**Koneru Lakshmaiah Education Foundation**

**(Deemed to be University)**

**Course Code: 22SDEC14A**

**Course Name: Embedded Prototype**

**(Skill Development Project)**

**A Project Report**

**On**

**IOT based Manhole Detection and Monitoring System**

**SUBMITTED BY:**

2200049143 – Nitheesh Kumar

2200049169 – Vinay Kumar

2200049172 – Sharath Kumar

2200049173 – Koushik Kumar

**UNDER THE GUIDANCE OF**

**Dr A.V. Prabu** Sir



Green fields, Vaddeswaram – 522 502

Guntur Dist., AP, India.

**K L E F**

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**(DST-FIST Sponsored Department)**



**DECLARATION**

The Project Report entitled **“IOT based Manhole Detection and Monitoring System”** is a record of bonafide work of 2200049143–Nitheesh Kumar, 2200049169–Vinay Kumar, 2200049172–Sharath Kumar, 2200049173–Koushik Kumar submitted in partial fulfillment for the award of B.Tech in Electronics and Communication Engineering to the K L University. The results embodied in this report have not been copied from any other departments/University/Institute.

**K L E F**

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**(DST-FIST Sponsored Department)**



**CERTIFICATE**

This is to certify that the Project Report entitled **“IOT based Manhole Detection and Monitoring System”** is being submitted 2200049143–Nitheesh Kumar, 2200049169–Vinay Kumar, 2200049172–Sharath Kumar, 2200049173–Koushik Kumar submitted in partial fulfilment for the award of B.Tech in  Electronics and Communication Engineering to the K L University is a record of bonafide work carried out under our guidance and supervision.

The results embodied in this report have not been copied from any other departments/ University/Institute.

Signature of Supervisor

Signature of the HOD Signature of the External Examiner

## ACKNOWLEDGMENT

It is great pleasure for me to express my gratitude to our honourable President **Sri. Koneru Satyanarayana**, for giving the opportunity and platform with facilities in accomplishing the project report.

I express the sincere gratitude to our Vice Chancellor, **Dr G P S Varma** for his administration towards our academic growth.

I express the sincere gratitude to our Pro VC, **Dr N Venkatram** for his administration towards our academic growth.

I record it as my privilege to deeply thank our principal, **Dr.T.K.Ramakrishna Rao** for providing us the efficient faculty and facilities to make our ideas into reality.

I express sincere gratitude to our pioneer **Dr. Suman Maloji,**  Vice-Principal & HOD-ECE for his leadership and constant motivation provided in successful completion of our academic semester.

I express my sincere thanks to our project mentors **Dr A.V. Prabu** for their novel association of ideas, encouragement, appreciation, and intellectual zeal which motivated us to venture this project successfully.

Finally, it is pleased to acknowledge the indebtedness to all those who devoted themselves directly or indirectly to make this project report success.

**ABSTRACT**

The **IoT-Based Manhole Detection and Monitoring System** aims to enhance urban safety and infrastructure management by providing real-time monitoring of manhole conditions. In many cities, manholes pose significant safety risks, often resulting in accidents due to issues such as gas leakage, water overflow, or damaged lids. The project integrates various sensors, including **gas sensors, water level sensors, tilt sensors, and ultrasonic sensors**, with the **ESP32** microcontroller to continuously monitor manhole conditions.

The system is designed to detect hazardous conditions, such as high gas concentrations, rising water levels, and lid displacement. When anomalies are detected, the system sends **SMS alerts** through a **GSM module** to municipal authorities, ensuring prompt action. Additionally, data is transmitted to a cloud platform for real-time visualization, enabling better maintenance management. This smart system helps prevent accidents, optimize manhole maintenance, and contribute to urban safety and efficiency.

