# DESIGN AND IMPLEMENTATION OF INTELLIGENT MANHOLE COVER MONITORING SYSTEM BASED ON NARROW BAND (NB-IOT)

**A PROJECT REPORT**

***Submitted by***


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***in partial fulfillment for the award of the degree***

***of***

**BACHELOR OF ENGINEERING**

**IN**

**COMPUTER SCIENCE AND ENGINEERING**



**PANIMALAR ENGINEERING COLLEGE**

**(An Autonomous Institution, Affiliated to Anna University, Chennai)**


**APRIL 2023**

# PANIMALAR ENGINEERING COLLEGE

**(An Autonmous Institution, Affiliated to Anna University, Chennai)**

## BONAFIDE CERTIFICATE

Certified that this project report **"DESIGN AND IMPLEMENTATION OF INTELLIGENT MANHOLE COVER MONITORING SYSTEM BASED ON NARROW BAND (NB-IOT)"** is the bonafide work of **"SANJANA S(211419104231), SHAKTHI SRI S(211419104243) & SARAH JACI J(211419104237)"** who carried out the project work under my supervision.

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**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

## DECLARATION BY THE STUDENT

We **SANJANA S (211419104231), SHAKTHI SRI S (211419104243) & SARAH JACI J (211419104237)** hereby declare that this project report titled "**DESIGN AND IMPLEMENTATION OF INTELLIGENT MANHOLE COVER MONITORING SYSTEM BASED NARROW BAND (NB-IOT)**" , under the guidance of **M.MAHESWARI, M.E.,** is the original work done by us and we have not plagiarized or submitted to any other degree in any university by us.

## ACKNOWLEDGEMENT

We would like to express our deep gratitude to our respected Secretary and Correspondent **Dr.P.CHINNADURAI, M.A., Ph.D.** for his kind words and enthusiastic motivation, which inspired us a lot in completing this project.

We express our sincere thanks to our beloved Directors **Tmt.C.VIJAYARAJESWARI**, **Dr.C.SAKTHI KUMAR,M.E.,Ph.D** and **Dr.SARANYASREE SAKTHI KUMAR B.E.,M.B.A.,Ph.D.,** for providing us with the necessary facilities to undertake this project.

We also express our gratitude to our Principal **Dr.K.Mani, M.E., Ph.D.** who facilitated us in completing the project.

We thank the Head of the CSE Department, **Dr. L.JABASHEELA , M.E.,Ph.D.,** for the support extended throughout the project.

We would like to thank my **Project Guide, M.MAHESWARI, M.E.,** andall the faculty members of the Department of CSE for their advice and encouragement for the successful completion of the project.

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# ABSTRACT

Recently, (Radio Frequency Identification) RFID based frameworks move beyond security to turn into tracking systems that integrate security with more proficient materials tracking inside the library, involving easier and quicker charging & discharging, materials handling and inventorying. In this study, a book tracking RFID-based system has been designed and developed to replace the existing library barcoding system. This system enables the librarians to minimize the spent time that is required for scanning barcodes during charging and discharging process. Further, this technology has been enhanced by robot features to identify the book. A smart city is the future goal to have cleaner and better amenities for the society. Smart underground infrastructure is an important feature to be considered while implementing a smart city. Drainage system monitoring plays a vital role in keeping the city clean and healthy. Since manual monitoring is incompetent, this leads to slow handling of problems in drainage and consumes more time to solve. To mitigate all these issues, the system using a wireless sensor network, consisting of sensor nodes is designed. The proposed system is low cost, low maintenance, ZIGBEE based real time which alerts transmit the managing station when any manhole crosses its threshold values. This system reduces the death risk of manual scavengers who clean the underground drainage and also benefits the public.

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# LIST OF ABBREVATIONS

| SHORT FORM | ABBREVATIONS |
|---|---|
| IOT | Internet of Things |
| LCD | Liquid Crystal Display |
| ISP | In System Programming |
| IDE | Integrated Development Environment |
| MCU | Microcontroller Unit |
| UART | Universal Asynchronous Receiver-Transmitter |
| GPIO | General Purpose Input Output |
| DHT | Digital Temperature and Humidity Sensor |
| SPL | Sound Pressure Level meter |
| GSM | Global System for Mobile communication |
| GPS | Global Positioning System |

# CHAPTER 1

# INTRODUCTION

## 1.1 PROBLEM DEFINITION

Now a days manhole problems in the populated cities is the major issues. Opening of manholes due to breakage of manhole cover, manhole explosions are major threat in recent days. Manhole cover opening leads to accidental fall of vehicles,pedestrians leading to accidents or loss of life. Manhole opening detection and alerting is mainly based on detecting the manholes which are opened due to overflow of sewage rain water during heavy rainfall and alerting. When a manhole opening is detected either due to overflow of sewage water, increase in pressure or temperature, it leads to the breakage of the manhole lids. To avoid such incidents even before it could affect the public, an alerting system is built wherein the buzzer alerts the surrounding and sends the sensed data to the managing authorities using GSM techniques. So, they can take precautionary action to close the manhole considering public safety.

## 1.2 SCOPE OF THE PROJECT

The aim of our project is to clean the drainage and make a smart city in all over India.

# CHAPTER 2

# LITERATURE SURVEY

**Title 1**: Secure Manhole Monitoring System Employing Sensors and GSM Techniques

**Author:** Nataraja N, Amruthavarshini R, Chaitra N L, Jyothi K, Krupaa N, S S M Saqquaf.

**Year : 2021**

**Description**:

Manhole opening detection and alerting is mainly based on detecting the manholes which are opened due to overflow of sewage / rain water during heavy rainfall and alerting when a manhole opening is detected.

**Advantages:**

To avoid such incidents even before it could affect the public, an alerting system is built wherein the buzzer alerts the surrounding and sends the sensed data to the managing authorities using GSM techniques.

**Disadvantages:**

Overflow of sewage water, increase in pressure or temperature, it leads to the breakage of the manhole lids.

**Title 2**: Design and Implementation of Intelligent Manhole Cover Monitoring System Based on NB-IoT

**Author:** Guo Xiucai, Liu Bingbing, Wang Lili.

**Year :2019**

**Description**:

This paper designs an intelligent manhole cover monitoring system based on narrow band Internet of things (NB-IoT) technology.

**Advantages:**

The sensing layer is based on the embedded ARM microprocessor and combines sensor technology to collect the manhole cover data.

**Disadvantages:**

Immature technology and insufficient comprehensive analysis.

**Title 3**: On a Working Monitoring System of Manhole Wells Based on Technology of Internet of Things.

**Author:** Yunhong Xie, Hong Wang, Jiong Liu, Renpeng Zhang, Yong Guo

**Year : 2018**

**Description**:

This system researches and develops the intelligent monitoring system of manhole well, and realizes the monitoring of manhole well status based on the Internet of things technology.

**Advantages:**

The lock well cover and the alarm terminal perceive the change of the well cover state, send information to the application layer through the network and notify the user, and the user will process it accordingly.

**Disadvantages:**

The ground cable is usually laid in the underground pipeline, and the manhole is used as the entrance and exit of the pipeline for maintenance of pipeline and ground cable.

**Title 4**: An IoT Based Proposed System for Monitoring Manhole in Context of Bangladesh

**Author:** Saadnoor Salehin, Syeda Sabrina Akter, Anika Ibnat, Tasmiah Tamzid Anannya, Nurun Nahar Liya, Manisha Paramita, Md Mahboob Karim

**Year : 2018**

**Description**:

This paper presents an manhole monitoring system which detects harmful chemicals and toxic gases inside the manhole, generates an alarm to the passersby in that situation, alerts the authority about the system state.

**Advantages:**

The system has been implemented in an academic environment to carry out the automated monitoring of a manhole to evaluate the proposed features.

**Disadvantages:**

The concerned authorities can take proper measures to maintain the manhole.

**Title 5:** Research on an intelligent monitoring device for cable manhole covers

**Author:** ZHANG Chongbiao, QIN Mingbo, CHENG Long, GE Qi, SONG Jiajia , ZHANG Jinbo,

**Year : 2018**

**Description:**

This paper proposed an monitoring device which uses six axis sensors to monitor the attitude of the cable well covers. Once the attitude changes, it is sent to the supervisors' mobile phones through wireless network.

**Advantages:**

Timely monitor whether the cable manhole cover is moved artificially, which is of great significance to improve the safety of road driving.

**Disadvantages:**

The criminals are given the opportunity to steal covers and cables.

# CHAPTER 3

# SYSTEM ANALYSIS

## 3.1 EXISTING SYSTEM

- In Existing method, there is no alert for manhole cover and real-time data.
- The manhole cover opening doesn't have the proper maintenance.

### 3.1.1 EXISTING SYSTEM DISADVANTAGES

- Peoples fall down in the hole. And smell pollution in the opening areas.
- Manual monitoring leads to high human resource.

## 3.2 PROPOSED SYSTEM

- In proposed method, the narrow band technology used to connect all nodes into the single master to update the information.
- To prevent manhole accidents using sensor provide the proper data.

### 3.2.1 PROPOSED SYSTEM ADVANTAGES

- Reduce the human deaths in the drainage system.
- The monitoring system easy to handle.

# CHAPTER 4

# HARDWARE AND SOFTWARE DESCRIPTION

## 4.1 HARDWARE DESCRIPTION

### 4.1.1 ARDUINO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs – light on a sensor, a finger on a button, or a Twitter message – and turn it into an output – activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

#### 4.1.1.1 ARDUINO MEGA

The MEGA 2560 is designed for more complex projects. With 54 digital I/O pins, 16 analog inputs and a larger space for your sketch it is the recommended board for 3D printers and robotics projects. This gives your projects plenty of room and opportunities.

