ Entry Level - Get started with Arduino using Entry Level products: easy to use and ready to power for first creative projects. These boards and modules are the best to start learning and tinkering with electronics and coding. The StarterKit includes a book with 15 tutorials that will walk you through the basics up to complex projects.
- ❖ Enhanced Features - Experience the excitement of more complex projects choosing one of the boards with advanced functionalities, or faster performances.
- ❖ Internet of Things-Make connected devices easily with one of these IoT products and open creativity with the opportunities of world wide web.
- ❖ Education - Arduino Education is committed to the empowering educator with the necessary hardware and software tools to create a more hands-on, innovative learning experiences. Take students on a fun and inspiring journey through a world of programming and electronics.
- ❖ Wearable - Add smartness to soft projects and discover the magic of sewing the power of electronics directly to textiles.
- ❖ Retired - Explore the history of Arduino with a journey through all the boards, accessories, shield, kits and documentation released since 2006[2].

2.3.1 Pin Diagram of Arduino Uno Board

The Arduino Uno board can be built with power pins, analog pins, ATmega328, ICSP header, Reset button, power LED, digital pins, test led 13, TX/RX pins, USB interface, an external power supply. The Arduino UNO board description is discussed below. The Arduino Uno power supply can be done with the help of a USB cable or an external power supply. The external power supplies mainly include AC to DC adapter otherwise a battery. The adapter can be connected to the Arduino Uno by plugging into the power jack of the Arduino board. Similarly, the battery leads can be connected to the Vin pin and the GND pin of the POWER connector. The suggested voltage range will be 7 volts to 12 volts. The 14 digital pins on the Arduino Uno can be used as input & output with the help of the functions like pinMode (), digitalWrite (), digitalRead().

- ❖ Pin1 (TX) and Pin0 (RX) (Serial): This pin is used to transmit and receive TTL serial data, and these are connected to the ATmega8U2 USB to TTL Serial chip equivalent pins.
- ❖ Pin2 and Pin3 (External Interrupts): External pins can be connected to activate an interrupt over a low value, change in value.
- ❖ Pins 3, 5, 6, 9, 10, and 11 (PWM): This pin gives 8-bit PWM o/p by the function of analogWrite ().
- ❖ SPI Pins (Pin-10 (SS), Pin-11 (MOSI), Pin-12 (MISO), Pin-13 (SCK): These pins maintain SPI-communication.
- ❖ Pin-13 (LED): The inbuilt LED can be connected to pin-13 (digital pin). As the HIGH-value pin, LED is activated, whenever the pin LOW.
- ❖ Reset Pin: This is used for reset (RST) the microcontroller [4].

- ❖ Pin-4 (SDA) and Pin-5 (SCL) (I2C): It supports TWI-communication with the help of the Wire library. Pin diagram of Arduino Uno are shown in Figure 2.2.

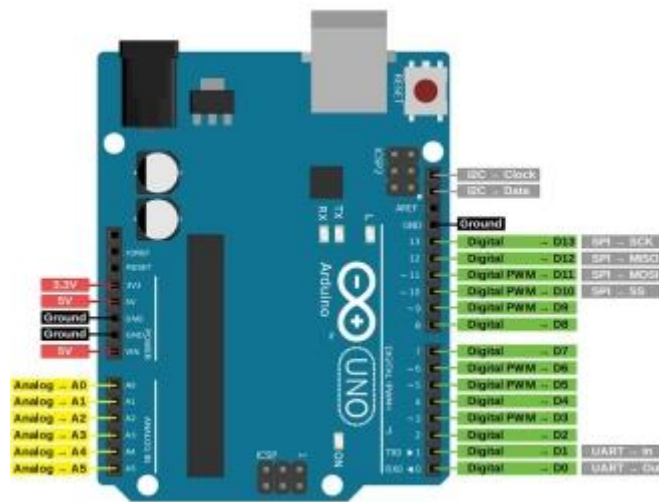


Figure 2.2 Pin Diagram of Arduino Uno[2]

- ❖ AREF (Reference Voltage): The reference voltage is for the analog i/p with analog Reference. Table 2.1 shows the specifications of Arduino uno board [2].

Table 2.1 Specifications of Arduino UNO Board

No	Arduino Uno	Specifications
1.	Microcontroller	ATmega328
2.	Operating voltage	5V

3.	Input voltage (recommended)	7 to 12V
4.	Input voltage (limit)	6 to 20V
5.	Digital I/O Pins	14 (of which 6 can be used as PWM pins)
6.	Analog I/O Pins	6
7.	DC Current per I/O Pin	40mA
8.	DC Current per 3.3V Pin	50mA
9.	Flash memory	32KB of which 0.5KB used by bootloader
10.	SRAM	2KB
11.	EEPROM	1KB
12.	Clock Speed	16MHz

2.4 DHT 11 (Temperature and Humidity) Sensor

Figure 2.3 shows DHT11 (temperature and humidity) sensor. The DHT11 temperature and humidity sensor complex with a calibrated digital signal output. DHT11 is a basic, ultra low-cost, digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure surrounding air, and spits out a digital signal on the data pin (no analog input pin needed). It is fairly to use but requires careful timing to grab data. It can collect new data once every 2 seconds. It is small size, low consumption and long transmission distance [3].

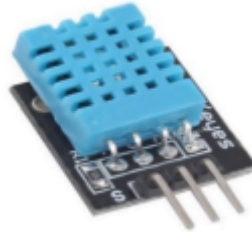


Figure 2.3 DHT 11 (Temperature and Humidity) Sensor

2.4.1 Specifications of DHT11 Sensor

The specifications of DHT11 sensor are:

- ❖ 3 to 5 V power and I/O
- ❖ 2.5mA max current use during conversion (while requesting data)
- ❖ Good for 20-80% humidity reading with 5% accuracy
- ❖ Good for 0-50 degree celsius temperature reading
- ❖ Accuracy is +/-2 degree celsius
- ❖ No more than 1Hz sampling rate (Once every second)
- ❖ Body size 15.5 mm x 12mm x 5.5 mm
- ❖ 4 pins with 0.1inches spacing

2.4.2 Working Principle of DHT11 Sensor

Inside the DHT11, there is a moisture-sensitive material that changes its electrical resistance with changes in humidity. The DHT11 typically operates on a 3.5V to 5.5V power supply and consume very little current, making it suitable for low power

applications. This material is part of a capacitive humidity sensor. As humidity increases, the resistance changes, affecting the capacitance of the sensor. The DHT11 also contains a thermistor, a type of temperature sensor. Thermistor's resistance varies with temperature changes. It is used to measure the ambient temperature. For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature.

The DHT 11 has a microcontroller built into it which processes the resistance values from both the humidity sensor and thermistor. It converts this resistance value into digital signal. The digital signals for humidity and temperature are then sent to the microcontroller's output pins, usually in the form of a single-wire communication protocol, where data is transmitted in a specific format.

To retrieve data from the DHT11, interfacing with a microcontroller like an Arduino or ESP 32 is needed. The microcontroller sends a start signal, and the DHT11 responds with a data packet containing humidity and temperature information. The microcontroller decodes the data packet and converts it into human-readable values for humidity and temperature. The final output is typically in degree Celsius for temperature and percentage for humidity, which can be read and used for various applications like weather monitoring, home automation, temperature monitoring and control system [3].

2.5 Waterproof Ultrasonic Sensor

The JSNSR04T ultrasonic sensor is very similar to the ultrasonic sensor in a car and has several important design advantages over conventional sensor. This obstacle sensor is available in two separate parts. One is the transducer, which is the sensing element, and the other is the control board. This module can provide information on objects ranging in size from 250mm to 4500mm. The JSMSR 04 waterproof ultrasonic sensor is shown in Figure 2.4.



