MANHOLE DETECTION AND MONITORING SYSTEM

Realtime project

“MANHOLE DETECTION AND MONITORING”

A Dissertation Submitted in partial fulfilment of the requirement for the award of degree of
BACHELOR OF TECHNOLOGY
In
Electronics and Communication Engineering

By

T. SAI CHANDANA (Roll No: 22D41A04B4)
V. SNEHA (Roll No: 23D45A0412)
V. MUKTHAVALI (Roll No: 23D45A0413)

Under the esteemed guidance
Mr. B. THIRUPATHI (Asst. Prof)

Department of Electronics and Communication Engineering

SRI INDU COLLEGE OF ENGINEERING & TECHNOLOGY
(An Autonomous Institution under UGC, New Delhi) Recognized under 2(f) and 12(B) of UGC Act. 1956 Sheriguda village, Ibrahimpatnam, RR District – 501 510, T.S,INDIA

2023 - 2024

CERTIFICATE

This is to certify that the project report entitled " MANHOLE DETECTION AND MONITORING " submitted by T. SAI CHANDANA (22D41A04B4), V.SNEHA (23D45A0412), V. MUKTHAVALI (23D45A0413) in partial fulfilment of the requirement for the award of the degree of Bachelor of Technology in Electronics and Communication Engineering to the Jawaharlal Nehru Technological University, Hyderabad is a record of bonafide work carried out by him under our guidance and supervision. The results presented in this have been verified and are found to be satisfactory. The results embodied in this thesis have not been submitted to any other University for the award of any other degree or diploma

Internal Guide

Head of the Department

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABREVATIONS

GPS ----------Global Positioning System

NODEMCU----------Node and MCU (Micro -Controller Unit)

LCD----------Liquid crystal display

MQ2----------Metal Oxide semiconducator type sensor

HC-SRO4----------High-Conductance ultrasonic sensor

PIR----------Passsive Infrared sensor

IR ----------Infrared Sensor

ABSTRACT

Urban infrastructure management is a critical aspect of maintaining public safety and operational efficiency. One of the persistent challenges in this domain is the monitoring and maintenance of manholes, which can pose significant hazards if not properly managed. This project presents a comprehensive solution for manhole detection and monitoring.

Our system integrates various sensors, including, IR sensor detects unauthorized opening or tilting, and the PIR sensor detects human motion the manhole, ultrasonic sensor monitors water levels, the gas sensor detects harmful gas emissions, the GPS module provides real-time location tracking, All the collected data is displayed on a 16x2 LCD screen for immediate on-site inspection and simultaneously transmitted to a remote monitoring centre using the ESP8266 module. The system is connected to the ThinkSpeak platform, enabling real-time alerts and notifications to be sent to maintenance personnel via a mobile application.

By providing timely and accurate information on the status of manholes, our system enhances preventive maintenance and rapid response capabilities, thereby reducing the risk of accidents and ensuring public safety.

CHAPTER 1 INTRODUCTION

1.1 OBJECTIVE:

The primary objective of a manhole detection and monitoring system using a GSM module, tilt sensor, IR sensors, PIR motion sensor, and NodeMCU is to enhance the safety and efficiency of urban infrastructure management. This sophisticated system continuously monitors the status of manhole covers by employing various sensors to detect displacement, unauthorized access, or tampering. The tilt sensor identifies any tilting or shifting of the manhole cover, while IR sensors ensure the cover is properly sealed. The PIR motion sensor adds an extra layer of security by detecting human presence near the manhole, potentially indicating unauthorized activity.

Data from these sensors is processed by the NodeMCU, which serves as the central processing unit, and is then communicated in real-time to municipal authorities via the GSM module. This enables immediate alerts and swift response to anomalies. The system not only prevents accidents and enhances public safety by ensuring manholes are securely closed, but also facilitates timely maintenance, optimizing resource allocation.

By providing precise information on the status of manholes, it allows for better preventive maintenance and efficient deployment of maintenance crews, ultimately contributing to a safer and more efficiently managed urban environment.

"Continuous monitoring of manhole covers using advanced sensors is critical to preventing accidents and ensuring public safety in urban environments."

1.2 INTRODUCTION

The aim of the manhole detection and monitoring project is to enhance the safety, efficiency, and reliability of urban infrastructure by providing realtime monitoring of manhole conditions. This system seeks to prevent accidents, ensure environmental safety, and facilitate proactive maintenance through the use of various sensors. Manhole monitoring is essential for protecting maintenance workers from hazardous conditions such as toxic gases and flooding, as well as safeguarding the public from accidents involving unauthorized access.