**INDEX**

|  |  |
| --- | --- |
| **S.NO** | **TITLE** |
| 1 | Introduction |
| 2 | Aim of the Project |
| 3 | Proposed Methodology |
| 4 | Components Explanation |
| 5 | Implementation Methodology |
| 6 | Results and Discussions |
| 7  8 | Source Code  Conclusion and Future Scope |

1.Introduction:

Manholes, while essential for urban drainage systems, pose a significant safety risk when they are open or damaged. These hazards often result in accidents, injuries, and even fatalities, especially when they are not monitored regularly. The increasing urbanization and the rise in traffic make it critical to monitor and maintain manholes effectively to prevent such incidents. Current manual inspection methods are often inefficient, leading to delayed responses and inadequate safety measures.

To address these issues, an **IoT-based Manhole Detection and Monitoring System** is proposed. This system integrates various sensors like **gas, ultrasonic, tilt, and water level sensors** with a microcontroller, **ESP32**, to provide real-time monitoring of manhole conditions. The system is designed to detect dangerous gas emissions, water overflow, and lid displacement, ensuring that any abnormal conditions are promptly addressed.

By leveraging the power of IoT technology, this system aims to provide continuous monitoring and instant alerts to the relevant authorities through SMS via a **GSM module**. Furthermore, the data is made accessible on a cloud platform for easy access and decision-making. This solution promises to improve urban safety, reduce maintenance time, and optimize the management of underground drainage systems.

2.Aim of the Project:

The primary aim of the **IoT-Based Manhole Detection and Monitoring System** is to nhance the safety, efficiency, and maintenance of urban drainage systems through real-time monitoring and automated alerts. Key objectives of the project include:

* **Real-time Monitoring**: Continuously monitor manhole conditions using various sensors such as gas, water level, ultrasonic, tilt, and temperature sensors.
* **Hazard Detection**: Detect potential risks like gas leakage, water overflow, and lid displacement to prevent accidents.
* **Automated Alerts**: Send instant SMS alerts to municipal authorities via the GSM module when hazardous conditions are detected.
* **Cloud Integration**: Upload real-time sensor data to a cloud platform for easy access and long-term data analysis.
* **Maintenance Optimization**: Assist authorities in timely maintenance and repairs based on the data collected, ensuring the safety and efficiency of manhole systems.
* **Cost and Time Efficiency**: Reduce manual inspections and maintenance efforts by providing automated and accurate monitoring of manholes.

This system aims to reduce the risk of accidents, streamline maintenance processes, and contribute to a safer urban environment.

3.Proposed Methodology:

The **IoT-Based Manhole Detection and Monitoring System** employs a combination of sensors, microcontrollers, and communication modules to continuously monitor the conditions of manholes and provide real-time alerts. The proposed methodology is as follows:

* **Sensor Integration**: Various sensors, including **gas sensors (MQ series)**, **ultrasonic sensors**, **tilt sensors (KY-017)**, **temperature sensors**, and **float sensors**, are used to monitor key parameters like gas levels, water levels, temperature, and tilt of the manhole cover. Each sensor is chosen for its ability to detect specific hazards, such as gas leaks or water overflow.
* **Microcontroller (ESP32)**: The **ESP32 microcontroller** acts as the central processing unit, collecting data from all connected sensors. The ESP32 is equipped with **Wi-Fi connectivity** to send data to the cloud and **GSM functionality** to send SMS alerts when predefined thresholds are crossed (e.g., high gas levels, excessive water levels, or lid displacement).
* **Data Processing & Alerts**: Data from the sensors is processed in real-time by the ESP32. When a hazardous condition is detected, the system automatically triggers an **SMS alert** via the **SIM800L GSM module** to notify municipal authorities. Additionally, the system updates the data to a cloud-based platform for visualization and monitoring.
* **Cloud Platform**: The collected sensor data is uploaded to an **IoT cloud platform** (e.g., **ThingSpeak** or **Blynk**) for visualization and remote monitoring. The platform provides an easy-to-use dashboard for authorities to track the status of multiple manholes, review historical data, and take appropriate actions.
* **Power Management**: To ensure continuous operation, the system uses an **18650 Li-ion battery** along with an **XL6009 booster module** to provide a stable 5V output. The battery ensures the system remains operational even during power outages, providing autonomy for long durations.
* This methodology aims to create an automated, reliable, and scalable solution for manhole monitoring that ensures public safety, streamlines maintenance, and optimizes resource management.