Figure 2.4 Waterproof Ultrasonic Sensor

The main benefit of using this waterproof ultrasonic obstacle sensor is the ability to remotely locate the sensing element in any control circuit. This ultrasonic [distance sensor](#) is an industrial-grade distance measurement sensor. It works just like other low-cost ultrasonic transducers but offers better performance, and it is compatible with harsh environmental conditions and is waterproof. It is easy to interface with Arduino[4].

2.5.1 Pin Diagram of

Waterproof Ultrasonic Sensor

The JSNSR04T Waterproof ultrasonic sensor pin configuration or pin diagram is illustrated in Figure 2.5.

- ❖ Pin 1: (5V): This pin refers to the positive power supply of the sensor.
- ❖ Pin 2: (Trig): This pin refers to the input pin of the sensor, which is kept at an active high for 10 microseconds to initialize the measurement by transmitting ultrasonic waves.
- ❖ Pin 3: (Echo): This pin refers to the output pin of the sensor, which is held at an active high for a period and this is equal to the time taken for the ultrasonic wave to return to the sensor.
- ❖ Pin 4: (GND): This pin refers to the ground pin, which is connected to the system's ground [4].

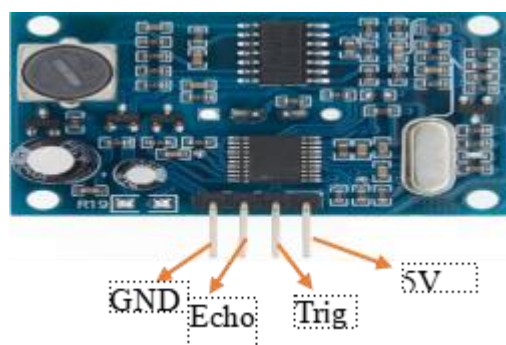


Figure 2.5 Pin Diagram of Waterproof Ultrasonic sensor

2.5.2 Specification of Waterproof Ultrasonic Sensor

The specification of waterproof ultrasonic sensor are;

- ❖ It is available in small size and is very easy to use.
- ❖ It provides high precision measurement and strong anti-interference.
- ❖ It requires low voltage and consumes less power.
- ❖ It is a closed integrated waterproof cable probe, which is used for wet and bad measurements.
- ❖ It is a closed integrated waterproof cable probe, which is used for wet and bad measurements.
- ❖ Its operating voltage is DC 3.0V to 5.5V.
- ❖ Its working current is less than 8mA.
- ❖ Its probe frequency is 40kHz.
- ❖ Its farthest range is 600cm.
- ❖ Its recent range is 20cm.

- ❖ It provides a distance accuracy of $\pm 1\text{cm}$.
- ❖ Resolution is 1mm.
- ❖ The measuring angle is 75° .
- ❖ The beam angle is less than 50° .
- ❖ Its Quiescent current is 5mA.
- ❖ The total current draw is 30mA. Its trigger signal is 10microseconds above the TTL pulse and serial port to send 0X55 instructions.
- ❖ The output of the echo signal is the signal level of output pulse width or TTL.
- ❖ The color of the product is blue.
- ❖ The type of wiring required is- for positive power 3-5.5V, Trig (RX) RX, Echo (output) TX and for negative Power supply GND.
- ❖ The size of the product is L42*W29*H12mm.
- ❖ The range of operating and storage temperature is -20°C to $+70^\circ\text{C}$ [4]

2.6 Gas Sensor

A gas sensor is a device that detects and measures the concentration of gases in an environment and the natural state of its movement. Gas sensors reveal the amount of gas in the environment and the natural of the gas composition with electctrical signals and can provide its change. These sensors are commonly used to monitor air quality, detect toxic gases, or measure the presence of flammable or combustibile gases. Gas

sensors work by interacting with gas molecules in the air and converting that interaction into an electrical signal, which can then be measured and analyzed. There are many types of MQ gas sensors such as MQ2, MQ4, MQ5, MQ6, MQ7, MQ8, MQ9, MQ136 etc. the type of MQ4 and MQ9 sensor are used to detect toxic gases. MQ4 gas sensor is used to detect methane and MQ9 gas sensor is used to detect carbon monoxide.

2.6.1 MQ4 Gas Sensor

The MQ-4 gas sensor is a semiconductor-based sensor commonly used to detect methane (CH_4) and other natural gases like propane and butane. It detects the concentration of methane gas in the air and outputs its reading as an analog voltage. The concentration sensing range of 300 ppm to 10,000 ppm is suitable for leak detection. It's widely used in applications like gas leak detection systems, environmental monitoring, and industrial safety.

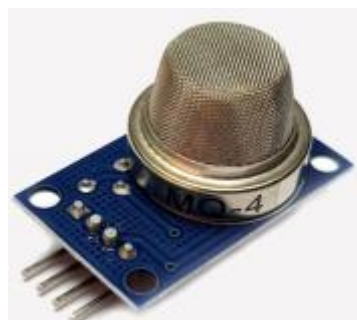


Figure 2.6 MQ4 Gas Sensor

The MQ-4 sensor is widely used due to its affordability and effectiveness in detecting hazardous gases. Figure 2.6 shows MQ4 gas sensor. Table 2.2 shows the pin configuration of MQ4 gas sensor [5].

Table 2.2 Pin Description of MQ4 Gas Sensor

Pin Name	Description
VCC	This pin powers the module, typically the operating voltage is +5V
GND	Used to connect the module to system ground
Digital Out (DO)	You can also use this sensor to get digital output from this pin, by setting a threshold value using the potentiometer
Analog Out (AO)	This pin outputs 0-5V analog voltage based on the intensity of the gas. It is a digital output pin (present on some models).

2.6.1.1 Features of MQ4 gas sensor

The features of MQ4 gas sensor are;

- ❖ Good sensitivity to combustible gas in wide range
- ❖ High sensitivity to natural gas
- ❖ Long life and low cost
- ❖ Simple drive circuit
- ❖ Detection gas: Natural Gas/Methane
- ❖ Concentration: 300-1000ppm
- ❖ Supply voltage: <24V

- ❖ Heater Voltage: $5V \pm 0.2V$
- ❖ Load resistance: Adjustable
- ❖ Heater resistance: $31\Omega \pm 3\Omega$
- ❖ Heater Consumption: $<900\text{mw}$ [5]

2.6.2 MQ9 Gas Sensor

The MQ-9 gas sensor belongs to the MQ series, which has multiple sensors specialized for a particular gas. In the case of the MQ-9 gas sensor, the target gases are carbon monoxide (CO) and other combustible gases that may be life-threatening if leaked. The concentration sensing carbon monoxide (CO) range of 10 ppm to 1,000 ppm is suitable for leak detection. As the ambient concentration of target gases rises, the sensor diligently absorbs them at a higher rate, conveying their presence through analogue values at its analogue pin. Its dual detection capability makes it especially useful in safety applications where both carbon monoxide and flammable gases pose a risk. Figure 2.7 shows MQ9 gas sensor. Table 2.3 shows the pin configuration of MQ9 gas sensor [6].



Figure 2.7 MQ9 Gas Sensor

Pin Name	Description
Vcc	It is a power supply pin for the heater element. It usually requires 5V DC.
GND	It's the ground connection pin.
Aout	It is the analogue output pin. The voltage on this pin varies depending on the gas concentration detected by the sensor.
Dout (optional)	This pin outputs 0-5V analog voltage based on the intensity of the gas. It is a digital output pin (present on some models).