**TECHNICAL SPECIFICATIONS:**

| | |
|---|---|
| **Microcontroller** | Atmega2560 |
| **Operating Voltage** | 5V |
| **Input Voltage (recommended)** | 7-12V |
| **Input Voltage (limit)** | 6-20V |
| **Digital I/O Pins** | 54 (of which 15 provide PWM output) |
| **Analog Input Pins** | 16 |
| **DC Current per I/O Pin** | 20 Ma |
| **DC Current for 3.3V Pin** | 50 Ma |
| **Flash Memory** | 256 KB of which 8 KB used by boot loader |
| **SRAM** | 8 KB |
| **EEPROM** | 4 KB |
| **Clock Speed** | 16 MHz |
| **LED_BUILTIN** | 13 |
| **Length** | 101.52 mm |
| **Width** | 53.3 mm |
| **Weight** | 37 g |

**Table 4.1 Technical specification of ARDUINO MEGA**

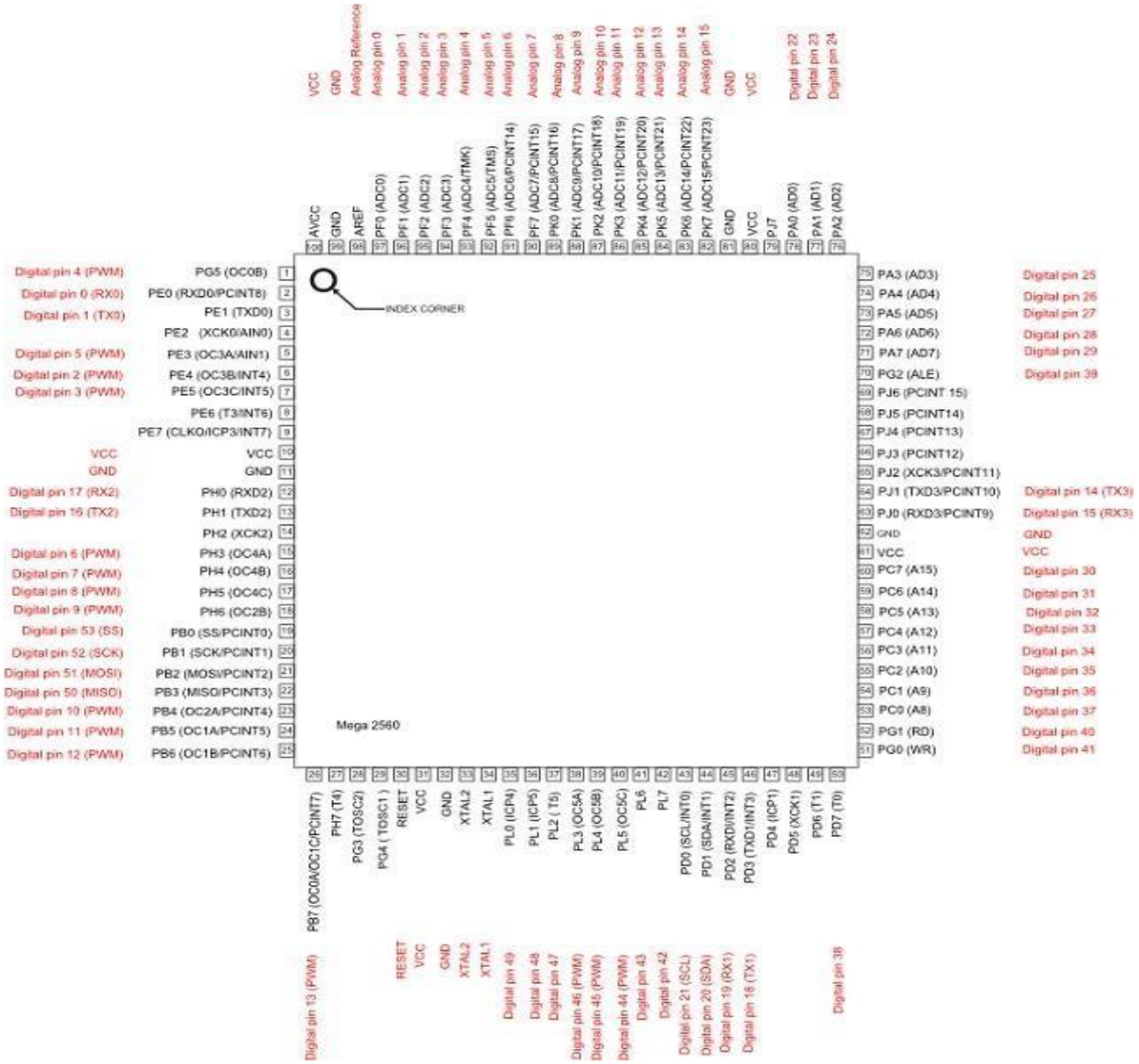



**FIG 4.1 Arduino Mega 2560 PIN mapping**

| Pin Number | Pin Name | Mapped Pin Name |
|---|---|---|
| 1 | PG5 ( OC0B ) | Digital pin 4 (PWM) |
| 2 | PE0 ( RXD0/PCINT8 ) | Digital pin 0 (RX0) |
| 3 | PE1 ( TXD0 ) | Digital pin 1 (TX0) |
| 4 | PE2 ( XCK0/AIN0 ) | |

| | | |
|---|---|---|
| 5 | PE3 ( OC3A/AIN1 ) | Digital pin 5 (PWM) |
| 6 | PE4 ( OC3B/INT4 ) | Digital pin 2 (PWM) |
| 7 | PE5 ( OC3C/INT5 ) | Digital pin 3 (PWM) |
| 8 | PE6 ( T3/INT6 ) | |
| 9 | PE7 ( CLKO/ICP3/INT7 ) | |
| 10 | VCC | VCC |
| 11 | GND | GND |
| 12 | PH0 ( RXD2 ) | Digital pin 17 (RX2) |
| 13 | PH1 ( TXD2 ) | Digital pin 16 (TX2) |
| 14 | PH2 ( XCK2 ) | |
| 15 | PH3 ( OC4A ) | Digital pin 6 (PWM) |
| 16 | PH4 ( OC4B ) | Digital pin 7 (PWM) |
| 17 | PH5 ( OC4C ) | Digital pin 8 (PWM) |
| 18 | PH6 ( OC2B ) | Digital pin 9 (PWM) |
| 19 | PB0 ( SS/PCINT0 ) | Digital pin 53 (SS) |
| 20 | PB1 ( SCK/PCINT1 ) | Digital pin 52 (SCK) |
| 21 | PB2 ( MOSI/PCINT2 ) | Digital pin 51 (MOSI) |
| 22 | PB3 ( MISO/PCINT3 ) | Digital pin 50 (MISO) |
| 23 | PB4 ( OC2A/PCINT4 ) | Digital pin 10 (PWM) |
| 24 | PB5 ( OC1A/PCINT5 ) | Digital pin 11 (PWM) |
| 25 | PB6 ( OC1B/PCINT6 ) | Digital pin 12 (PWM) |

| | | |
|---|---|---|
| 26 | PB7 ( OC0A/OC1C/PCINT7 ) | Digital pin 13 (PWM) |
| 27 | PH7 ( T4 ) | |
| 28 | PG3 ( TOSC2 ) | |
| 29 | PG4 ( TOSC1 ) | |
| 30 | RESET | RESET |
| 31 | VCC | VCC |
| 32 | GND | GND |
| 33 | XTAL2 | XTAL2 |
| 34 | XTAL1 | XTAL1 |
| 35 | PL0 ( ICP4 ) | Digital pin 49 |
| 36 | PL1 ( ICP5 ) | Digital pin 48 |
| 37 | PL2 ( T5 ) | Digital pin 47 |
| 38 | PL3 ( OC5A ) | Digital pin 46 (PWM) |
| 39 | PL4 ( OC5B ) | Digital pin 45 (PWM) |
| 40 | PL5 ( OC5C ) | Digital pin 44 (PWM) |
| 41 | PL6 | Digital pin 43 |
| 42 | PL7 | Digital pin 42 |
| 43 | PD0 ( SCL/INT0 ) | Digital pin 21 (SCL) |
| 44 | PD1 ( SDA/INT1 ) | Digital pin 20 (SDA) |
| 45 | PD2 ( RXDI/INT2 ) | Digital pin 19 (RX1) |
| 46 | PD3 ( TXD1/INT3 ) | Digital pin 18 (TX1) |

| | | |
|---|---|---|
| 47 | PD4 ( ICP1 ) | |
| 48 | PD5 ( XCK1 ) | |
| 49 | PD6 ( T1 ) | |
| 50 | PD7 ( T0 ) | Digital pin 38 |
| 51 | PG0 ( WR ) | Digital pin 41 |
| 52 | PG1 ( RD ) | Digital pin 40 |
| 53 | PC0 ( A8 ) | Digital pin 37 |
| 54 | PC1 ( A9 ) | Digital pin 36 |
| 55 | PC2 ( A10 ) | Digital pin 35 |
| 56 | PC3 ( A11 ) | Digital pin 34 |
| 57 | PC4 ( A12 ) | Digital pin 33 |
| 58 | PC5 ( A13 ) | Digital pin 32 |
| 59 | PC6 ( A14 ) | Digital pin 31 |
| 60 | PC7 ( A15 ) | Digital pin 30 |
| 61 | VCC | VCC |
| 62 | GND | GND |
| 63 | PJ0 ( RXD3/PCINT9 ) | Digital pin 15 (RX3) |
| 64 | PJ1 ( TXD3/PCINT10 ) | Digital pin 14 (TX3) |
| 65 | PJ2 ( XCK3/PCINT11 ) | |
| 66 | PJ3 ( PCINT12 ) | |
| 67 | PJ4 ( PCINT13 ) | |

| | | |
|---|---|---|
| 68 | PJ5 ( PCINT14 ) | |
| 69 | PJ6 ( PCINT 15 ) | |
| 70 | PG2 ( ALE ) | Digital pin 39 |
| 71 | PA7 ( AD7 ) | Digital pin 29 |
| 72 | PA6 ( AD6 ) | Digital pin 28 |
| 73 | PA5 ( AD5 ) | Digital pin 27 |
| 74 | PA4 ( AD4 ) | Digital pin 26 |
| 75 | PA3 ( AD3 ) | Digital pin 25 |
| 76 | PA2 ( AD2 ) | Digital pin 24 |
| 77 | PA1 ( AD1 ) | Digital pin 23 |
| 78 | PA0 ( AD0 ) | Digital pin 22 |
| 79 | PJ7 | |
| 80 | VCC | VCC |
| 81 | GND | GND |
| 82 | PK7 ( ADC15/PCINT23 ) | Analog pin 15 |
| 83 | PK6 ( ADC14/PCINT22 ) | Analog pin 14 |
| 84 | PK5 ( ADC13/PCINT21 ) | Analog pin 13 |
| 85 | PK4 ( ADC12/PCINT20 ) | Analog pin 12 |
| 86 | PK3 ( ADC11/PCINT19 ) | Analog pin 11 |
| 87 | PK2 ( ADC10/PCINT18 ) | Analog pin 10 |
| 88 | PK1 ( ADC9/PCINT17 ) | Analog pin 9 |

| | | |
|---|---|---|
| 89 | PK0 ( ADC8/PCINT16 ) | Analog pin 8 |
| 90 | PF7 ( ADC7 ) | Analog pin 7 |
| 91 | PF6 ( ADC6 ) | Analog pin 6 |
| 92 | PF5 ( ADC5/TMS ) | Analog pin 5 |
| 93 | PF4 ( ADC4/TMK ) | Analog pin 4 |
| 94 | PF3 ( ADC3 ) | Analog pin 3 |
| 95 | PF2 ( ADC2 ) | Analog pin 2 |
| 96 | PF1 ( ADC1 ) | Analog pin 1 |
| 97 | PF0 ( ADC0 ) | Analog pin 0 |
| 98 | AREF | Analog Reference |
| 99 | GND | GND |
| 100 | AVCC | VCC |

**Table 4.2 Arduino Mega 2560 PIN mapping table**

Each of the 54 digital pins on the Mega can be used as an input or output, using **pinMode()**, **digitalWrite()**, and **digitalRead()** functions. They operate at 5 volts. Each pin can provide or receive 20 Ma as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50 k ohm. A maximum of 40Ma is the value that must not be exceeded to avoid permanent damage to the microcontroller.