4.Components Explanation:

| **S. No** | **Component** | **Description** |
| --- | --- | --- |
| **1** | **ESP32** | A powerful microcontroller with built-in Wi-Fi and Bluetooth; used as the main controller to read sensor data and send it to the cloud or via GSM. |
| **2** | **SIM800L GSM Module** | A GSM/GPRS module used to send SMS alerts to municipal authorities in case of critical conditions. |
| **3** | **Ultrasonic Sensor (HC-SR04)** | Used to measure the water level inside the manhole. It detects distance by sending and receiving ultrasonic waves. |
| **4** | **IR Sensor** | Detects the presence or absence of the manhole cover, helping identify if the cover has been removed. |
| **5** | **Gas Sensor (MQ-135)** | Detects harmful gases such as methane, carbon monoxide, or other toxic fumes inside the manhole. |
| **6** | **Tilt Sensor (KY-017)** | Detects tilt or angular movement of the manhole cover to monitor displacement or tampering. |
| **7** | **Temperature Sensor (LM35/DHT11)** | Monitors the temperature inside the manhole to detect abnormal conditions. |
| **8** | **Float Sensor** | Senses rising water levels indicating possible overflow conditions. |
| **9** | **GPS Module (Neo-6M)** | Provides real-time geolocation data of the manhole for tracking and mapping. |
| **10** | **OLED Display (SSD1306)** | Displays real-time readings and system status for local monitoring. |
| **11** | **18650 Li-ion Battery** | Rechargeable battery used as the main power source for the system. |
| **12** | **XL6009 Booster Module** | Boosts the battery voltage to 5V to ensure stable operation of all components. |
| **13** | **Buzzer** | Provides audio alerts or warnings for quick identification of any issue onsite. |
| **14** | **Connecting Wires & PCB** | Used to connect all components and ensure reliable electrical connections. |

5.Implementation Methodology:

The implementation of the IoT-based Manhole Detection and Monitoring System involves multiple stages, combining sensor integration, embedded system development, and communication via GSM/GPS modules. Each step ensures robust, real-time monitoring, data acquisition, and alert mechanisms for manhole conditions.

**Step 1: Hardware Design and Sensor Integration**

* **Microcontroller (ESP32):**  
  Acts as the central controller that reads sensor inputs and manages data processing and communication.
* **Sensor Network Integration:**
  + **Ultrasonic Sensor:** Measures water levels inside the manhole.
  + **IR Sensor:** Detects the presence or removal of the manhole cover.
  + **Gas Sensor (MQ-135):** Detects toxic gases like methane or ammonia.
  + **Tilt Sensor:** Monitors if the manhole cover has been tilted or displaced.
  + **Float Sensor:** Detects potential overflow levels.
  + **Temperature Sensor:** Measures internal temperature for safety analysis.
* **Power Supply Design:**
  + **3.7V Li-ion Battery Pack (18650):** Powers the entire system.
  + **XL6009 Booster:** Converts battery output to 5V for component compatibility.

**Step 2: Embedded Software Development**

* **Arduino IDE Development:**
  + Write and compile embedded C/C++ code to read sensor values and control modules.
* **Functional Code Implementation:**
  + readWaterLevel(): Measures water level via the ultrasonic sensor.
  + detectGasLevel(): Converts analog output to gas concentration.
  + checkCoverStatus(): IR and tilt sensors determine cover status.
  + detectOverflow(): Reads float sensor state.
  + getTemperature(): Converts analog voltage to temperature.
  + sendAlertSMS(): Uses SIM800L to send alerts via SMS.
* **Sensor Calibration:**
  + Ensure proper threshold setup for gas detection, water levels, and temperature.