Table 2.3 Pin Description of MQ9 Gas Sensor

2.6.2.1 Features of MQ9 gas sensor

The features of MQ9 gas sensor are

- ❖ Good sensitivity to CO/combustable gas in wide range
- ❖ Long life and low cost
- ❖ Simple drive circuit
- ❖ Detection gas: CO and combustable
- ❖ Concentration: 10-1000ppm CO, 100-1000ppm combustable gas
- ❖ Supply voltage: $\leq 10\text{V DC}$
- ❖ Heater Voltage: $5\text{V} \pm 0.2\text{V}$
- ❖ Load resistance: Adjustable
- ❖ Heater resistance: $31\Omega \pm 3\Omega$

❖ Heater Consumption: <350mw[6]

2.7 SIM800L GSM Module

The SIM800L is a quad-band GSM/GPRS module, that work on frequencies GSM850MHz, DCS1800MHz and PCS1900MHz where it can meet all the space requirements in user applications, such as smart phone, PDA and other devices. It has a micro SIM slot, antenna for the network signal, microphone, speaker pin outs and ring. The power supply requirements for this module is restrictiy 3.4 to 4.4v DC with the minimum 2A. It isn't used directly to the Arduino board or any 5V source without regulator, it also needs a voltage translator for better serial communications. Figure 2.8 shows SIM800L GSM module [7].



Figure 2.8 SIM800L GSM Module

2.7.1 Pin Configuration of SIM800L GSM Module

Table 2.4 shows pin description of SIM800L GSM module.

Table 2.4 Pin Description of SIM88L GSM module

Name	Description
GND	Ground
TXD	Transmit Data
RXD	Receive Data
RST	SIM Reset
VCC	4V Input Supply(Typical)
NET	Network Status
SPK-	Differential audio output(SpeakerN)
SPK+	Differential audio output(SpeakerP)
MIC-	Differential audio input(MicrophoneN)
MIC+	Differential audio input(MicrophoneP)
DTR	Data terminal ready
RING	Ring Indicator

Pin configuration of SIM800L GSM module is shown in Figure 2.9.

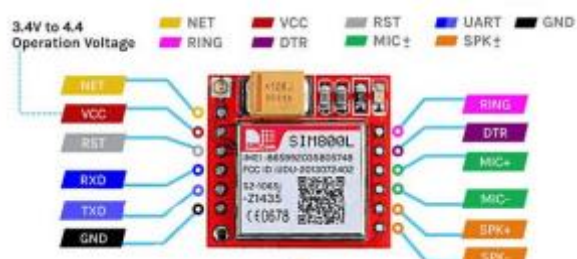


Figure 2.9 Pin Configuration of SIM88L GSM Module

2.7.2 Specifications of SIM800L GSM Module

The specifications of SIM800L GSM module are:

- ❖ With power saving technique for low current consumption
- ❖ Audio channel with includes two microphone input, a receiver output and a speaker output
- ❖ External antenna pad
- ❖ Power supply: 3.4 to 4.4V(4v Typical)
- ❖ Current required: 1A-2.6A(Max)
- ❖ Band Frequency: Quad-band
- ❖ Default baud rate: 9600bps
- ❖ Working temperature range: -40°C to +85°C
- ❖ SIM interface: 1.3V, 3V
- ❖ Timing functions: Use AT commands set
- ❖ PCB dimensions: 23mm×25mmy[7]

2.7.3 Subscriber Identity Module

(SIM)

SIM stands for Subscriber Identity Module which is unique for all the subscribers in the Global System for Mobile Communication (GSM) mobiles. Thus, it can be considered as identity in case of mobile Communication between server and client. The SIM card can also be used as location finder as it registers to the closest base station. It can also be used to save number or to transfer the numbers from one mobile to another. Figure 2.10 shows the typical SIM card for mobile phones.



Figure 2.10 Typical SIM Card [8]

It is the Subscriber Identity Module that contains the integrated circuit to store the International Mobile Subscriber Identity or IMSI and authenticate the subscribers on the Communication system.

Subscriber Identity Module means the chip or card which contains the IMSI information and which can be inserted in equipment to identify the subscriber to the network. The SIM is embedded in a smart card that can be removed and transferred to different mobile phones. There are six types of SIM. These are as follows;

- ❖ SIM Cards (UICC)
- ❖ Chip or Embedded SIMS (MFF2 UICC)

- ❖ eSIMs (eUICC)
- ❖ 2FF (Mini-SIM)
- ❖ 3FF (Micro-SIM)
- ❖ 4FF (Nano-SIM)
- ❖ MFF2 (Chip SIM)

These Universal Integrated Circuit Cards (UICC) are minuscule, plastic memory chips that slide into a device. SIM cards are used routinely to connect IoT and non IoT related devices such as phones, laptops, tablets, and many other types of devices. They typically come in four different SIM card sizes. The size depend on the hardware configuration of devices. The second type of SIM card technology is formerly called Machine-to-Machine Form Factor Universal Integrated Circuit Cards (MFF2 UICC) but nicknamed embedded SIMS or chip SIMS. Unlike a regular SIM card that can be slide in and out of a device, a chip SIM comes in one standard size and put directly onto a device's circuit board during manufacturing. Because it's embedded in the device, the chip SIM is already covered, adding an extra layer of security. It also gives the chip SIM more protection against corrosion, constant motion, and other outside elements.

The SIM technology is the new kid on the connectivity technology. An eSIM or an Embedded Universal Integrated Circuit Card (eUICC) essentially takes the traditional SIM card and makes it digital. An eSIM can still come in all the SIM card sizes of a UICC or MFF2 UICC SIM, embedded or non-embedded, but it's reprogram

millimeter able. It is better connections, lower costs, stronger security, easier bulk device management, and more.

This form factor is no longer in use for modern devices. It measured 5.6millimeter $53.98\text{millimeter} \times 0.76\text{millimeter}$ A 2FF form factor, also known as a mini SIM measures 25millimeter x 15millimeter x 0.76millimeter. Even though its name has "mini" in it, it's actually the largest form factor option available today. Because of this, it's best used for larger devices such as ATMs, amusement park rides, or vending machines. Figure 2.11 shows different types of SIM.

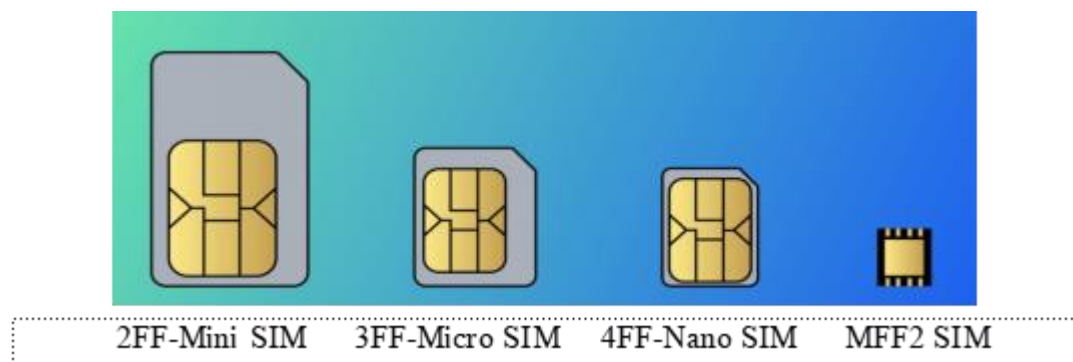


Figure 2.11 Four Types of SIM [8]

Its minuscule size at 6millimeter x 5millimeter $\times 0.9$ millimeter allows it to be

directly put onto a device during manufacturing. It is perfect for IoT or M2M devices outdoors or on the move like such as fleet vehicle cameras, drones, outside alarms, and more.

SIM card provides security system to users. SIM cards allow the storage of application data that communicate with the handset or server using the SIM application tool kit. The SIM card stores network specific information to authenticate the identity of the subscriber in the network. Micro SIM have been invented for latest mobile phones.

The SIM also contains other data like Short Message Service Centre number or SMSC, Service Provider Name or SPN, Service Dialing Number or SDN, Value Added Service or VAS etc. The SIM comes in various data capacities ranging from 32KB to 128K and can store 250 contacts [8].

2.8 5V DC Fan

A 5V dc fan is a type of fan that operates on a 12-volt direct current (DC) power source. These fans are designed to provide cooling of ventilation in various electronic devices, computer systems, and other applications that require efficient cooling. The fans come in different sizes, from small fans used in computer cases to larger fans used in industrial equipment. Figure 2.12 shows 5V DC fan.