By continuously monitoring for dangerous gases like methane, hydrogen sulfide, and carbon monoxide, the system mitigates health risks and explosion hazards. Additionally, monitoring water levels helps manage flood risks and maintain proper drainage functionality. Proactive maintenance is enabled by early detection of issues such as blockages and structural damage, reducing the likelihood of costly emergency repairs and allowing for efficient resource management. The system addresses problems faced by manholes, including gas accumulation, flooding, structural damage, and unauthorized access, by providing real-time alerts and data for timely interventions. Overall, the manhole monitoring system ensures safer, more efficient, and environmentally sound urban infrastructure management, protecting both workers and the public from potential hazards.

4/28/23, 12:15 PM Man falls into open drain, dies after four days - Times of India

Printed from
THE TIMES OF INDIA

Man falls into open drain, dies after four days

TNN | Jul 30, 2018, 02.38 AM IST

NEW DELHI: A 29-year-old youth died after slipping into an open drain near west Delhi's Mayapuri industrial area. The incident happened on July 25 when the youth was on his way back home. He had suffered injuries on his head and later succumbed.

The incident was reported from Phase I, JJ colony near the industrial area. Locals said the man, Arjun, was walking back to his house when the incident happened. They said that the road leading to the colony remains dark and it was flooded with drain water that had overflowed after the evening showers. "It was impossible to distinguish where the hole created by a broken slab over the drains was that day," said Rajesh Kumar, a neighbour.

Arjun slipped and fell into the drain, hitting his head on iron rods protruding out on the edges. A passerby saw him fall and alerted others, who pulled him out and took him to the DDU hospital.
Doctors told the family members that a rod had pierced through his head and referred him to the Safdurjung hospital where he died on Sunday.
Arjun had come to Delhi five years ago from a village in UP. He stayed with his wife Sunita and his child at a rented house at the JJ colony, and had a cart selling food items in the area.

✞ **339 Lives Lost to Manual Scavenging in the Last Five Years, Govt Data Reveals**

Fig(1)

"Deaths have occurred in states/UTs due to hazardous cleaning of sewers and septic tanks and non observance of safety precautions as prescribed under Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 and MS Rules 2013," the government said.

✞ **Open manholes, damaged slabs risk lives of commuters**

Fig(2)

The manholes covers are not properly placed and are raised above the ground level at scooter market, which is posing great inconvenience to the commuters. During the rains, the situation becomes precarious as the manholes are submerged under water and can't be seen, thus increasing the danger of harming the passerby.