**APPLICATIONS:**

- Arduboy, a handheld game console based on Arduino.
- Arduinome, a MIDI controller device that mimics the Monome.
- Ardupilot, drone software and hardware.
- ArduSat, a cubesat based on Arduino.
- C-STEM Studio, a platform for hands-on integrated learning of computing, science, technology, engineering, and mathematics (C-STEM) with robotics.
- Data loggers for scientific research.
- OBDuino, a trip computer that uses the on-board diagnostics interface found in most modern cars.

### 4.1.2 POWER SUPPLY

This section describes how to generate +5V DC power supply

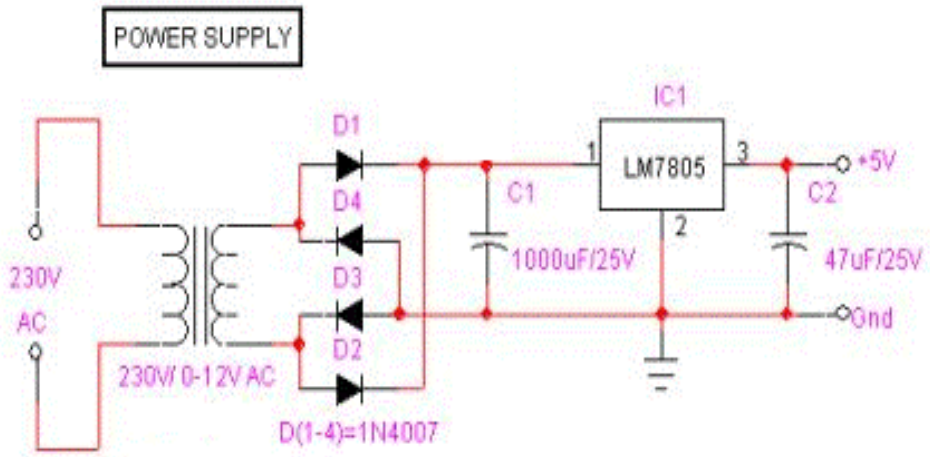



**FIG 4.2 Power Supply**

The power supply section is the important one. It should deliver constant output regulated power supply for successful working of the project. A 0-12V/1 Ma transformer is used for this purpose. The primary of this transformer is connected in to main supply through on/off switch& fuse for protecting from overload and short circuit protection. The secondary is connected to the diodes to

convert 12V AC to 12V DC voltage. And filtered by the capacitors, which is further regulated to +5v, by using IC 7805.

### 4.1.3 LCD

LCD screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

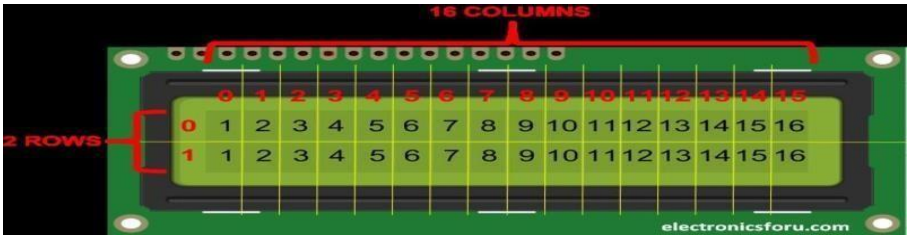



**FIG 4.3 16X2 LCD Diagram**

### 4.1.4 ULTRASONICSENSOR


**HC-SR04**

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. It comes complete with ultrasonic transmitter and receiver modules.as the name indicates measure distance by using ultrasonic waves .the sensor head emits ultrasonic wave and receives the

wave reflected back from the target .Ultrasonic measures the distance through the target by measuring time between emission and reception

**Electric Parameter**

| | |
|---|---|
| Working Voltage | DC 5 V |
| Working Current | 15Ma |
| Working Frequency | 40Hz |
| Max Range | 4m |
| Min Range | 2 cm |
| MeasuringAngle | 15 degree |
| Trigger Input Signal | 10Us TTL pulse |
| Echo Output Signal | Input TTL lever signal and the range in proportion |
| Dimension | 45*20*15mm |
| Main parts | Transmitter &receiver |
| Technology used | Non-contact technology |
| Resolution | 3mm |

**Table 4.3 Electric Parameters**

### 4.1.5 INTERNET OF THINGS

The **internet of things** (**IoT**) is the network of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities.

### 4.1.6 ESP-12E BASED NODEMCU

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

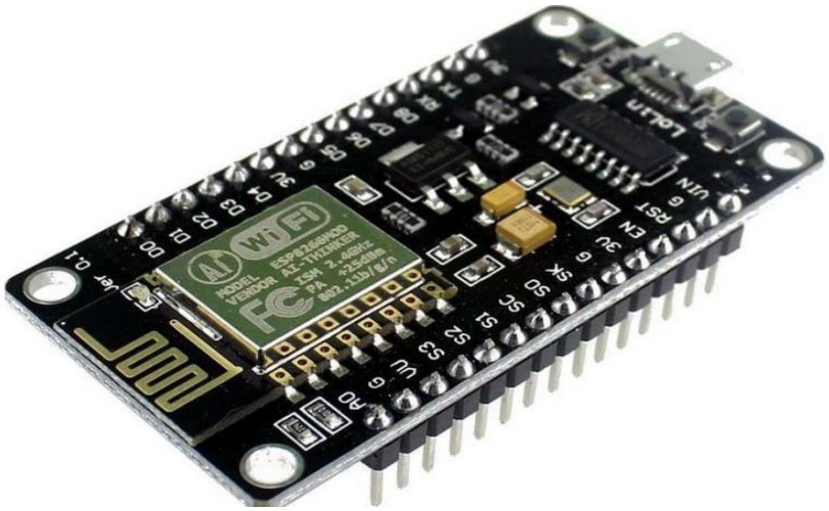
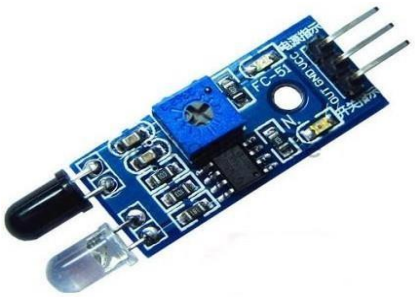


**FIG 4.4 ESP-12E Based NODEMCU**

### 4.1.7 IR SENSOR

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes, that can be detected by an infrared

sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, The resistances and these output voltages, change in proportion to the magnitude of the IR light received.




### 4.1.8 GAS SENSOR

The sensors contain two in contact with an electrolyte. The electrodes are typically fabricated by fixing a high surface area precious metal on to the porous hydrophobic membrane. The working electrode contacts both the electrolyte and the ambient air to be monitored usually via a porous membrane. The electrolyte most commonly used is a mineral acid the electrodes and housing are usually in a plastic housing which contains a gas entry hole for the gas and electrical contacts.

### 4.1.9 DHT 11 HUMIDITY & TEMPERATURE SENSOR

`DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

### 4.1.10 FLOW SENSOR

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse signal. The provided sensors are well-manufactured from the topmost grade components and the latest technology under the supervision of our dexterous professionals.

### 4.1.11 BUZZER

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

## 4.1.12 GLOBAL POSITIONING SYSTEM

GPS or Global Positioning System is a satellite navigation system that furnishes location and time information in all climate conditions to the user. GPS is used for navigation in planes, ships, cars and trucks also. The system gives critical abilities to military and civilian users around the globe. GPS provides continuous real time, 3-dimensional positioning, navigation and timing worldwide.

The Global Positioning System (GPS) is a satellite-based navigation system made up of at least 24 satellites. GPS works in any weather conditions, anywhere in the world, 24 hours a day, with no subscription fees or setup charges. The U.S. Department of Defense (USDOD) originally put the satellites into orbit for military use, but they were made available for civilian use in the 1980s.

## APPLICATION OF GPS:

GLOBAL POSITIONING SYSTEM (GPS) Application is considered a dual-use technology, meaning it has significant military and civilian applications

## 4.1.13 GSM

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. The working of GSM modem is based on commands, the commands

always start with AT (which means ATtention) and finish with a <CR> character.

## 4.1.14 ZIGBEE PROTOCOL

## NRF24L01:

The nRF24L01+ is a single chip 2.4GHz transceiver with an embedded baseband protocol engine (Enhanced ShockBurst™), suitable for ultra-low power wireless applications. The nRF24L01+ is designed for operation in the world wide ISM frequency band at 2.400 - 2.4835GHz.

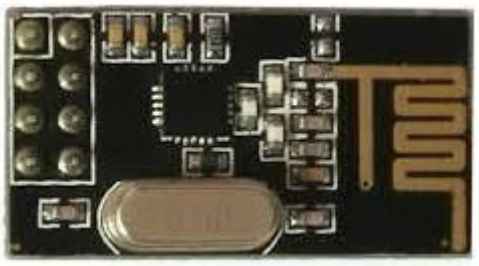


**FIG 4.5** NRF24L01

## 4.2 SOFTWARE REQUIREMENTS

### 4.2.1 EMBEDDED C

Embedded C is most popular programming language in software field for developing electronic gadgets. Each processor used in electronic system is associated with embedded software.