These fans are commonly used because many electronics components and devices are powered by 5-volt DC power supplies. 5V DC fans are known for their reliability, energy efficiency, and the ability to control their speed using voltage regulation, making them suitable for a wide range of cooling needs in different applications [9].



Figure 2.12 5V DC Fan

2.9 Relay

A relay is an electromechanical or solid-state device that is used to control the flow of electrical current in an electrical circuit. It acts as a switch, allowing a small electrical signal to control a larger load or circuit. Relays are commonly used in various applications, such as in automation, automotive systems, electronics, and more, to perform tasks like switching lights, motors, or other devices on and off based on input signals. There are different types of relays, including electromagnetic relays (which use coils and switches) and solid-state relays (which use semiconductors like transistors).

Relays are essential for providing isolation between control and reliability in many electrical systems[9].

2.9.1 One Channel Relay

A 5V one-channel relay is an electrically operated switch that uses a low-voltage signal (5V) to control a higher voltage circuit.



Figure 2.13 One Channel Relay

The input voltage can be from any microcontroller or logic chip that outputs a digital signal. Figure 2.13 shows one channel relay [9].

2.9.2 Specification of One Channel Relay

The specifications of one channel relay are:

- ❖ Operating Voltage: 5V DC
- ❖ Relay Type: Electromagnetic
- ❖ Current: Can typically handle currents up to 10A at 250V AC or 30V DC.
- ❖ Operating time is 10msec.
- ❖ Release time is 5msec.
- ❖ Maximum switching is 300 operating per minute.
- ❖ Isolation: Provides electrical isolation between the control and the load
- ❖ Indicator LED: Often includes an LED to show the relay status
- ❖ Home Automation: Controlling appliances or lights
- ❖ Robotics: Switching motors and actuators
- ❖ Arduino/Raspberry Pi Projects: Used in DIY electronics projects for controlling higher voltage components.
- ❖ Connect the VCC pin to the 5V power supply.
- ❖ Connect the GND pin to the ground.
- ❖ Connect the IN pin to the digital output of your microcontroller (e.g., Arduino or Raspberry Pi).
- ❖ Connect the load to the normally open (NO) or normally closed (NC) terminal and common (COM) terminal based on your requirement.

2.10 LCD Display (20 x 4)

In LCD 20 x 4, the term LCD stands for Liquid Crystal Display that uses a plane panel display technology, used in screens of computer monitors, TVs, smartphones, tablets and mobile devices, etc.



Figure 2.14 20 x 4 LCD Display

A liquid crystal display has a backlight that provides light to each pixel that is arranged in a rectangular network. Every pixel includes a blue, red, green sub-pixel that can be switched ON/OFF.

LCD display is an electronic device that is used to display data and the message is known as LCD 20 x 4. It includes 20 columns and 4 rows so it can display 80 characters ($20 \times 4 = 80$) in total and every character will be made with 5×8 (40) pixel dots. So, the total pixels within LCD can be 3200 (80×40) pixels. There are different types of displays available in the market with different combinations such as 16 x 2, 16 x 4, 8 x 1 and 20 x 4. However, the LCD 20 x 4 is broadly used in devices, DIY circuits, electronic project programmable friendly and simple to access. Once all these pixels are deactivated, then it will appear black and when all the sub-pixels are activated then it will appear white. By changing the levels of each light, different color combination is achievable. Figure 2.14 shows 20x4 LCD display[9].

2.10.1 Specifications of LCD Display

The specifications of LCD 20 x 4 are:

- ❖ The operating voltage ranges from 4.7 V to 5.3 V
- ❖ The display bezel is 72 x 25 mm
- ❖ The operating current is 1mA without a backlight
- ❖ PCD size of the module is 80L x 36W x 10H mm
- ❖ HD47780 controller
- ❖ LED color for backlight is green or blue
- ❖ Number of columns – 20
- ❖ Number of rows -4
- ❖ Number of LCD pins – 16
- ❖ Characters – 80
- ❖ It works in 4-bit and 8-bit modes
- ❖ Pixel box of each character is 5 x 8 pixel
- ❖ Font size of character is 0.125W x 0.2 H[10]

2.10.2 Pin Configuration of LCD Display

Pin Configuration of LCD 20 x 4 are:

- ❖ Pin 1 (Ground): This pin connects the ground terminal.
- ❖ Pin 2 (+5V): This pin provides a +5V supply to the LCD.
- ❖ Pin 3 (VE): This pin selects the contrast of the LCD.
- ❖ Pin 4 (Register Select): This pin is used to connect a data pin of an MCU and gets either 1 or 0. Data mode = 0 and command mode = 1.
- ❖ Pin 5 (Read and Write): This pin is used to read/write data.
- ❖ Pin 6 (Enable): This enables the pin must be high to perform the Read/Write procedure. This pin is connected to the data pin of the microcontroller to be held high constantly
- ❖ Pin 7 (Data Pin): The data pins are from 0-7 which are connected through the microcontroller for data transmission. LCD module can also work on the 4-bit mode through working on pins 1, 2, 3 and other pins are free.
- ❖ Pin 8 – Data Pin 1
- ❖ Pin 9 – Data Pin 2
- ❖ Pin 10 – Data Pin 3
- ❖ Pin 11 – Data Pin 4
- ❖ Pin 12 – Data Pin 5
- ❖ Pin 13 – Data Pin 6
- ❖ Pin 14 – Data Pin 7
- ❖ Pin 15 (LED Positive): This is a +Ve terminal of the backlight LED for the display and it is connected to +5V to activate the LED backlight.

- ❖ Pin 16 (LED Negative): This is a –Ve terminal of a backlight LED of the display and it is connected to the GND terminal to activate the LED backlight.

2.10.3 Working Principle of LCD Display

The basic working principle of LCD is passing the light from layer to layer through modules. These modules will vibrate and line up their position on that permits the polarized sheet to allow the light to pass through it. These molecules are accountable for viewing the data on every pixel. Every pixel utilizes the method of absorbing light to illustrate the digit. To display the value, the position of molecules must be changed the angle of light.

. This data will supply to the molecules and will be there till they get changed. The registers used in LCD are two types like data register and command register. The register can be changed by using the RS pinout. If it is '0' then it is command register and if it is '1' then it is data register.

The main function of the command register is to save instructions illustrated on LCD. That assists in data clearing and changes the cursor location and controls the display. The data register is used to save the data to exhibit on the LCD. Once data is transmitted to LCD, then it shifts to the data register to process the data. If the register value is fixed at one that the data register will start working [9].

2.11 Jumper Wire

Jumper wires are short electrical wires with connector pins at each end, typically used to interconnect the components of a breadboard or other prototype or test circuit, without soldering. They come in three types: male-to-male, male-to-female, and female-to-female, allowing various connections between devices and components. Jumper wires are essential tools in electronics for creating temporary connections and testing circuits quickly and easily. The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into things, while female end do not and are used to plug things into. The term jumper wire simply refers to a do not and are used to plug things into. The term jumper wire simply refers to a conducting wire that establishes an electrical connection between two points in a circuit. A jumper wire is an electric wire that connects remote electric circuits used for printed circuit boards. Figure 2.15 shows three types of jumper wire [10].



Figure 2.15 Three Types of Jumper Wire

2.12 Summary

In this chapter, hardware requirements of manhole detection and monitoring system are briefly described and expressed in respective Figures. Introduction of Arduino Uno, specifications and pin connection of Arduino are also explained. Microcontroller and its specification, operating system and advantages are described. The hardware implementation steps and overall operation of the system will be described in the next chapter.

CHAPTER 3

SYSTEM IMPLEMENTATION

This chapter describes the implementation of manhole detection and monitoring system. Fan ON system and SMS notification system using Arduino Uno are also explained in this chapter. The overall circuit diagram of the system and system operation are described in this section.