CHAPTER 2

2.1 BLOCK DIAGRAM OF THE PROJECT

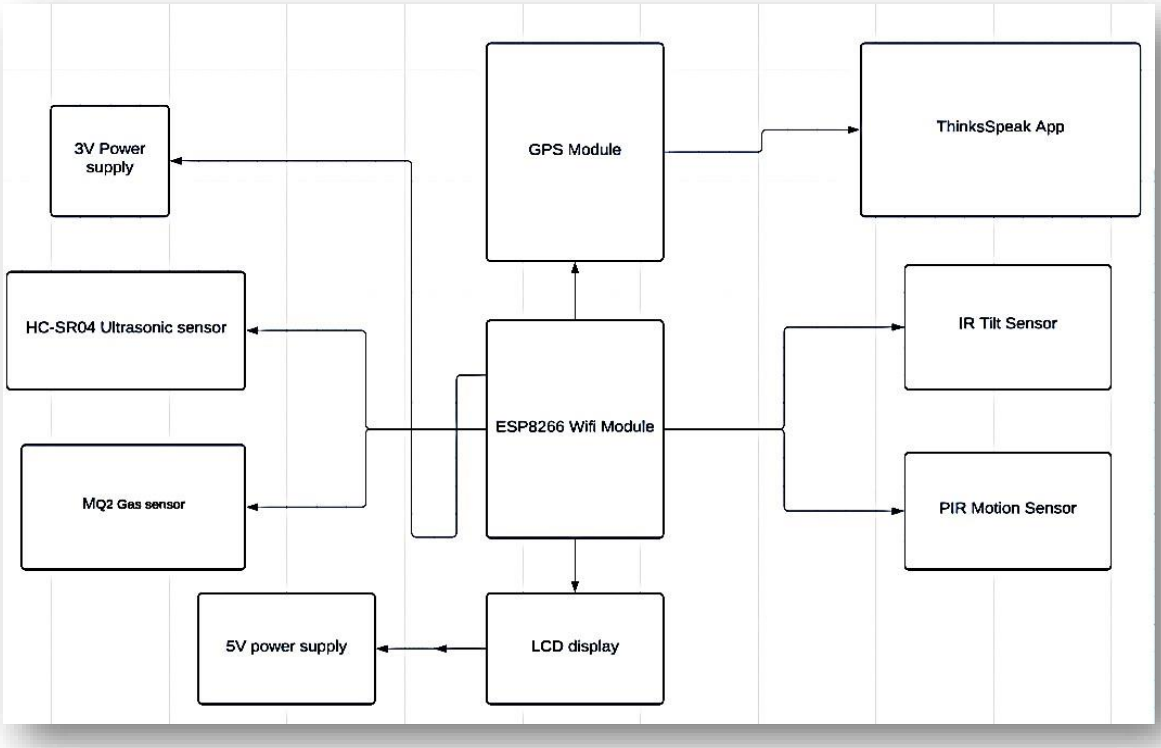

Fig 2.1

PIN CONFIGURATION

Component	ESP8266 Pin	Sensor Pin	Power
IR Sensor	D5	OUT	3.3V
PIR Sensor	D6	OUT	3.3V
HC-SR04	D7 (TRIG)	TRIG	5V
	D8 (ECHO)	ECHO	
MQ-2	A0	AO	5V
LCD I2C	D2 (SDA)	SDA	5V
	D1 (SCL)	SCL	
GPS Module	D4 (TX)	RX	3.3V
	D3 (RX)	TX	
Bluetooth (opt)	D3 (TXD)	RXD	3.3V
	D4 (RXD)	TXD	

Fig 2.2

2.2 FUNCTIONS OF EACH BLOCK

1. **POWER SUPPLY:**

   The primary function of a power supply is to convert one form of electrical energy into another and, as a result power supplies.

2. **GPS Module:**

   GPS modules receive satellite signals to provide location (latitude and longitude) and other related data such as altitude and speed.

   Specifications:

   i Operating Voltage: 3.3V - 5V
   ii Communication: UART (Serial)
   iii Baud Rate: 9600 (common)
   iv Position Accuracy: 2.5 meters CEP

3. **ESP8266 (NodeMCU):**

   The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability.

Specifications:

i Operating Voltage: 3.3V
ii Digital I/O Pins: 17
iii Analog Input: 1 (max input 3.3V)
iv Flash Memory: 4MB
v Wi-Fi: 802.11 b/g/n

4. **16x2 LCD with I2C Interface:**

   A 16x2 LCD display with an I2C interface allows easy communication with microcontrollers using only two data lines (SDA and SCL).

Specifications:

i Operating Voltage: 5V
ii Interface: I2C
iii Address: Typically, 0x27 or 0x3F
iv Characters: 16 per line, 2 lines

5. **MQ-2 Gas Sensor:**

The MQ-2 is a gas sensor that detects methane, butane, LPG, and smoke in the air. It outputs an analog signal proportional to the concentration of gases.

Specifications:

i **Operating Voltage: 5V**
ii **Detection Range: 300 - 10000 ppm**
iii **Preheat Time: 20 seconds**
iv **Sensitivity: Adjustable via potentiometer Analog**
v **Output: Varies with gas concentration**

6. **HC-SR04 Ultrasonic Sensor:**

The HC-SR04 is an ultrasonic sensor that measures distance by using sonar. It emits a sound pulse and measures the time it takes for the echo to return.

Specifications:

i **Operating Voltage: 5V**
ii **Operating Current: 15mA**
iii **Measuring Range: 2cm - 400cm**
iv **Resolution: 0.3cm**
v **Ultrasonic Frequency: 40kHz**

7. **PIR Motion Sensor:**

PIR (Passive Infrared) sensors detect motion by measuring changes in infrared radiation levels emitted by surrounding objects.

Specifications:

i **Operating Voltage: 5V**
ii **Detection Range: Up to 7 meters**
iii **Detection Angle: 110 degrees**
iv **Output: Digital (High when motion detected)**

8. **IR Sensor (Tilt Sensor):**

The IR sensor can be used to detect tilt or angular changes. It outputs a digital signal when the tilt is detected.

Specifications:

i **Operating Voltage: 3.3V - 5V**
ii **Output: Digital**
iii **Detection Angle: Typically, up to 90 degrees tilt**

Chapter 3

HARDWARE IMPLEMENTATION

3.1 Initialization

The ESP8266 initializes and connects to the specified WiFi network. The GPS module, LCD, and sensors (MQ-2, HC-SR04, PIR, and IR) are initialized.

3.1.1 Sensor Data Acquisition

Gas Sensor (MQ-2)*: Continuously measures the gas concentration. The analog value from the sensor is read and converted to a gas level value. Ultrasonic Sensor (HC-SR04)*: Measures the distance to the water surface to detect water levels. The distance is calculated using the time taken for ultrasonic waves to reflect back.

PIR Sensor: Detects human motion. It outputs a digital signal (HIGH or LOW) indicating the presence of motion.

IR Sensor: Detects tilt of the manhole cover. It outputs a digital signal indicating the tilt status.

GPS Module: Continuously provides the latitude and longitude coordinates of the manhole.

3.1.2Display Data on LCD

The data from all sensors (gas level, water level, motion detection, tilt detection, and GPS coordinates) are displayed on the 16x2 LCD. The display is updated every second for real-time monitoring.

3.4 Upload Data to ThingSpeak

The ESP8266 uploads the sensor data to the ThingSpeak server every second. ThingSpeak provides a visual representation of the data over time, accessible from anywhere with an internet connection.