Embedded C programming plays a key role in performing specific function by the processor. In day-to-day life we used many electronic devices such as mobile phone, washing machine, digital camera, etc.

Let's see the block diagram representation of embedded system programming:

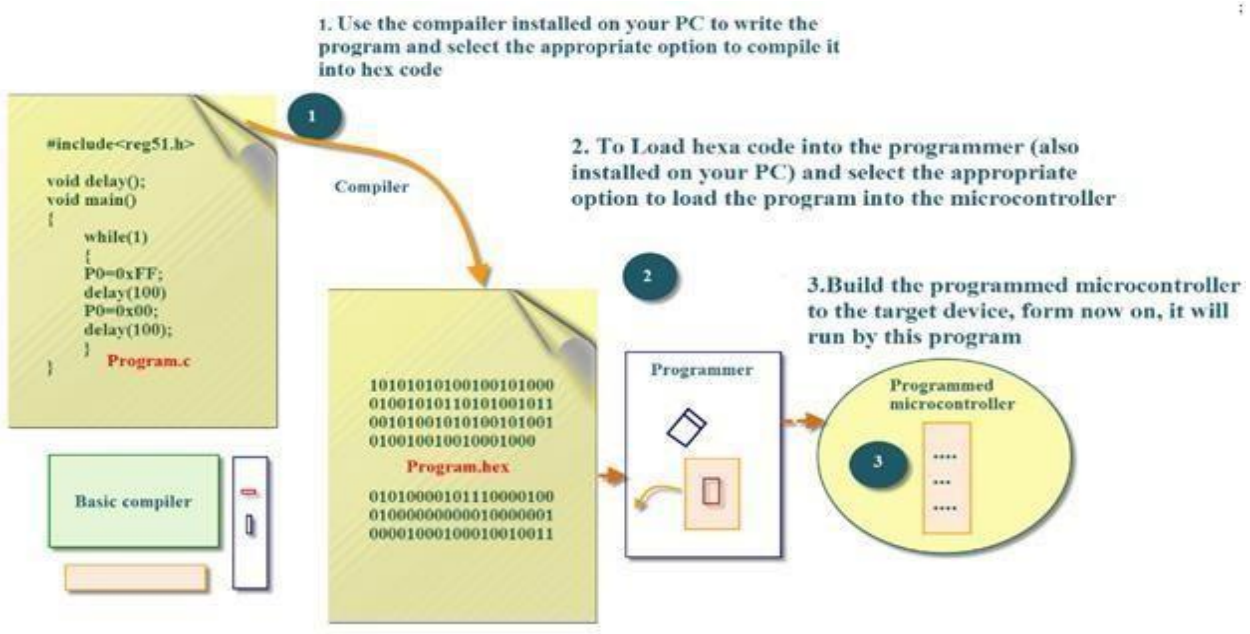



**FIG 4.6 Block Diagram Representation Of Embedded System Programming**

The Embedded C code written in above block diagram is used for blinking the LED connected with Port0 of microcontroller.

### 4.2.2 EMBEDDED SYSTEM PROGRAMMING

Function is a collection of statements that is used for performing a specific task and a collection of one or more functions is called a programming language. Every language is consisting of basic elements and grammatical rules. The C language programming is designed for function with variables, character set, data types, keywords, expression and so on are used for writing a C program.

The extension in C language is known as embedded C programming language. As compared to above the embedded programming in C is also have some additional features like data types, keywords and header file etc is represented by #include<**microcontroller** name.h>.

### 4.2.3 EMBEDDED SYSTEM

Let's see the block diagram shows the basic structure of an embedded system.

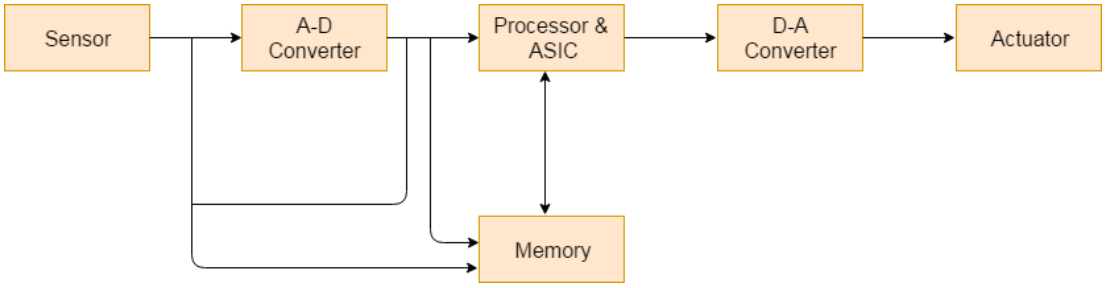



**FIG 4.7 The Basic Structure Of An Embedded System**

- **Sensor**: Sensor used for sensing the change in environment condition and it generate the electric signal on the basis of change in environment condition. Therefore it is also called as transducers for providing electric input signal on the basis of change in environment condition.
- **A-D Converter**: An analog-to-digital converter is a device that converts analog electric input signal into its equivalent digital signal for further processing in an embedded system.

- **Processor & ASICs**: Processor used for processing the signal and data to execute desired set of instructions with high-speed of operation. Application specific integrated circuit (ASIC) is an integrated circuit designed to perform task specific operation inside an embedded system.
- **D-A Converter**: A digital-to-analog converter is a device that converts digital electric input signal into its equivalent analog signal for further processing in an embedded system.
- **Actuators**: Actuators is a comparator used for comparing the analog input signal level to desired output signal level for providing the error free output from the system.

### 4.2.4 ARDUINO SOFTWARE IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus.

| | |
|---|---|
|  | ***Verify***<br>Checks your code for errors compiling it. |
|  | ***Upload***<br>Compiles your code and uploads it to the configured board. See uploading below for details.<br><br>Note: If you are using an external programmer with your board, you can hold down the "shift" key on your computer when using this icon. The text will change to "Upload using Programmer" |
|  | ***New***<br>Creates a new sketch. |
|  | ***Open*** |

| | |
|---|---|
| | Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content.<br><br>Note: due to a bug in Java, this menu doesn't scroll; if you need to open a sketch late in the list, use the **File \| Sketchbook** menu instead. |
|  | ***Save***<br>Saves your sketch. |
|  | ***Serial***<br>Opens the serial monitor. |

# CHAPTER 5

# SYSTEM DESIGN

## 5.1 DATAFLOW DIAGRAM

### 5.1.1 LEVEL-0 DFD DIAGRAM

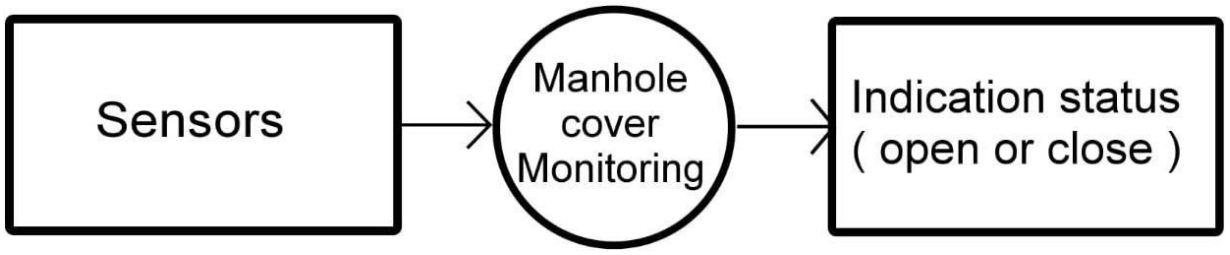



**FIG 5.1 Level-0 DFD diagram**

It is also known as a context diagram. It shows the entire abstraction of the process. Here ,the process of manhole monitoring is done with the help of sensors based on the concept of IoT which indicates whether the manhole is open or close.

## 5.1.2 LEVEL-1 DFD DIAGRAM

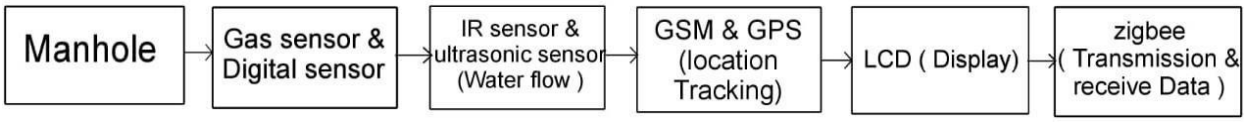



**FIG 5.2 Level-1 DFD diagram**

In 1-level DFD, we highlight the main functions of the system and breakdown the high-level process of 0-level DFD into subprocesses. Here, we use various types of sensors to measure the temperature, gas and water flow. Also we use LCD & zigbee for display and data transmission purposes.