3.1 Power Supply of the System

To supply power for Arduino Uno, four lithium batteries and voltage regulator are used. Four lithium batteries are connected in series, a voltage regulator to ensure the input voltage is within the safe operating range of the Arduino. Two standard lithium batteries provide a normal voltage of 3.7V each, resulting in the total of 14.8V, when connected in series. The safe voltage of Arduino Uno is 5V and voltage regulator is used to provide a steady and regulated 5V output for the Arduino 5Vpin.

3.2 Interfacing of Arduino Uno with Waterproof Ultrasonic Sensor

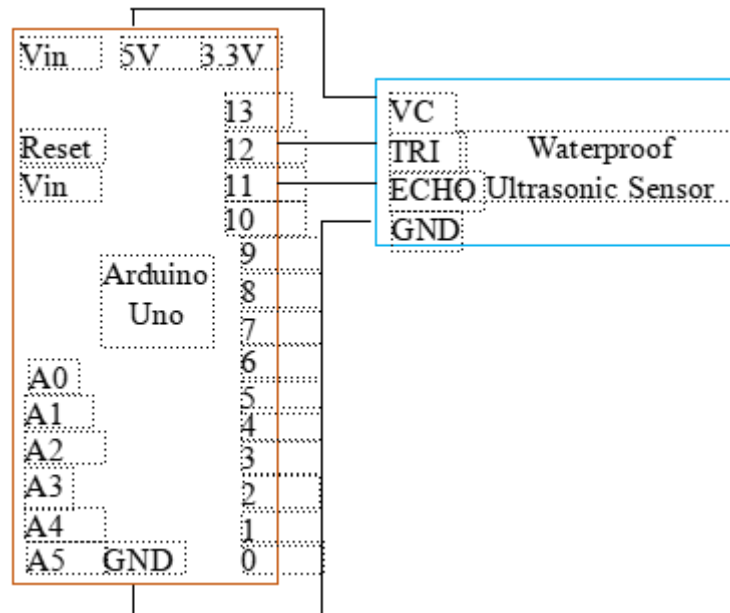


Figure 3.1 Interfacing of Arduino Uno with Waterproof Ultrasonic Sensor

Figure 3.1 shows Interfacing of Arduino Uno with Waterproof Ultrasonic Sensor. The waterproof ultrasonic sensor typically has four pins VCC, ECHO, Trig and GND pin. VCC pin provides power to the sensor. It is usually connected to the 5V pin of the Arduino Uno. GND pin is connected to the ground of the Arduino Uno. ECHO and TRIG pin output the digital data from the sensor. They are connected to the digital input pin on the Arduino Uno.

3.3 Interfacing of Arduino Uno with DHT11 Sensor

The HT11 sensor typically has three pins VCC, GND and DATA pin. VCC pin provides power to the sensor. It is usually connected to the 5V pin of the Arduino Uno. GND pin is connected to the Arduino Uno. DATA pin outputs the digital data from the sensor. It is connected to a digital pin on the Arduino Uno. Figure 3.2 shows interfacing of Arduino Uno with DHT11 sensor.

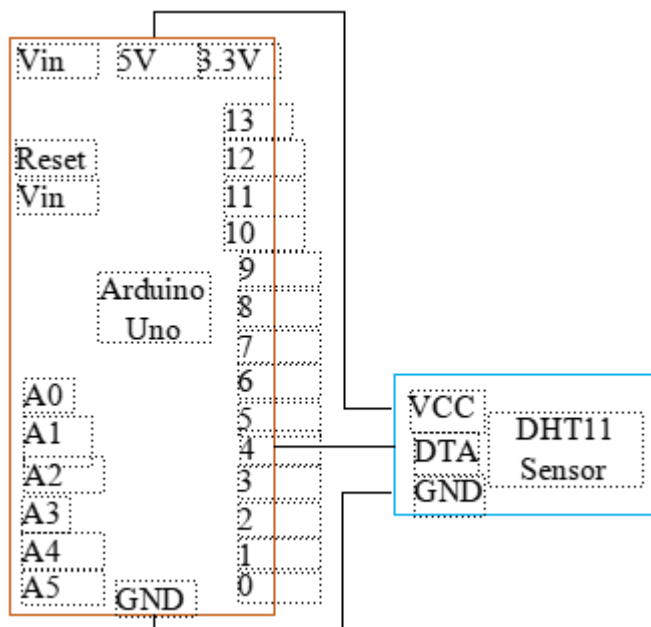


Figure 3.2 Interfacing of Arduino Uno with DHT11 Sensor

3.4 Interfacing of Arduino Uno with MQ4 and MQ9 Gas Sensors

Each gas sensor typically has three pins VCC, AOOUT and GND pin. VCC pin provides power to the sensor. It is usually connected to the 5V pin of the Arduino Uno. GND pin is connected to the ground of the Arduino Uno. AOOUT pin outputs the analog data from the sensor. It is connected to the analog input pin on the Arduino Uno. Figure 3.3 shows interfacing of Arduino Uno MQ4 and MQ9 gas sensors.

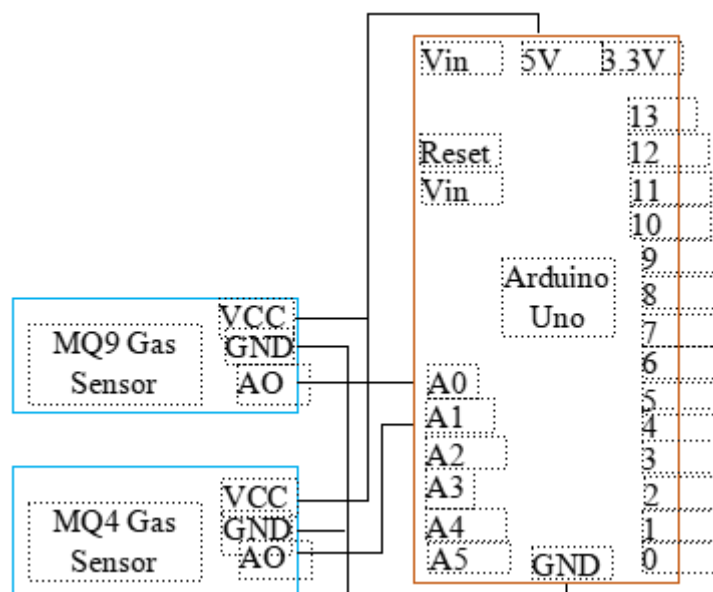


Figure 3.3 Interfacing of Arduino Uno with MQ4 and MQ9 Gas Sensors

3.5 Interfacing of Arduino Uno with SIM800L GSM Module

The SIM800L GSM module typically has four pins VCC, TX, RX and GND pin. VCC pin provides power to the sensor. It is usually connected to the 5V pin of the Arduino Uno. GND pin is connected to the ground of the Arduino Uno. TX and RX pin output the digital data from the sensor. They are connected to the digital input pin on the Arduino Uno. Figure 3.4 shows interfacing of Arduino Uno with waterproof Ultrasonic sensor.