3.5 Generate Alerts

The system checks the sensor readings against predefined thresholds: Gas Level: If the gas concentration exceeds a specified threshold, an alert is generated.

Water Level: If the water level is detected to be too high, an alert is generated.

Motion Detection: If the PIR sensor detects motion, an alert is generated.

Tilt Detection: If the IR sensor detects tilt, an alert is generated. When an alert condition is met, an SMS is sent to a predefined phone number using the ESP8266 and a connected GSM module.

3.2 Detailed Component Functionality

ESP8266 WiFi Module:

Connection: Connects to WiFi to send data to ThingSpeak and handle HTTP requests for SMS alerts.
Processing: Reads data from sensors and updates the LCD display.

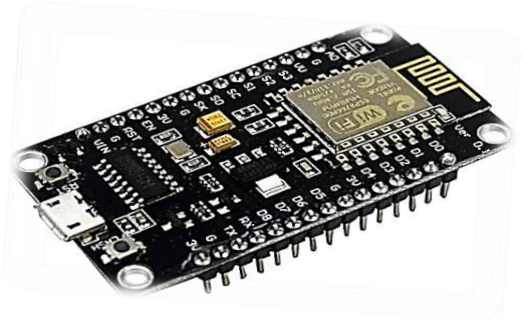

Fig3.1

MQ-2 Gas Sensor:

Detection: Detects flammable gas concentrations and provides an analog output proportional to the gas level.
Threshold: Set a threshold value to trigger alerts if the gas level exceeds safe limits.

Fig3.2

HC-SR04 Ultrasonic Sensor:

Distance Measurement: Sends an ultrasonic pulse and measures the time for the echo to return. Calculates distance based on the speed of sound. Water Level: Detects if the water level exceeds a predefined threshold.

Fig3.3

PIR Motion Sensor:

Motion Detection: Detects infrared radiation changes caused by human motion. Outputs a HIGH signal when motion is detected.

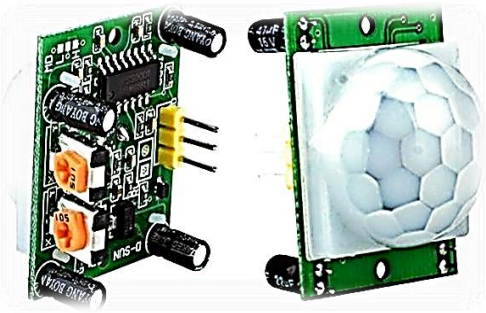

Fig3.4

IR Sensor (Tilt Sensor):

Tilt Detection: Outputs a HIGH signal when the sensor detects a tilt, indicating the manhole cover has been moved.

fig3.5

GPS Module

Location Tracking: Provides real-time GPS coordinates (latitude and longitude) of the manhole location.

Fig3.6

16x2 I2C LCD

Display: Shows real-time sensor data, including gas levels, water levels, motion detection status, tilt status, and GPS coordinates.

Fig3.7

System Integration

The ESP8266 integrates all sensor readings, displays the data on the LCD, uploads it to ThingSpeak, and monitors conditions for generating alerts. The modular nature allows easy addition of more sensors or modifications to the alert criteria.

CHAPTER 4

WORKING PRINCIPLE

- **This project employs an ESP8266 microcontroller to monitor environmental conditions in a manhole using various sensors, with data displayed on an LCD and uploaded to ThingSpeak for remote monitoring.**

- **It includes a PIR sensor to detect motion, an IR sensor to sense obstacles, a gas sensor to measure hazardous gases, an ultrasonic sensor to determine distance, and a GPS module to provide location coordinates.**

- **Initially, the ESP8266 sets up the LCD, sensors, and WiFi connection. It collects data from each sensor: motion detection from the PIR sensor, obstacle presence from the IR sensor, gas concentration levels, and distance measurements.**

- **If any sensor detects hazardous conditions—such as motion, obstacles, high gas levels, or close distances—an alert state is triggered, and an alert function is called.**

- **This data, including the alert status, is then uploaded to ThingSpeak for continuous remote monitoring, with the system repeating these steps every second to ensure real-time surveillance.**

- **This comprehensive setup helps promptly detect and report dangerous conditions within the manhole, thereby enhancing safety and enabling timely interventions.**

CIRCU IT DESIGN:

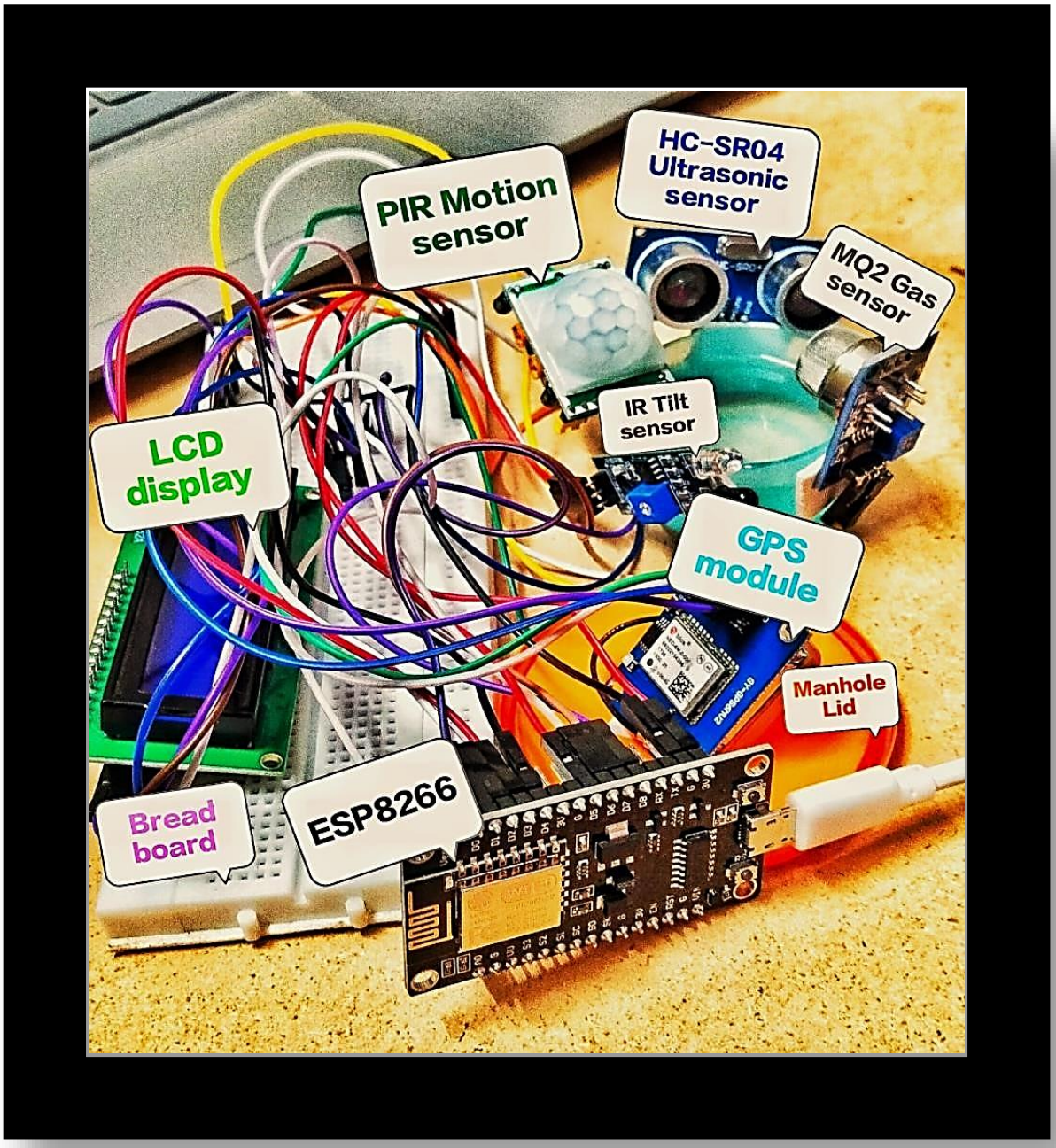

FIG4.1

CHAPTER 5

SOURCE CODE &LIBARARIES USED

- **Code Explanation**

- **Setup and Loop**

- *setup()*: Initialize the sensors, LCD, WiFi, and serial communication. - *loop()*: Continuously read sensor values, update the LCD, check for alerts, and upload data to ThingSpeak.

```
cpp
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <ESP8266WiFi.h>
#include <TinyGPS++.h>
#include <ESP8266HTTPClient.h>

LiquidCrystal_I2C lcd(0x27, 16, 2);
TinyGPSPlus gps;

#define PIR_PIN 5       // GPIO5 (D1)
#define IR_PIN 4        // GPIO4 (D2)
#define MQ_PIN A0       // Analog pin A0 #define
TRIG_PIN 14     // GPIO14 (D5)
#define ECHO_PIN 12     // GPIO12 (D6)

const char* ssid = "Jas"; const char*
password = "jas26102";
const char* server = "api.thingspeak.com";
String apiKey = "I6USUOWVFEQGFXO9";

const float DEFAULT_LATITUDE = 37.4219999;
const float DEFAULT_LONGITUDE = -122.0840575;

const int GAS_THRESHOLD = 300;
const float DIST_THRESHOLD = 10.0;

int pirState = LOW; int
irState = LOW; int
gasValue = 0; float
distance = 0.0;
```

```
float latitude = DEFAULT_LATITUDE; float
longitude = DEFAULT_LONGITUDE;
int alertState = 0;

void setup() {
Serial.begin(9600);
lcd.init();   lcd.backlight();

  pinMode(PIR_PIN, INPUT);
pinMode(IR_PIN, INPUT);
pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);

  Serial1.begin(9600); // Using hardware serial for GPS

  connectWiFi();
}

void loop() {   pirState =
digitalRead(PIR_PIN);   irState =
digitalRead(IR_PIN);   gasValue =
analogRead(MQ_PIN);
  distance = getDistance();

  while          (Serial1.available()          >          0)          {
gps.encode(Serial1.read());
  }

  if       (gps.location.isValid())       {
latitude = gps.location.lat();
    longitude = gps.location.lng();
  }

  lcd.clear();
lcd.setCursor(0, 0);
lcd.print("P:");
lcd.print(pirState);
lcd.print(" I:");
lcd.print(irState);
lcd.print(" G:");
lcd.print(gasValue);
```

```
lcd.setCursor(0, 1);
lcd.print("D:");
lcd.print(distance, 1);
lcd.print(" ");
lcd.print(latitude, 2);
lcd.print(",");
lcd.print(longitude, 2);

 if (pirState == HIGH || irState == HIGH || gasValue > GAS_THRESHOLD
|| distance < DIST_THRESHOLD) {
   alertState = 1;
sendAlert();   }
else {
alertState = 0;
 }

 uploadDataToThingSpeak(pirState, irState, gasValue, distance, latitude,
longitude, alertState);

 delay(1000);
}

float getDistance() {
digitalWrite(TRIG_PIN, LOW);
delayMicroseconds(2);
digitalWrite(TRIG_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIG_PIN, LOW);

 float duration = pulseIn(ECHO_PIN, HIGH);
float distance = (duration * 0.0343) / 2;   return
distance;
}

void sendAlert() {
 Serial.println("Alert! Manhole activity detected.");
}

void connectWiFi() {   WiFi.begin(ssid,
password);   while (WiFi.status() !=
WL_CONNECTED) {     delay(1000);