**Step 3: GSM and GPS Communication Integration**

* **SIM800L GSM Module:**
  + Sends real-time alerts (SMS) to municipal authorities or a central server when critical thresholds are crossed.
* **Neo-6M GPS Module:**
  + Acquires geolocation of the manhole and appends it to SMS for accurate tracking.
* **Serial Communication Setup:**
  + ESP32 communicates with SIM800L and GPS via SoftwareSerial or hardware UART.

**Step 4: Local Display and Alert System**

* **OLED Display (SSD1306):**
  + Displays real-time sensor readings and system status.
* **Buzzer:**
  + Provides audible alerts if any sensor detects abnormal conditions (e.g., gas leak or open manhole).

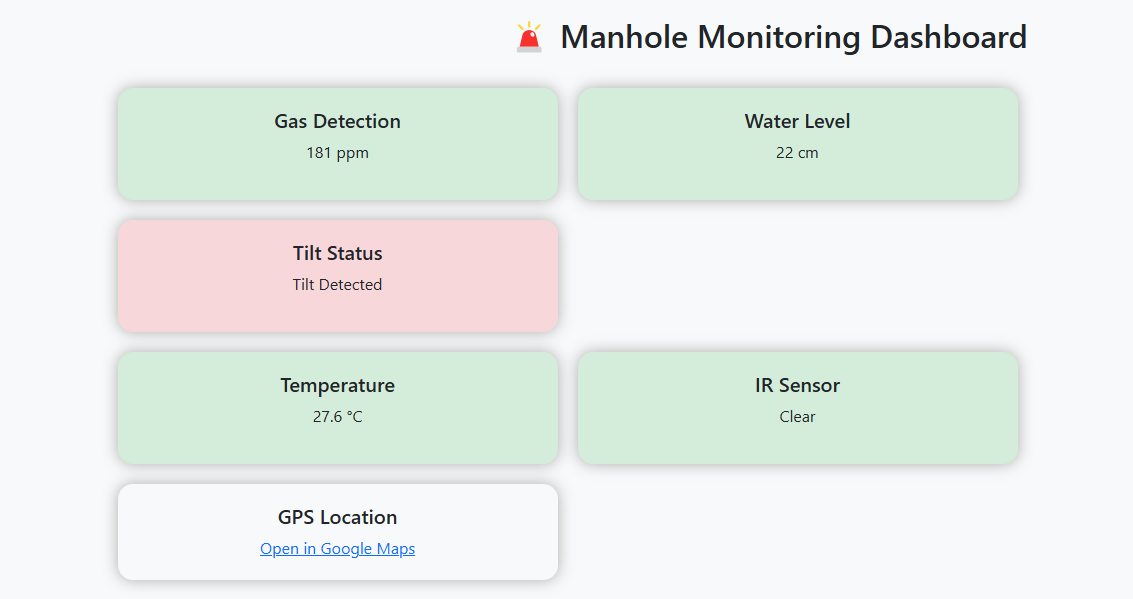
**Step 5: Testing and Deployment**

* **Unit Testing:**
  + Each sensor and module is tested independently to verify accuracy and reliability.
* **System Integration Testing:**
  + The full system is assembled and tested in lab conditions, followed by field trials in real manhole setups.
* **Deployment:**
  + Device is enclosed in a waterproof, rugged casing and installed near or inside a manhole for live monitoring.

**5.1 Webpage Implementation**

A screenshot of a computer

AI-generated content may be incorrect.

6.RESULT: 

7.Source Code:

#include <WiFi.h>

#include <ESPAsyncWebServer.h>

// Replace with your network credentials

const char\* ssid = "Krnk Reddy";

const char\* password = "krnkreddy";

// Create AsyncWebServer object on port 80

AsyncWebServer server(80);

// Simulated sensor readings

int gasValue = 0;

int waterLevel = 0;

bool tiltDetected = false;

bool irDetected = false;

void setup() {

  Serial.begin(115200);

  WiFi.begin(ssid, password);

  Serial.println("Connecting to WiFi...");

  while (WiFi.status() != WL\_CONNECTED) {

    delay(1000);

    Serial.print(".");