## 5.1.3 LEVEL-2 DFD DIAGRAM

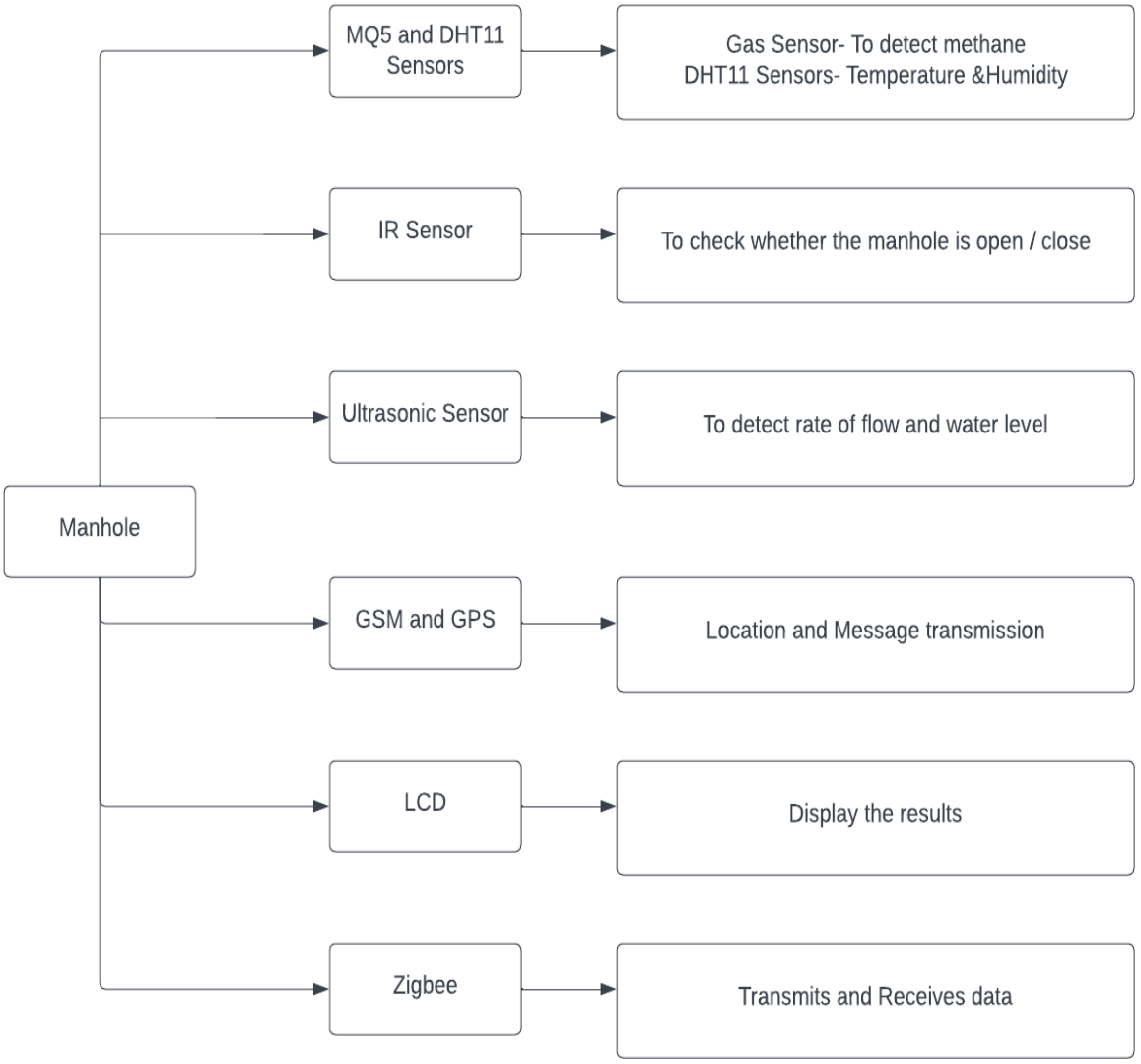



**FIG 5.3 Level-2 DFD diagram**

2-level DFD goes one step deeper into parts of 1-level DFD. It can be used to plan or record the specific detail about the system's functioning.

## 5.2 UML DIAGRAMS

### 5.2.1 USECASE DIAGRAMS

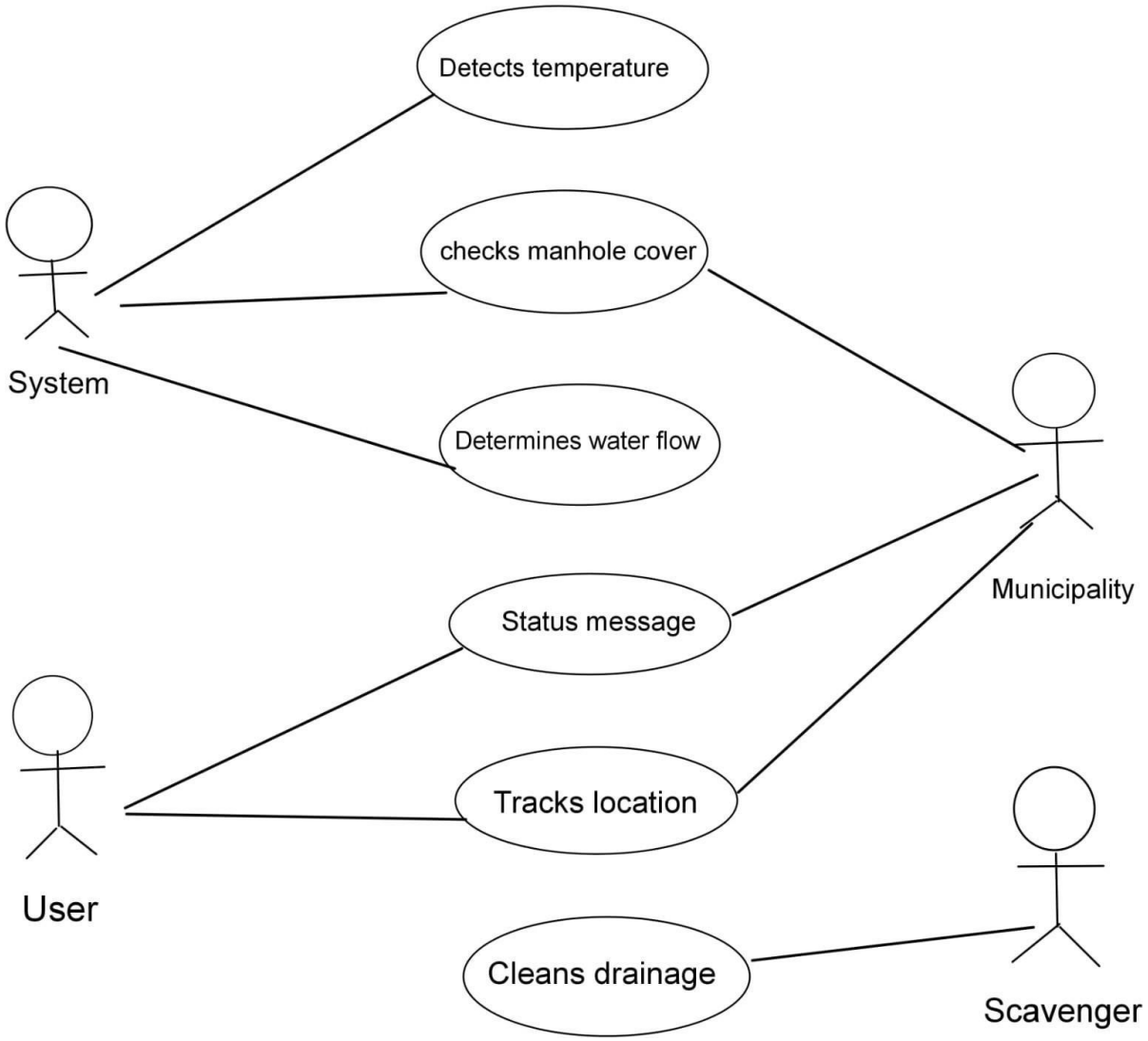



**FIG 5.4 Usecase diagram**

The main purpose of a use case diagram is to portray the dynamic aspect of a system. It accumulates the system's requirement, which includes both internal as well as external influences. It invokes persons, use cases, and several things that invoke the actors and elements accountable for the implementation of use case diagrams. It represents how an entity from the external environment can interact with a part of the system.

## 5.3 ARCHITECTURE DIAGRAM

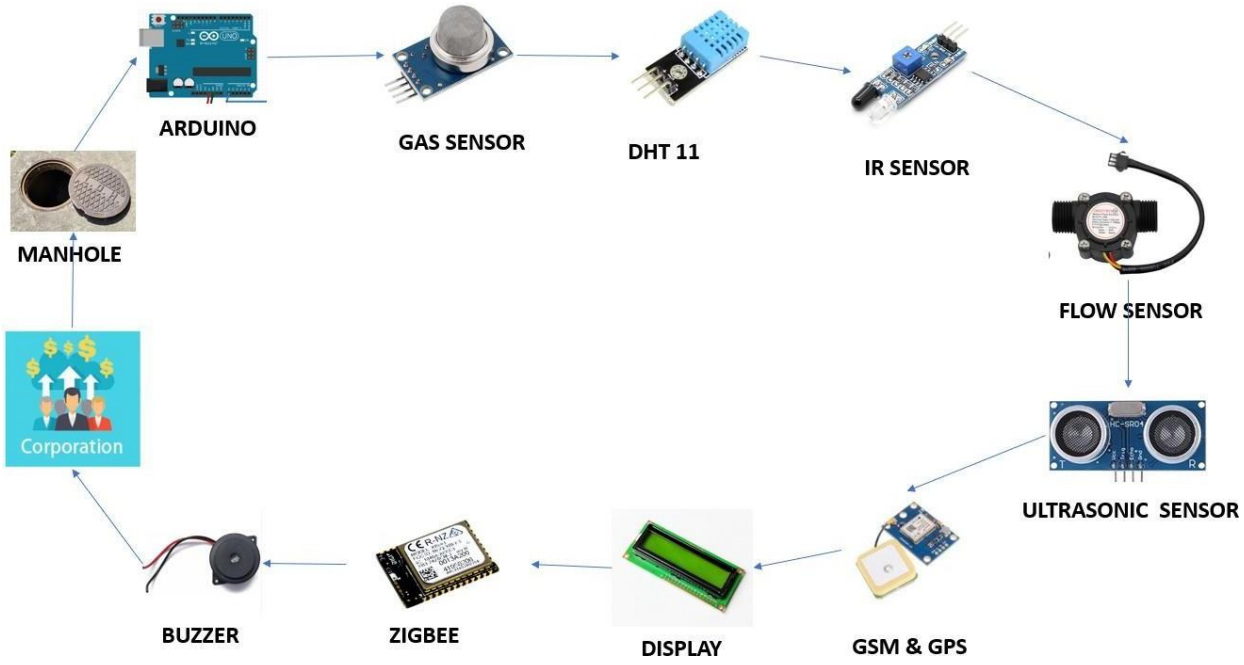



**FIG 5.5 Architecture diagram**

The above architecture diagram shows the work flow of the project. The devices such as Arduino, gas sensor, DHT11, IR sensor, flow sensor, ultrasonic sensor, GSM & GPS has been attached to the manhole cover to sense the requirements and to collect data. The data collected has sent to the corporation and a buzzer alert has been made to alert the corporation.