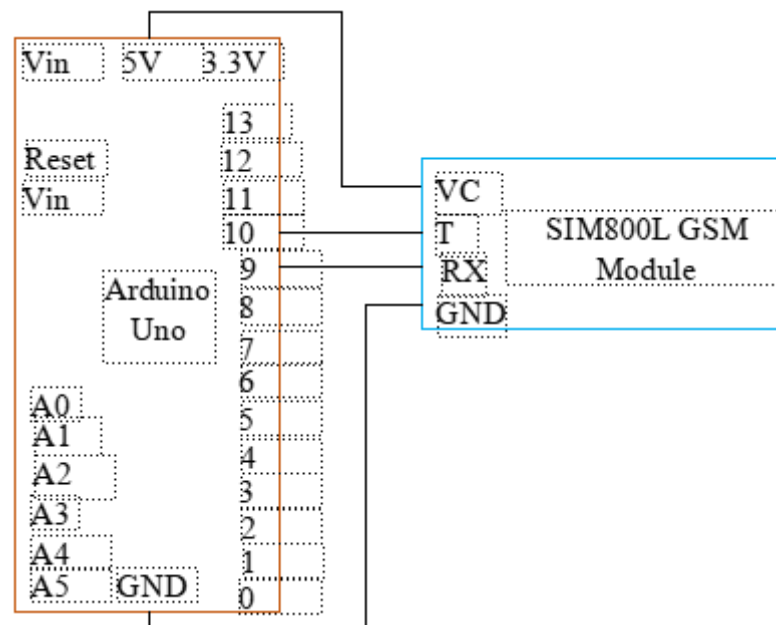


Figure 3.4 Interfacing of Arduino Uno with SIM 800L GSM Module

3.6 System Operation of Manhole Detection and Monitoring System

Manholes are essential for underground utilities, but their improper maintenance can lead to environmental hazards. Manhole detection and monitoring system will not only help in maintaining the proper health and safety of the city but also in reducing the work of government personnel. Blockages in drains during monsoon season, causes problems in the routine of the public. When there is a blockade in the drainage, it causes environmental pollution. Uncleaning society is not good for health. Moreover, cleaning society is very important to be more higher living standard. Therefore, this system should be used in large cities with dense population.

So, this system has been added in order to measure and reduce more gases such as methane and carbon monoxide (CH_4 and CO) that can cause harm to people in the drainage. When the temperature inside the manhole increases, bacteria can grow and diseases can also spread in public. This system can also be used to reduce this risk. And it is a system that can predict whether or not there is a block in the drainage system by looking at the water level of the manhole.

The system used temperature and humidity (DHT11) sensor, waterproof ultrasonic sensor, MQ4 and MQ9 gas sensors are interfaced with microcontroller Arduino UNO in order to make the system smart.

Firstly, power is supplied for the whole system. LCD displays water level in drainage after the waterproof ultrasonic sensor operated and if the water level is over 20cm, the SMS will be sent to the user's phone. DHT 11 sensor detects the temperature and humidity in drainage and displays it on LCD. MQ4 gas sensor senses the amount

of methane (CH₄) in the drainage and displays on LCD. MQ9 gas sensor senses the amount of carbon monoxide (CO) in the drainage and displays on LCD.

When the temperature and humidity is greater than 35 degree celsius, fan is ON and alert message to the user. When CH₄ level is over 500ppm, fan is ON and alert message to the user. When CO level is greater than 200ppm, fan is ON and the system will inform to user by sending alert message through GSM module. It will send an SMS when one of the sensors exceeds its threshold level.

In summary the respective sensors reach the threshold level, the indication of that respective value and sensor is being sent to the microcontroller.

For manhole detection and monitoring system, the hardware components are installed according to the circuit diagram. Table 3.1 shows pin connection table of the system.

Table 3.1 Pin Connection Table of the System

Arduino Uno	Waterproof Ultrasonic Sensor	DHT11 Sensor	MQ4 Gas Sensor	MQ9 Gas Sensor	LCD	SIM Module
VCC	VCC	VCC	VCC	VCC	VCC	VCC
GND	GND	GND	GND	GND	GND	GND
A0	-	-	-	AOUT	-	-
A1	-	-	AOUT	-	-	-
D4	-	DTA	-	-	-	-

D9	-	-	-	-	-	RX
D10	-	-	-	-	-	TX
D11	ECHO	-	-	-	-	-
D12	TRIG	-	-	-	-	-
L2C Clock	-	-	-	-	SDA	-
L2C Data	-	-	-	-	SC L	-

Figure 3. 5 shows the overall circuit diagram of the proposed system.

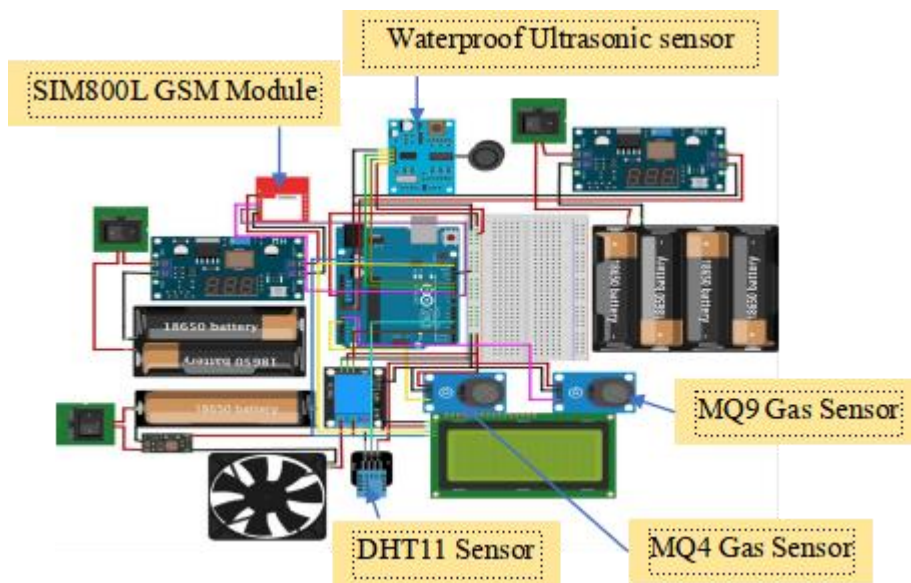


Figure 3. 5 Overall Circuit Diagram of the System

3.7 Hardware Implementation of Manhole Detection and Monitoring System

In this thesis, the manhole detection and monitoring system include automatic fan ON system and SMS notification system.

The Arduino Uno alone can't provide enough power or the correct voltage for the fan. A 18650 battery that have 3.7V is used and raised its voltage with the voltage regular and connected it to a pin of the fan. And another pin of the fan is connected to the relay module controlled by Arduino D2.

For SMS notification system, Arduino Uno cannot supply enough voltage. So, two 18650 batteries that have 3.7V respectively are used. The SIM 800L GSM module typically operates at a voltage of 3.4V to 4.4V, with an ideal operating voltage around 4.0V. It is crucial not to exceed this range, as doing so can damage the module. In this system, to get stable operation within this voltage regulator is used. The VCC pin of the SIM800L module should be connected to the output pin of the voltage regulator. This output pin is usually labeled as "OUT+" on the voltage regulator module. The ground of the SIM800L should also be connected to the common ground of the voltage regulator and Arduino Uno.

When power is supplied to the system, the sensor will sense temperature in the manhole. If the temperature is less than and equal 35 degree celsius, the measurable value is only displayed on LCD. If the temperature is greater than 35 degree celsius, the measurable value is displayed on LCD, fan is ON and alert message to the user through GSM module.

When power is supplied to the system, it detect the amount of methane (CH₄) gas in the drainage. If the measurable value is less than and equal 500 ppm, the data is only displays on LCD. And if the measurable value is greater than 400 ppm, the data displays on LCD, fan is ON and alert message to the user through GSM module.

When power is supplied to the system, it detect the amount of carbon monoxide (CO) gas in the drainage. If the measurable value is less than and equal 200 ppm, the

data is only displays on LCD. And if the measurable value is greater than 200 ppm, the data displays on LCD, fan is ON and alert message to the user through GSM module.

When power is supplied to the system, it sense the level of water in the manhole. The water level is 20cm, only LCD display. If the water level is greater than 20cm, the data is displayed on LCD and alert message to the user through GSM module. It will send an SMS when one of the sensors exceeds its threshold level. Top view of overall hardware implementation of the system is shown in Figure 3.6.



Figure 3.6 Top View of Overall Hardware Implementation of the System

Figure 3.7 shows inside view of hardware implementation of the system.



Figure 3.7 Inside View of Hardware Implementation of the System

Figure 3.8 shows side view of hardware implementation of the system.



Figure 3.8 Side View of Hardware Implementation of the System

Figure 3.9 shows inside view of MQ4 gas sensor, MQ9 gas sensor, DHT11 sensor and fan.