   Serial.println("Connecting to WiFi...");
 }
```

```
  Serial.println("Connected to WiFi");
}

void uploadDataToThingSpeak(int pir, int ir, int gas, float dist, float lat, float
lng, int alert) {
  if (WiFi.status() == WL_CONNECTED) {
    WiFiClient client;
    HTTPClient http;

    String url = "http://" + String(server) + "/update?api_key=" + apiKey +
                 "&field1=" + String(pir) +
                 "&field2=" + String(ir) +
                 "&field3=" + String(gas) +
                 "&field4=" + String(dist) +
                 "&field5="      +      String(lat,      6)      +
"&field6=" + String(lng, 6) +
                 "&field7=" + String(alert);

    http.begin(client, url);
int httpCode = http.GET();
if (httpCode > 0) {
     Serial.println("Data uploaded to ThingSpeak");
    } else {


 Serial.println("Error uploading data to ThingSpeak");
    }
    end();
}
}
```

5.2 Libraries:

Detailed Explanation

- **Libraries and Initial Setup**

Libraries

i. **Wire.h: For I2C communication.**
ii. **LiquidCrystal_I2C.h: For controlling the I2C LCD.**
iii. **ESP8266WiFi.h: For WiFi functionality.**
iv. **TinyGPS++.h: For handling GPS data.**
v. **Objects and Constants lcd: An object of the LiquidCrystal_I2C class for the 16x2 LCD.**
vi. **GPS: An object of the TinyGPSPlus class for the GPS module. Various constants for pin assignments and default GPS coordinates.**

- **setup Function**
  - **Initializes serial communication.**
  - **Initializes the LCD and turns on the backlight.**
  - **Sets pin modes for the sensors.**
  - **Connects to the WiFi network using connectWiFi() function.**

- **loop Function**
  - **Continuously reads sensor data.**
  - **Reads GPS data and checks if it is valid.**
  - **Displays sensor and GPS data on the LCD.**
  - **Checks for abnormal conditions and sends alerts if necessary.**
  - **Uploads the data to ThingSpeak.**

- **Sensor Reading and Processing**

1. PIR Sensor pir State = digitalRead(pirPin); reads the state of the PIR sensor (motion detection).
2. *IR Sensor*
IR State = digitalRead(irPin); reads the state of the IR sensor (tilt detection).
3. Gas Sensor gasValue = analogRead(mqPin); reads the analog value from the gas sensor. 4. Ultrasonic Sensor
- distance = getDistance(); calculates the distance using the HC-SR04 sensor.

- **GPS Data Handling**
  - **while (Serial.available() > 0) { gps.encode(Serial.read()); }: Reads GPS data from the serial port.**
  - **Checks if the GPS location is valid and updates latitude and longitude.**

- **Display Data on LCD**

  Uses the lcd.print function to display sensor data and GPS coordinates on the 16x2 LCD.

- **Alert Mechanism**

  Checks if any sensor reading is beyond predefined thresholds.

  Calls sendAlert() function to send an SMS alert if any abnormal condition is detected.