# CHAPTER 6

# SYSTEM ARCHITECTURE

## 6.1 BLOCK DIAGRAM

### TRANSMITTER: DRAINAGE SECTION

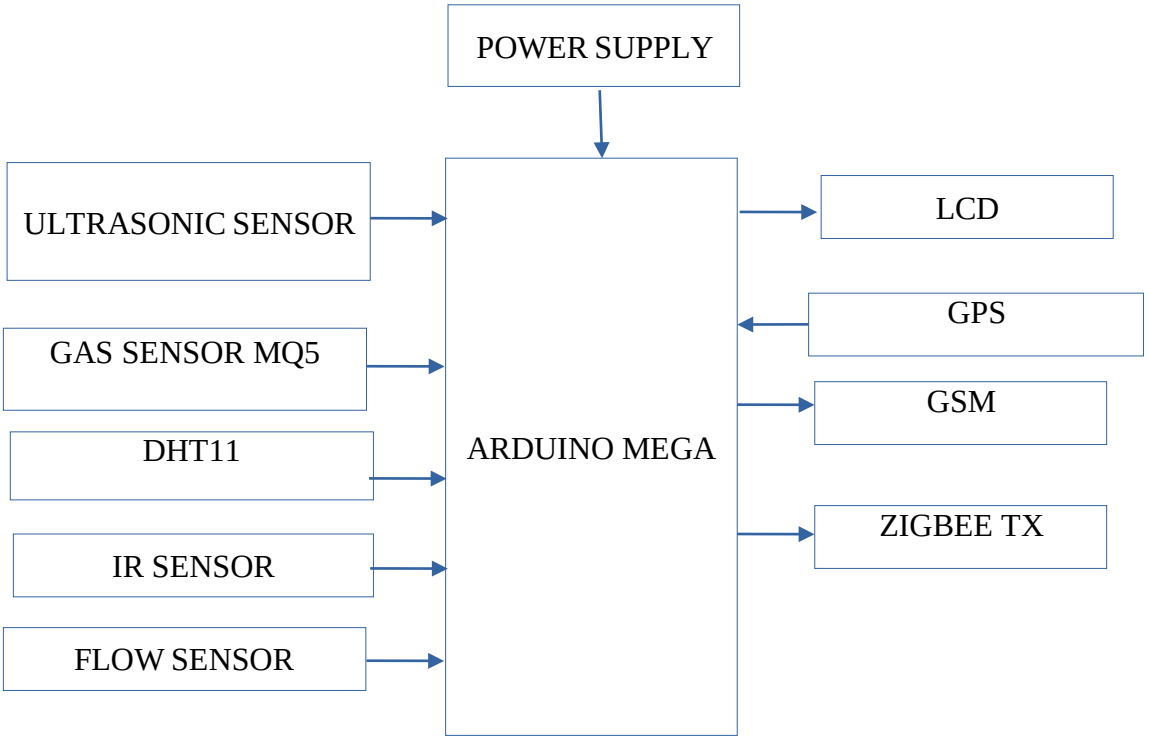



**FIG 6.1 Transmitter: Drainage Section**

## RECEIVER SECTION: MASTER (CONTROL ROOM)

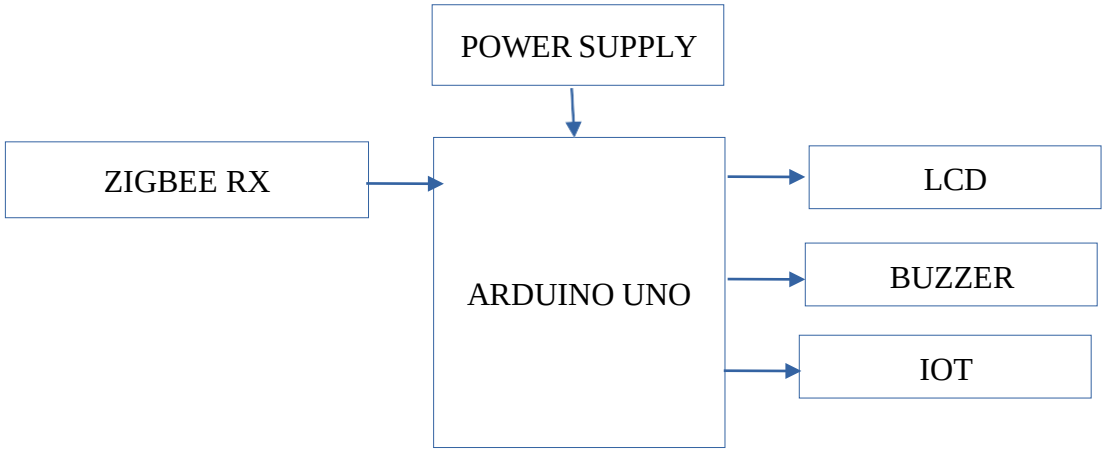



**FIG 6.2 Receiver Section: Master (Control Room)**

## 6.2 WORKING PRINCIPLE

In this proposed method, ARDUINO MEGA & ARDUINO UNO microcontroller is used to interface with the sensors and to the communication devices. The MQ 5 – The MQ5 Gas Sensor module is useful for methane gas leakage detecting. The dht11 –low-cost digital sensor for sensing temperature and humidity. An infrared (IR) sensor is a device to confirm whether the cover is open or close. Flow sensors are mainly used to measure the quantity or the rate of flow of liquids. We are using it to detect overflow the ultrasonic sensor provides the water levels of the sewage tanks. GSM and GPS used to send location with SMS, particular area where problem is occurred. The LCD is used to display the updated value from the sensors. The Zigbee used for to transmit and receive the data in the sensor.

## 6.3 MODULE DESCRIPTION

### 6.3.1. TRANSMISSION SIDE WORKING

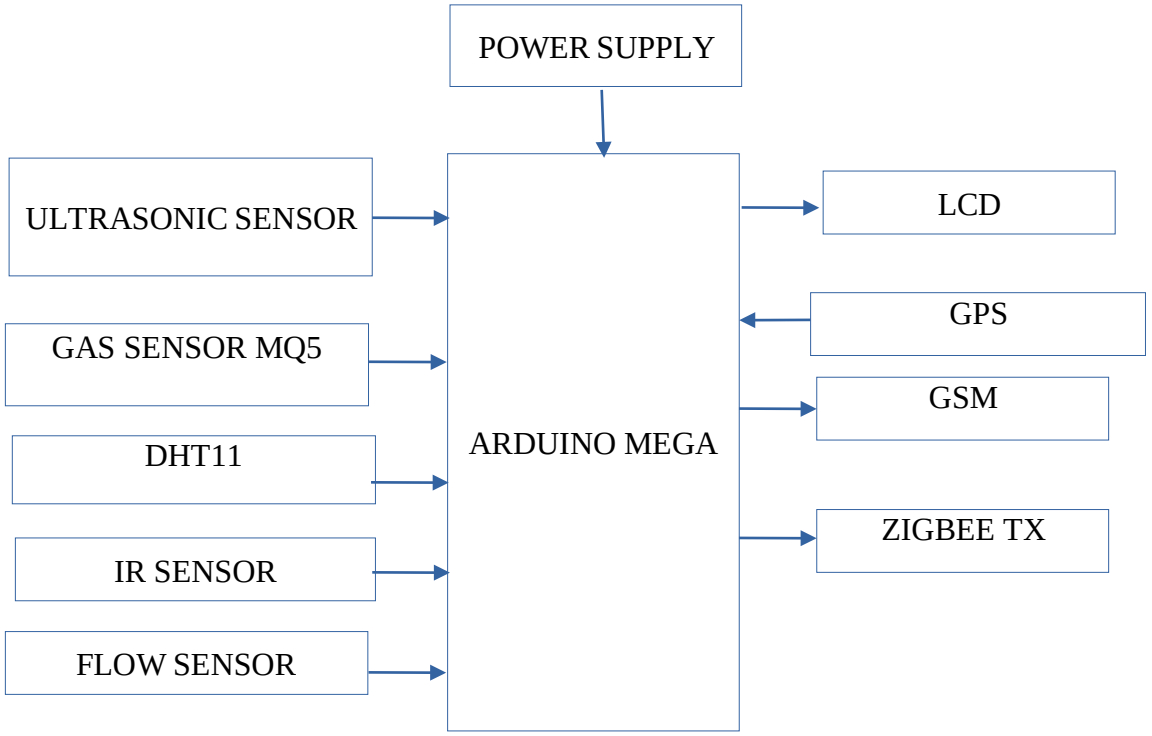



**FIG 6.3 Transmission Side Working**

In this transmitter side ARDUINO MEGA microcontroller is used to interface with the sensors and to the communication devices. The MQ 5 – The MQ5 Gas Sensor module is useful for methane gas leakage detecting. The dht11 – low-cost digital sensor for sensing temperature and humidity. An infrared (IR) sensor is a device to confirm whether the cover is open or close. Flow sensors are mainly used to measure the quantity or the rate of flow of liquids. We are using it to detect overflow the ultrasonic sensor provides the water levels of the sewage tanks. The GPS and GSM is used for track the location and send SMS where problem is occurred and ZIGBEE transmitter is used to transmit signal to the receiver side.

### 6.3.2 RECEIVER SIDE WORKING

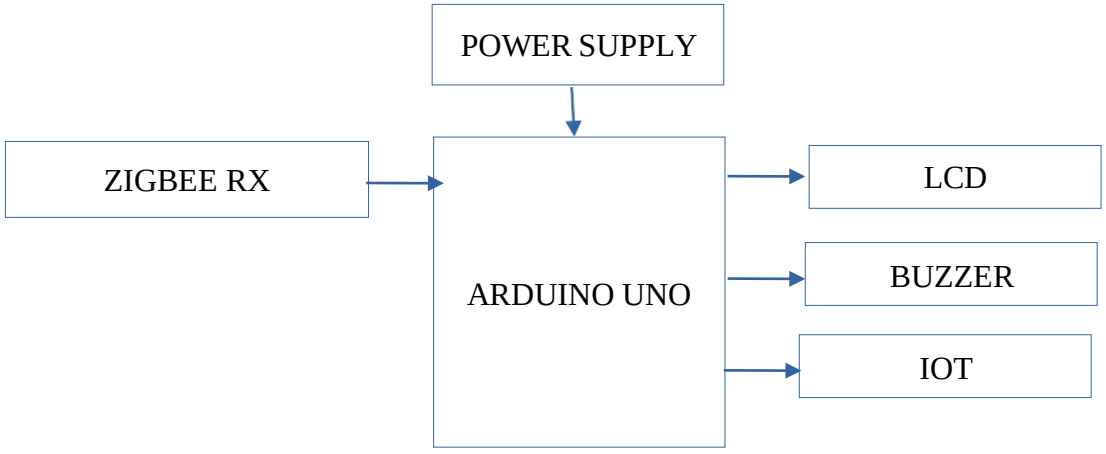



**FIG 6.4 Receiver Side Working**

In receiving side when data receive from transmitting side the receive side ZIGBEE get that data and transmit to Arduino. If any problem occurred in drainage buzzer gives the alert to receiver LCD also display the problem condition. We store and see the data in cloud by using IOT module.