Figure 3.9 Inside view of MQ4 Gas Sensor, MQ9 Gas Sensor, DHT11 Sensor and Fan

Figure 3.10 shows top view of power supply of the system.

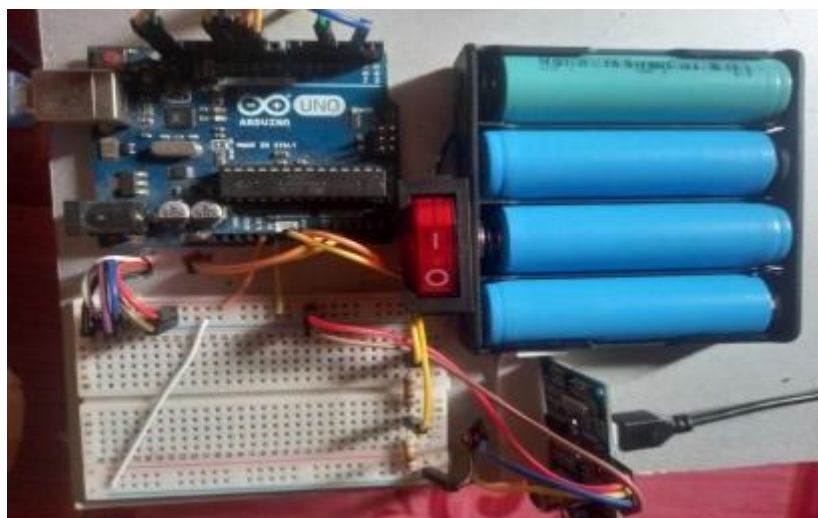


Figure 3.10 Top View of Power Supply of the System

3.8 Summary

This chapter has discussed overall hardware implementation of manhole detection and monitoring system. In this section, pin connection table and overall circuit diagram of the system are described. The test and results of manhole detection and monitoring system are described in the next chapter.

CHAPTER 4

TEST AND RESULTS

This chapter emphasizes the test and results of manhole detection and monitoring system. It includes the testing and final results of the system.

4.1 Testing DHT11 Sensor with Arduino Uno

Firstly, DHT11 is connected to Arduino Uno for testing temperature and humidity in drainage. The USB plug of the Arduino uno is connected to the computer's

USB. And then upload the program of to the Arduino uno. Figure 4.1 shows the testing result of DHT11 sensor with Arduino Uno.

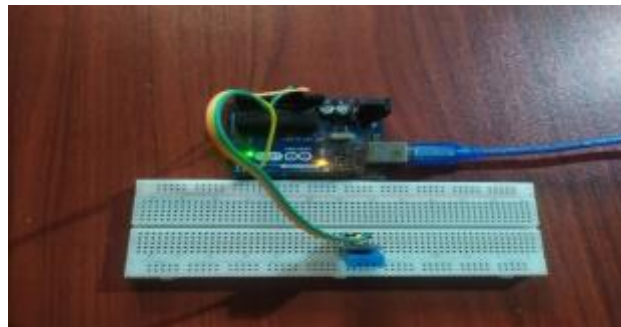


Figure 4.1 Testing DHT11 Sensor with Arduino Uno

4.2 Testing MQ4 Gas Sensor with Arduino Uno



Figure 4.2 Testing MQ4 Gas Sensor with Arduino Uno

Figure 4.2 shows testing MQ4 gas sensor with Arduino Uno. MQ4 gas sensor is connected to Arduino Uno for testing methane in the drainage. The USB plug of the Arduino Uno is connected to the computer's USB. And upload the program to the Arduino Uno.

4.3 Testing MQ9 Gas Sensor with Arduino Uno

MQ9 gas sensor is connected to Arduino Uno for testing carbon monoxide in drainage. Figure 4.3 shows the testing result of MQ9 gas sensor with Arduino Uno.

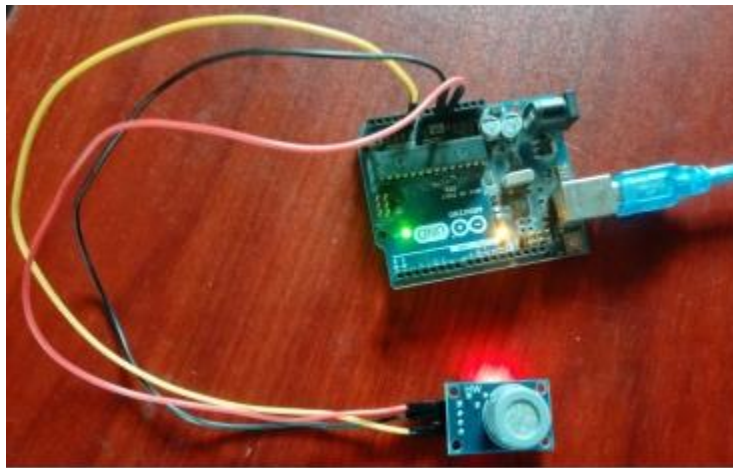


Figure 4.3 Testing MQ9 Gas Sensor with Arduino Uno

4.4 Testing Waterproof Ultrasonic Sensor with Arduino Uno

Waterproof ultrasonic sensor is connected to Arduino Uno for testing water level in the manhole. Figure 4.4 shows the testing result of waterproof ultrasonic sensor with Arduino Uno.



Figure 4.4 Testing Waterproof Ultrasonic Sensor with Arduino Uno

4.5 Testing SIM800L GSM Module with Arduino Uno

SIM 800L GSM module is connected to Arduino Uno for alert messages the condition of manhole system to user's phone in real time. Figure 4.5 shows the testing result of SIM800L GSM module with Arduino Uno.

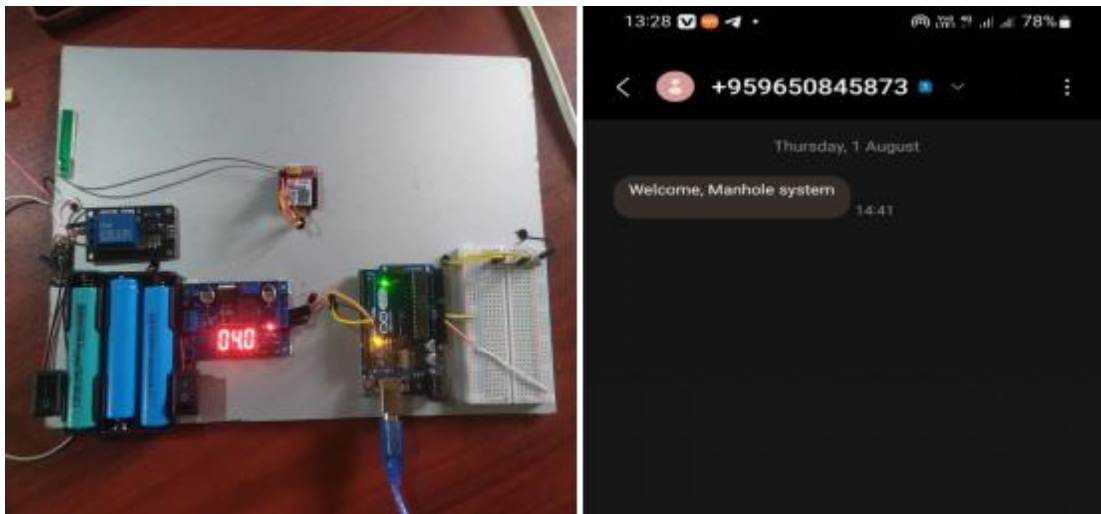


Figure 4.5 Testing SIM800L GSM Module with Arduino Uno

4.6 Testing LCD Display with Arduino Uno

LCD display is connected to Arduino Uno for display the condition of manhole system. Figure 4.6 shows the testing result of LCD display with Arduino Uno.