- **Upload Data to ThingSpeak**

  The uploadDataToThingSpeak() function sends the sensor data to ThingSpeak for remote monitoring and visualization.

- **Helper Functions**

  getDistance

  Calculates the distance using the HC-SR04 ultrasonic sensor.

  Sends a trigger pulse and measures the time it takes for the echo to return.

  Calculates the distance based on the speed of sound.

- **sendAlert**

  - Sends an alert via SMS using a WiFi client and an SMS gateway.

- **connectWiFi**

  - Connects to the specified WiFi network and waits until the connection is established.

CHAPTER 6

RESULT

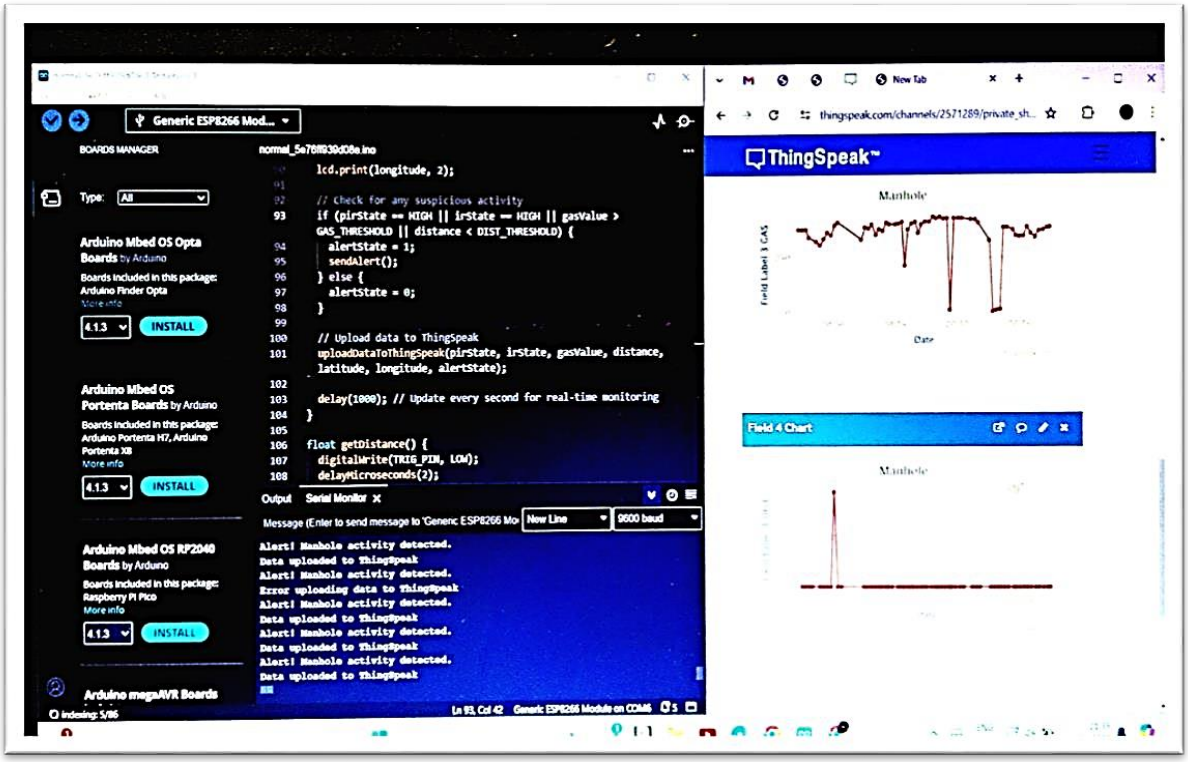

FIG6.1

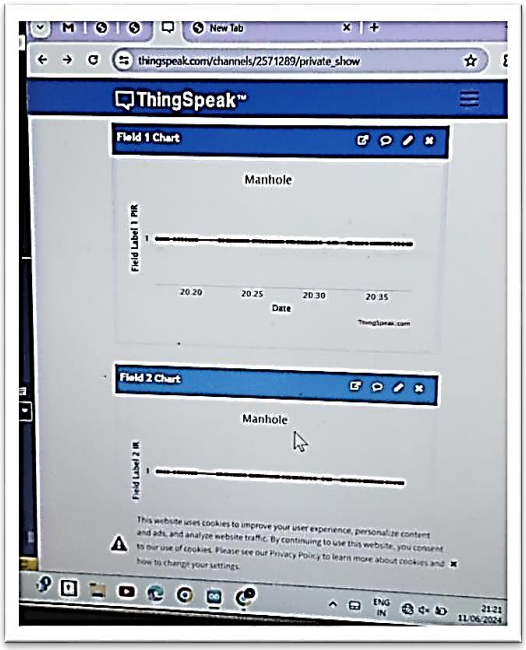

FIG6.2

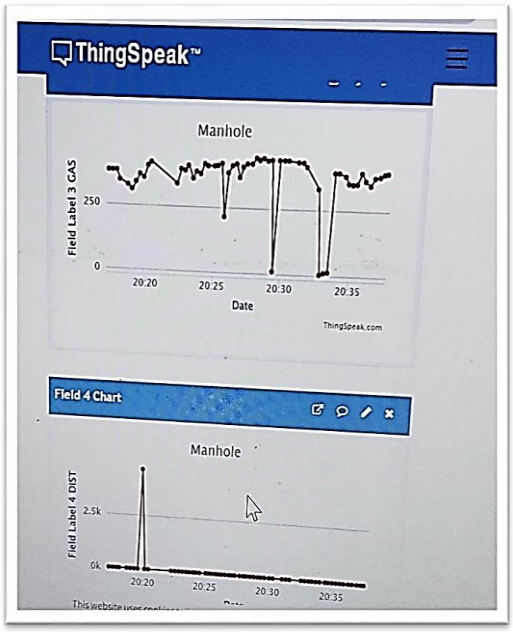

FIG6.3

CHAPTER 7

BENEFITS & APPLICATIONS

7.1 The benefits of the manhole monitoring system include:

1.Enhanced Safety: Prevents public accidents by detecting unauthorized access to manholes.
2. Environmental Protection: Water level monitoring aids in effective flood management and drainage system functionality.
3. Efficient Maintenance: Proactive issue detection allows for timely intervention, reducing the need for emergency repairs.
4. Remote Monitoring and Data Analysis: Aggregated data over time supports informed decision-making for infrastructure improvements, remote monitoring and real-time alerts, facilitating quick responses to hazards.
5.Operational Efficiency: Minimizes downtime and service disruptions, ensuring continuous operation of urban infrastructure.
- Improves response times to emergencies with real-time data and alerts.
6. Cost Savings: Extends the lifespan of manhole infrastructure, delaying the need for expensive replacements.
7. Preventing Accidents: Detecting open or damaged manholes can prevent accidents and injuries to pedestrians and vehicles. 8. Crime Prevention: Monitoring can help prevent unauthorized access and vandalism.
9.Early Detection of Issues: Identifies potential structural problems before they become severe, allowing for timely maintenance. 10. Flood Prevention: Monitors water levels to prevent overflow and flooding in urban areas.

7.2 APPLICATIONS:

- **Urban Infrastructure Management**
- **Public Safety**
- **Flood Prevention**
- **Environmental Protection**
- **Construction And Development**
- **Smart City Initiatives**

CHAPTER 8
FUTURE ENHANCEMENT