# CHAPTER 7

# SYSTEM IMLEMENTATION

## 7.1 TRANSMITTER SIDE CODING:

```
#include "lcd.h"

#include "gps.h"

#include "gsm.h"

#include <ultrasonic.h>

#include<SoftwareSerial.h>

SoftwareSerial Serial(6, 7);

#include"dht11.h"

DHT dht;

bool leakage_flag = false;

int sensorInterrupt = 0; // interrupt 0

int sensorPin       = 2; //Digital Pin 2

unsigned int SetPoint = 400; //400 milileter

/*The hall-effect flow sensor outputs pulses per second per litre/minute of flow.*/

float calibrationFactor = 90; //You can change according to your datasheet

volatile byte pulseCount = 0;

float flowRate = 0.0;

unsigned int flowMilliLitres = 0;
```

```
unsigned long totalMilliLitres = 0;
unsigned long oldTime = 0;
ULTRASONIC U1;
#define D_temp A0
#define ir_pin 3
#define gas_pin 4
bool refill_flag = false;
bool gas_flag = false;
void ultrasonic(void);
void setup()
{
  Serial.begin(9600);
  Serial.begin(9600);
  lcd.begin(16, 2);
  U1.begin(A1, A2);
  pinMode(sensorPin, INPUT);
  digitalWrite(sensorPin, HIGH);
  pinMode(ir_pin, INPUT);
  dht.dht_read(D_temp);
  lcd.clear();
```

```
  lcd.setCursor(1, 0);
  lcd.print("DRAINAGE_BLOCK");
  lcd.setCursor(3, 1);
  lcd.print("MONITORING");
  delay(2000);
  lcd.clear();
  attachInterrupt(sensorInterrupt, pulseCounter, FALLING); //you can use Rising or
Falling
  //gps();
}
void loop()
{
  if ((millis() - oldTime) > 1000)    // Only process counters once per second
  {
    temperature();
    lcd_update();
    ultrasonic();
    lcd.setCursor(9, 0);
    lcd.print("D:");
    lcd.setCursor(11, 0);
    int pin = digitalRead(ir_pin);
```

```
lcd.print(pin);
if (pin == 0)
{
  Serial.print('D');
  gsm("1234567890", "DRAINAGE OPEN");
}
lcd.setCursor(13, 0);
lcd.print("G:");
lcd.setCursor(15, 0);
lcd.print(digitalRead(gas_pin));
lcd.setCursor(0, 1);
if (digitalRead(gas_pin) == 0)
{
  Serial.print('B');
  gsm("1234567890", "METHANE DETECTED");
}
lcd.print("F:");
detachInterrupt(sensorInterrupt);
```

//We also apply the calibrationFactor to scale the output based on the number of pulses per second per units of measure (litres/minute in this case) coming from the sensor.

```
    flowRate = ((1000.0 / (millis() - oldTime)) * pulseCount) / calibrationFactor;
    oldTime = millis();
    flowMilliLitres = (flowRate / 60) * 1000;
    totalMilliLitres += flowMilliLitres;
    unsigned int frac;
    lcd.setCursor(2, 1);
    lcd.print(flowMilliLitres, DEC);
    if (flowMilliLitres > 5)
    {
      Serial.print('E');
      lcd.setCursor(4, 1);
      lcd.print("flow blocked");
      gsm("1234567890", "FLOW BLOCKED ");
    }
  }
  pulseCount = 0;
  attachInterrupt(sensorInterrupt, pulseCounter, FALLING);
}
//Insterrupt Service Routine
```

```
void pulseCounter()
{
  // Increment the pulse counter
  pulseCount++;
}
void temperature(void)
{
  dht.dht_read(D_temp);
  if (dht.temperature > 33)
  {
    Serial.print('A');
    gsm("1234567890", "HIGH TEMPERATURE");
  }
}
void lcd_update(void)
{
  lcd.setCursor(0, 0);
  lcd.print("T:");
  lcd.setCursor(2, 0);
  lcd.print(dht.temperature);
```

```
  delay(1000);
}
void ultrasonic(void)
{
  lcd.setCursor(5, 0);
  lcd.print("U:");
  int cm = U1.ultra();
  if (cm < 10)
  {
    Serial.print('C');
    lcd.print("F");
    gsm("1234567890", "DRAINAGE FULL");
  }
  else if (cm > 10 && cm < 30)
  {
    lcd.print("M");
  }
  else if (cm > 30)
  {
    lcd.print("E"); } }
```

## 7.2 RECIEVER SIDE CODING:

```
#include<SoftwareSerial.h>
SoftwareSerial Serial(2, 3); //RX TX
void iot_send(String text);
char inchar;
# define D_buzzer 7
void setup() {
Serial.begin(9600);
Serial.begin(9600);
  digitalWrite(D_buzzer, LOW);
  pinMode(D_buzzer, OUTPUT);
}
void loop() {
  while (Serial.available() > 0)
  {
    inchar = (char)Serial.read();
    Serial.println(inchar);
    switch (inchar)
    {
      case'A':
```

```
  digitalWrite(D_buzzer, !digitalRead(D_buzzer));
  digitalWrite(D_buzzer, HIGH);
  delay(2000);
  digitalWrite(D_buzzer, LOW);
  iot_send("*HIGH TEMPERATURE#");
  break;
case'B':
  digitalWrite(D_buzzer, !digitalRead(D_buzzer));
  digitalWrite(D_buzzer, HIGH);
  delay(2000);
  digitalWrite(D_buzzer, LOW);
  iot_send("*METHANE DETECTED#");
  break;
case'C':
  digitalWrite(D_buzzer, !digitalRead(D_buzzer));
  digitalWrite(D_buzzer, HIGH);
  delay(2000);
  digitalWrite(D_buzzer, LOW);
  iot_send("*DRAINAGE FULL#");
  break;
```

```
      case'D':
        digitalWrite(D_buzzer, !digitalRead(D_buzzer));
        digitalWrite(D_buzzer, HIGH);
        delay(2000);
        digitalWrite(D_buzzer, LOW);
        iot_send("*DRAINAGE OPEN#");
        break;
      case'E':
        digitalWrite(D_buzzer, HIGH);
        delay(2000);
        digitalWrite(D_buzzer, LOW);
        iot_send("*DRAINAGE BLOCKED#");
        break;}}
  delay(1000); }
void iot_send(String text){
  for (int i = 0; i < text.length(); i++){
    Serial.write(text[i]);
  }
  delay(3000);
}
```

# CHAPTER 8

# CONCLUSION

## 8.1 CONCLUSION

This article presented the development and validation of an IoT system to monitor the trash level and geolocation of trash bins efficiently. All aspects of an IoT system including the design of a TBLMU, long-range data transmission, long-time data storage, and visualization of the trash bin level were developed. Finally, the developed system was validated by evaluating the accuracy of the sensor employed, maximum transmission distance between a TBLMU and a gateway, life expectancy of a TBLMU, battery charging time, and cost. Based on the results obtained, the proposed IoT system was suitable for the municipality or municipal solid waste management companies to manage the MSW efficiently.

## 8.2 APPLICATIONS

This method is used in drainage monitoring system to collect the information from all node to the master device using narrow band internet of things.

## 8.3 FUTURE ENHANCEMENT

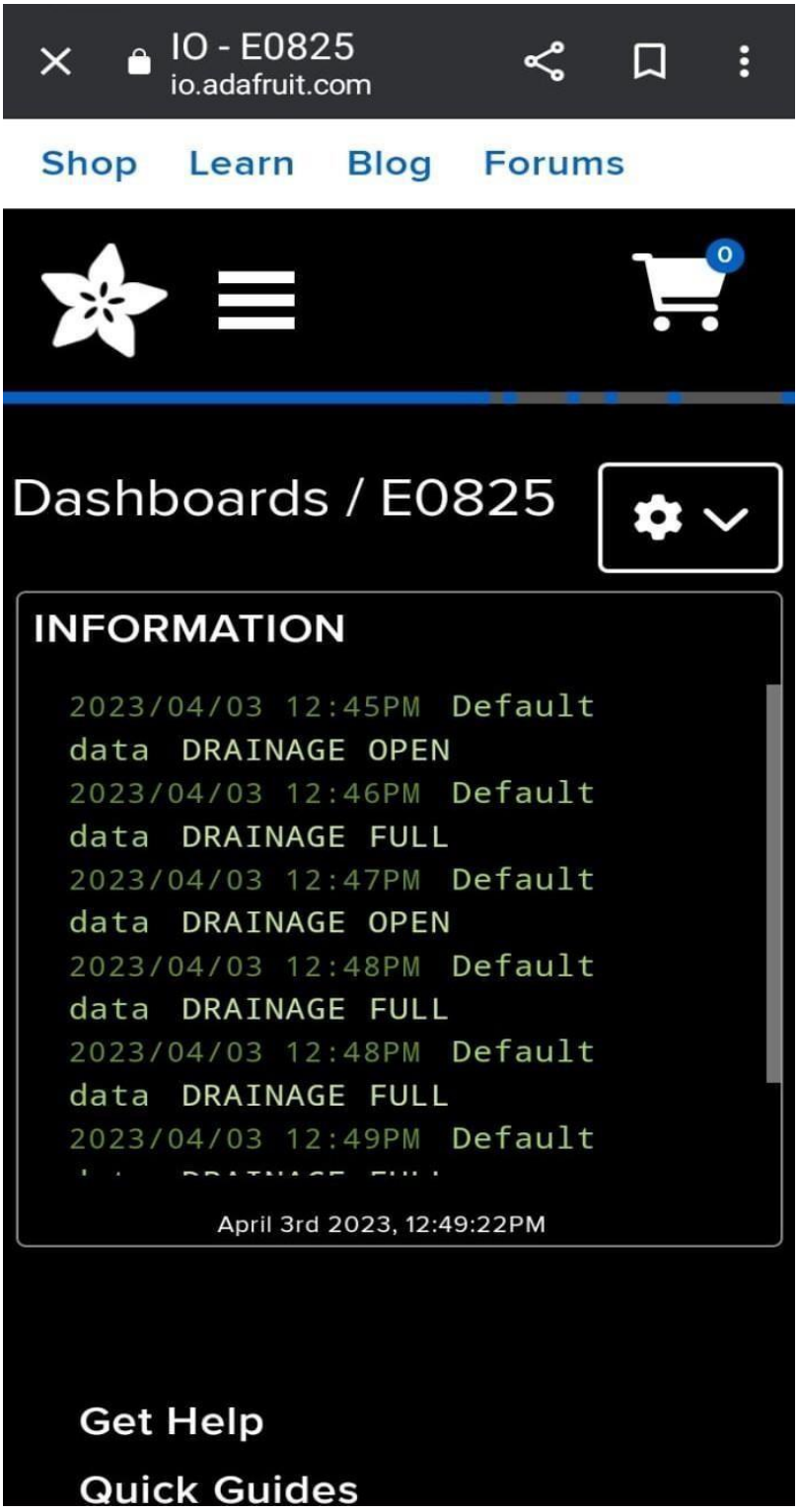
In future we can include AI in drainage places in that system and explore more things in future.