Figure 4.6 Testing LCD Display with Arduino Uno

4.7 Test and Results of DHT11 Sensor and LCD Display

DHT11 sensor and LCD display with Arduino Uno are connected respectively. Figure 4.7 shows the testing results of DHT11 sensor and LCD display.

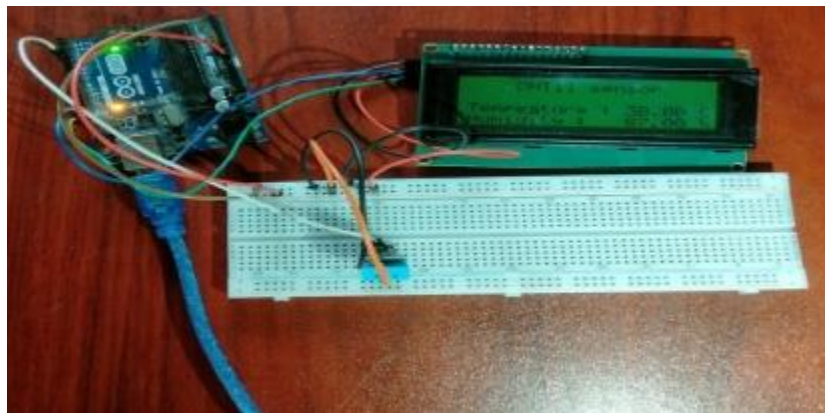


Figure 4.7 Test and Results of DHT11 Sensor and LCD Display

4.8 Test and Results of MQ4 Gas Sensor and LCD Display

MQ4 gas sensor and LCD display with Arduino Uno are connected respectively. Figure 4.8 shows the testing results of MQ4 gas sensor and LCD display.



Figure 4.8 Test and Results of MQ4 Gas Sensor and LCD Display

4.9 Test and Results of MQ9 Gas Sensor and LCD Display



Figure 4.9 Test and Results of MQ9 Gas Sensor and LCD Display

Figure 4.9 shows the testing results of MQ9 gas sensor and LCD display. MQ9 gas sensor and LCD display with Arduino Uno are connected respectively.

4.10 Test and Results of Waterproof Ultrasonic Sensor and LCD Display

Waterproof ultrasonic sensor and LCD display with Arduino Uno are connected respectively. Figure 4.10 shows the testing results of waterproof ultrasonic sensor and LCD display.

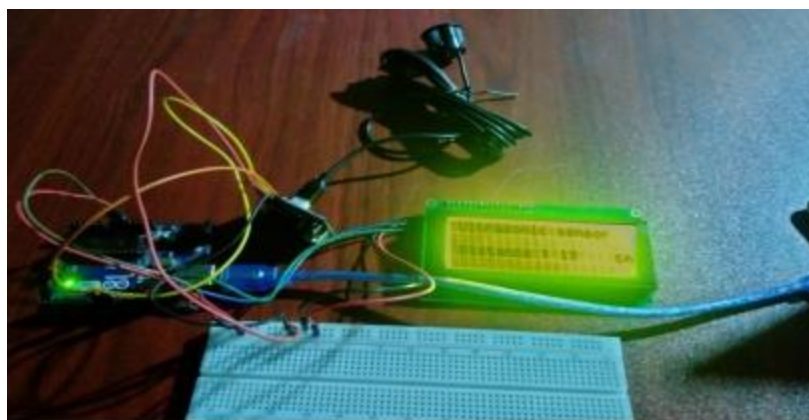


Figure 4.10 Test and Results of Waterproof Ultrasonic Sensor and LCD Display

4.11 Overall Test and Results

Initially the pins of Arduino Uno, DHT11 sensor, MQ4 gas sensor, MQ9 gas sensor, Waterproof ultrasonic sensor, SIM800L GSM module, LCD display, fan and three voltage regulators to drop required voltage to safe project. When the power is on, LCD display “Hello, World”, “PTU EC Project”, “Manhole System”, “By Myat & Nyein”. Figure 4.11 shows starting state of the system.

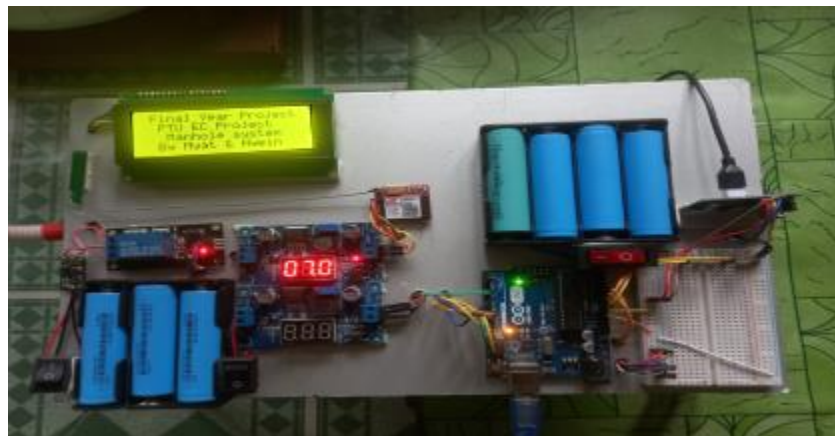


Figure 4.11 Starting State of The System

DHT 11 sensor detect temperature and humidity in drainage. If the measurable value is greater than 35 degree celsius, the measurable value is displayed on LCD, fan is ON and alert message to the user. Figure 4.12 shows the condition of temperature above 35 degree celsius and humidity level of 70%.



Figure 4.12 Temperature and Humidity Above 35 Degree Celsius

Methane (CH_4) level is sensed MQ4 gas sensor is greater than 500ppm or carbon monoxide (CO) level is sensed MQ9 gas sensor is greater than 200ppm, fan is On and alert message to the user through GSM module. The measurable value is displayed on LCD. Figure 4.13 shows the condition of CH_4 level above 500ppm and CO level above 200ppm.



Figure 4.13 CH_4 Level Above 500ppm and CO Level Above 200ppm

Waterproof ultrasonic sensor senses the water level and if the water level is greater than 20cm, alert message to the user through GSM module. Figure 4.14 shows the water level above 20cm. The alert message will be sent to the user if any of sensors exceeds the threshold level.



Figure 4.14 Water Level Above 20cm

Figure 4.15 shows the results of SMS notification.



Figure 4.15 Results of SMS Notification

4.12 Summary

This chapter has discussed the test and results of the software and hardware components of the system. Moreover, hardware testing results have been discussed in this chapter. And, results of manhole detection and monitoring system are described in detail. Discussions, conclusion and further extension of manhole detection and monitoring system are described in the next chapter.

CHAPTER 5

CONCLUSION, DISCUSSION AND FURTHER EXTENSION

This chapter describes conclusion and discussion of manhole detection and monitoring system. Further extension of the system is also described.

5.1 Conclusion and Discussion

Nowadays, underground monitoring is challenging problem. This prototype proposes different methods for monitoring and managing underground drainage system. Various parameters like temperature, toxic gases and level of water are being monitored and updated with SMS by connecting via SIM 800L module. This enables the person in-charge to take the necessary actions regarding the same. The author studied the hardware components and Arduino IDE software which are used for creation of Manhole Detection and Monitoring system and also knew how to create Manhole detection and Monitoring system. The author tried to create Manhole Detection and Monitoring system by using Arduino IDE software, the other faced the problem that matching of the software with the window of PC and hardware components. So, the author can fix this error by learning YouTube videos and Google search engine from internet. If the GSM module does not get enough power supply, it cannot send the SMS message. In addition, all hardware components cannot work if power supply is not on the common ground. Finally, design and implementation of Manhole Detection and Monitoring system has been achieved in this thesis. In this thesis, the supply to the entire system is given through the USB hub by using an external power source.

5.2 Further Extension

This system can also be added water flow rate sensor for detecting water flow and GPS module for showing the location of where the drain is blocked. It can be connected to ESP8266 and added to the IoT system. The system can also be monitored with IoT that can send data anywhere the internet is available.