- **GSM Module: Incorporate GSM modules to enable data transmission and alerts via mobile networks, ensuring connectivity even in areas without Wi-Fi coverage.**
- **LoRaWAN: Utilize LoRaWAN technology for long-range, low-power communication, ideal for monitoring manholes spread over large areas.**
- **Solar Power: Utilize solar panels to power the monitoring system, making it more sustainable and reducing the need for frequent battery replacements.**
- **Data Management Challenges**
- **Maintenance and Upkeep**
- **SMS/Email Alerts: Implement a mechanism to send SMS or email alerts for critical conditions.**
- **Battery Backup: Add a battery backup system to ensure continuous operation during power outages.**
- **Mobile App Integration: Develop a mobile application for easier monitoring and control.**
- **Advanced Analytics: Use advanced analytics on the ThingSpeak platform to detect trends and predict potential issues**

CHAPTER 9

CONCLUSION

- **Manhole detection and monitoring systems provide significant advantages in terms of safety, efficiency, cost savings, and environmental protection.**

- **By leveraging advanced technologies such as sensors, connectivity, and data analytics, these systems enable proactive and effective management of urban infrastructure, contributing to the overall well-being and safety of the community.**

Manhole detection and monitoring systems are versatile and beneficial in a wide range of applications.

CHAPTER 10

REFERENCES

https://nevonprojects.com/iot-based-manhole-detection-and-monitoring-system/
https://iotdesignpro.com/projects/iot-manhole-monitoring-system
https://www.ijert.org/research/manhole-detection-and-monitoring-systemIJERTCONV9IS12005.pdf
https://ijcrt.org/papers/IJCRT23A5449.pdf
https://www.wiihey.com/en/applications/manhole-cover-monitoring.html
https://reports.valuates.com/market-reports/QYRE-Auto-4J14822/global-manholedetection-and-monitoring-system
https://onlinelibrary.wiley.com/doi/10.1155/2022/3081649

Project Title: **Manhole Detection and Monitoring System**

Guide(s): **Mr.B.THIRUPATHI** (Associate Prof)

Student Name(s): **T. Saichanadana**

V. Sneha

V. Mukthavali

Academic Year: 2023-24

Name of Course from which Principles are applied in this project	Related Course Outcome Number	Description of the application	Page Number	Attained PO

Guide Signature