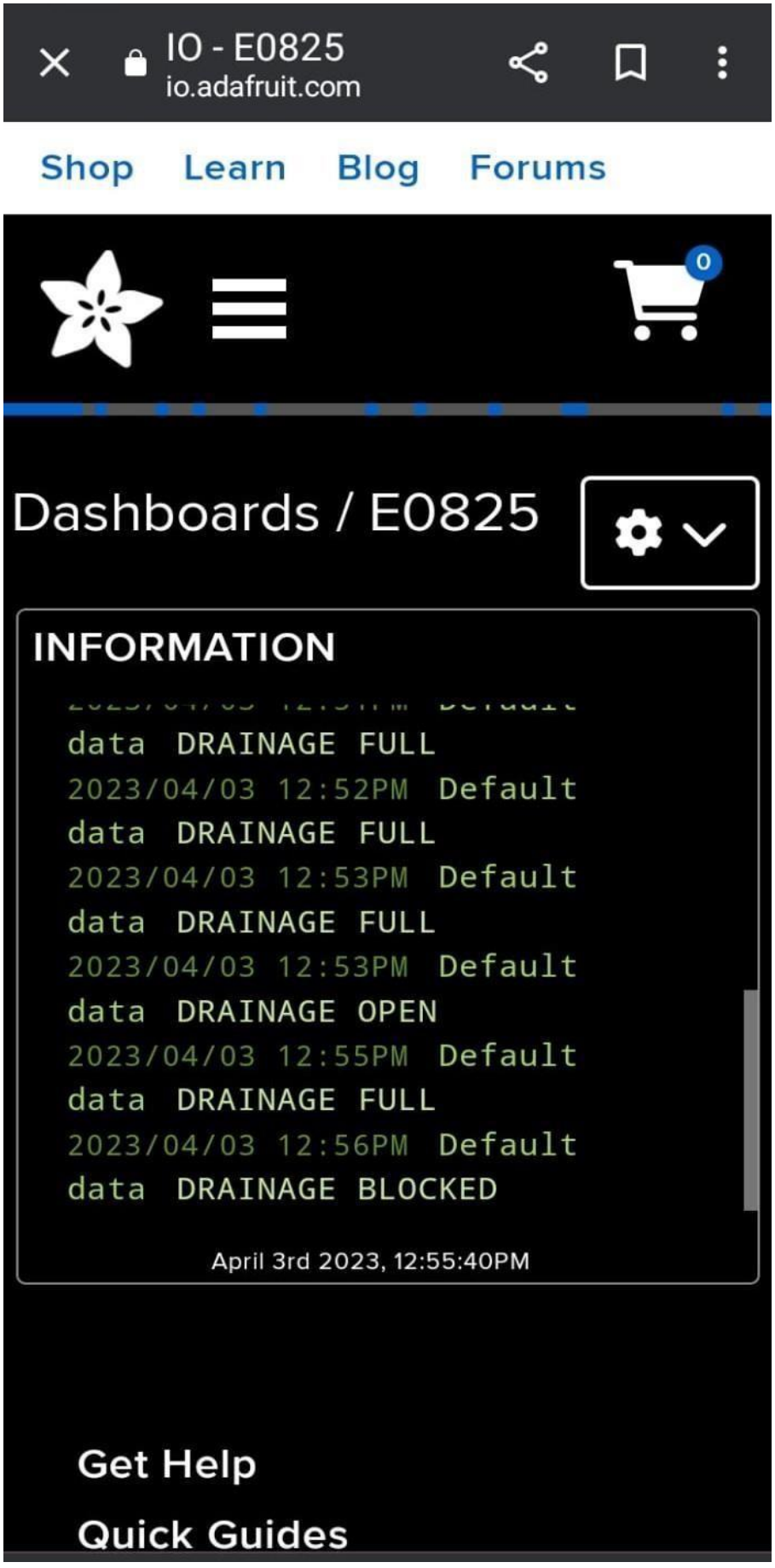
## 8.4 ADVANTAGES

- Reduce the human deaths in the drainage system.
- The monitoring system easy to handle.

# APPENDICES

## A.1 SAMPLE SCREENS

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# REFERENCES

[1] K. Ravi Kumar, K. Vijaya Lakshmi, G. Rohin Kumar, G. Jagan Mohan and P. Devi Vara Prasad, "Smart Manhole Monitoring System," 2023 5th International Conference on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, 2023, pp. 475-481, doi: 10.1109/ICSSIT55814.2023.10060880.

[2] V. S. A, S. R, V. S and A. K, "Development of Manhole Cover Detection and Continuous Monitoring of Hazardous Gases using WSN and IoT," 2022 6th International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2022, pp. 202-206, doi: 10.1109/ICCMC53470.2022.9754094.

[3]J. Zhang and X. Zeng, "Design of Intelligent Manhole Cover Monitoring System Based on Narrow Band Internet of Things," 2022 7th International Conference on Intelligent Computing and Signal Processing (ICSP), Xi'an, China, 2022, pp. 1354-1357, doi: 10.1109/ICSP54964.2022.9778462.

[4] Y. Guan and Q. Hou, "Design of Intelligent Well Cover Monitoring System Based on Lora," 2021 5th International Conference on Communication and Information Systems (ICCIS), Chongqing, China, 2021, pp. 119-123, doi: 10.1109/ICCIS53528.2021.9645965.

[5] Y. Xie, H. Wang, J. Liu, R. Zhang and Y. Guo, "On A Working Monitoring System of Manhole Wells Based on Technology of Internet of Things," 2021 6th International Conference on Intelligent Computing and Signal Processing (ICSP), Xi'an, China, 2021, pp. 1452-1455, doi: 10.1109/ICSP51882.2021.9408734.

[6] M. L. Brusseau and J. Artiola, “Chemical contaminants,” in Environmental and Pollution Science. Amsterdam, The Netherlands: Elsevier, 2019, pp. 175–190.

[7] X. Guo, B. Liu and L. Wang, "Design and Implementation of Intelligent Manhole Cover Monitoring System Based on NB-IoT," 2019 International Conference on Robots & Intelligent System (ICRIS), Haikou, China, 2019, pp. 207-210, doi: 10.1109/ICRIS.2019.00061.

[8] L. Lei, Z. H. Sheng and L. Xuan, "Development of low power consumption manhole cover monitoring device using LoRa," 2019 IEEE International Instrumentation and Measurement Technology Conference (I2MTC), Auckland, New Zealand, 2019, pp. 1-6, doi: 10.1109/I2MTC.2019.8826885.

[9] K. T. Wegedie, “Households solid waste generation and management behavior in case of Bahir Dar City, Amhara National Regional State, Ethiopia,” Cogent Environ. Sci., vol. 4, no. 1, 2018, Art. no. 1471025.

[10] S. R. J. Ramson, D. Bhavanam, S. Draksharam, R. Kumar, D. J. Moni, and A. A. Kirubaraj, “Radio frequency identification and sensor networks based bin level monitoring systems—A review,” in Proc. 4th Int. Conf. Devices, Circuits Syst.,2018, pp. 17–20

[11] N. Nataraja, R. Amruthavarshini, N. L. Chaitra, K. Jyothi, N. Krupaa and S. S. M. Saqquaf, "Secure Manhole Monitoring System Employing Sensors and GSM Techniques," 2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT), Bangalore, India, 2018, pp. 2078-2082, doi: 10.1109/RTEICT42901.2018.9012245.

[12] Z. Chongbiao, Q. Mingbo, C. Long, G. Qi, S. Jiajia and Z. Jinbo, "Research on an Intelligent Monitoring Device for Cable Manhole Covers," 2018 2nd IEEE Advanced Information Management,Communicates,Electronic and Automation Control Conference (IMCEC), Xi'an, China, 2018, pp. 103-106, doi: 10.1109/IMCEC.2018.8469316.

[13] B. Ke and D. Mao, "Design of manhole covers missing alarm monitoring and management system," 2017 IEEE 2nd Information Technology, Networking,

Electronic and Automation Control Conference (ITNEC), Chengdu, China, 2017, pp. 682-686, doi: 10.1109/ITNEC.2017.8284819.

[14] M. A. Al Mamun, M. A. Hannan, A. Hussain, and H. Basri, “Integrated sensing systems and algorithms for solid waste bin state management automation,” IEEE Sensors J., vol. 15, no. 1, pp. 561–567, Jan. 2015.

[15] M. S. Islam, M. Hannan, H. Basri, A. Hussain, and M. Arebey, “Solid waste bin detection and classification using dynamic time warping and MLP classifier,” aste Manage., vol.34, no. 2, pp. 281–290, 2014.

[16] Y. Liu, M. Du, C. Jing and Y. Bai, "Design of supervision and management system for ownerless manhole covers based on RFID," 2013 21st International Conference on Geoinformatics, Kaifeng, China, 2013, pp. 1-4, doi: 10.1109/Geoinformatics.2013.6626149.

[17] M. Hannan, M. Arebey, R. A. Begum, and H. Basri, “An automated solid waste bin level detection system using a gray level aura matrix,” Waste Manage., vol. 32, no. 12, pp. 2229–2238, 2012.

[18] D. Hoornweg and B. Perinaz, “What a waste: A global review of solid waste management,” Urban Develop. Ser., Knowl. Papers, vol. 15, pp. 87–88, Jan. 2012.

[19] S. Longhi et al., “Solid waste management architecture using wireless sensor network technology,” in Proc. 5th Int. Conf. New Technol., Mobility Secur.,2012, pp.1–5.

[20] M. Hannan, M. Arebey, R.A.Begum, and H. Basri, “Radio frequency identification (RFID) and communication technologies for solid waste bin and truck monitoring system,” Waste Manage., vol. 31, no. 12, pp. 2406–2413, 2011.