  }

  Serial.println("");

  Serial.print("Connected to WiFi. IP Address: ");

  Serial.println(WiFi.localIP());

  server.on("/", HTTP\_GET, [](AsyncWebServerRequest \*request){

    String html = "<!DOCTYPE html><html><head><title>Manhole Dashboard</title>";

    html += "<meta charset='UTF-8'><meta name='viewport' content='width=device-width, initial-scale=1'>";

    html += "<meta http-equiv='refresh' content='5'>";

    html += "<style>body { font-family: Arial; background: #f9f9f9; text-align: center; padding: 20px; }";

    html += ".card { background: #fff; padding: 20px; margin: 10px auto; border-radius: 12px; width: 300px; box-shadow: 0 0 10px #ccc; }</style></head><body>";

    html += "<h2>🚨 Manhole Monitoring Dashboard</h2>";

    html += "<div class='card'><h3>Gas Sensor</h3><p>" + String(gasValue) + " ppm</p></div>";

    html += "<div class='card'><h3>Water Level</h3><p>" + String(waterLevel) + " cm</p></div>";

    html += "<div class='card'><h3>Tilt Sensor</h3><p>" + String(tiltDetected ? "Tilt Detected" : "Stable") + "</p></div>";

    html += "<div class='card'><h3>IR Sensor</h3><p>" + String(irDetected ? "Obstacle Detected" : "Clear") + "</p></div>";

    html += "</body></html>";

    request->send(200, "text/html", html);

  });

  server.begin();

}

void loop() {

  // Simulate random readings

  gasValue = random(50, 300);           // 50–300 ppm

  waterLevel = random(5, 35);           // 5–35 cm

  tiltDetected = random(0, 2);          // true or false

  irDetected = random(0, 2);            // true or false

  delay(5000); // Wait 5 seconds to match refresh rate

}

8.Conclusion :

The **IoT-Based Manhole Detection and Monitoring System** successfully integrates various sensor technologies, microcontrollers, and communication modules to provide a comprehensive solution for monitoring manholes in real-time. The key achievements of the project include:

* Seamless integration of multiple sensors such as gas sensors, ultrasonic sensors, tilt sensors, temperature sensors, and float sensors, to monitor critical parameters such as gas leaks, water levels, and tilt of the manhole cover.
* Utilization of the **ESP32 microcontroller** for data collection and processing, along with **Wi-Fi** and **GSM functionality** to ensure data transmission and immediate alerting for hazardous conditions.
* Real-time processing of sensor data with automated **SMS alerts** sent via the **SIM800L GSM module** to notify authorities when predefined thresholds (e.g., high gas levels, excessive water levels, or lid displacement) are crossed.
* Cloud-based monitoring using platforms like **ThingSpeak** or **Blynk**, enabling municipal authorities to remotely track manhole conditions, visualize data, and access historical information for better decision-making.
* Reliable **power management** with the use of an **18650 Li-ion battery** and **XL6009 booster module** to ensure uninterrupted operation, even during power outages.

This project demonstrates the potential of integrating IoT, cloud platforms, and embedded systems to create a robust and scalable manhole detection and monitoring solution. It enhances public safety, simplifies maintenance, and contributes to smarter urban resource management.

8.1 FUTURE SCOPE:

The **IoT-Based Manhole Detection and Monitoring System** provides a strong foundation for enhancing urban infrastructure management. The future scope of this project includes several potential enhancements and expansions to increase its effectiveness, scalability, and adaptability:

1. **Integration of Additional Sensors**: The system can be further enhanced by incorporating additional sensors, such as **humidity sensors**, **motion detectors**, and **gas composition sensors**, to monitor more environmental parameters and detect a wider range of hazards.
2. **AI and Machine Learning for Predictive Analytics**: By incorporating machine learning algorithms, the system could analyze historical data to predict potential manhole failures or hazardous conditions before they occur. This predictive capability could help authorities take preemptive action and avoid costly repairs or accidents.
3. **Enhanced Communication Modules**: Integrating **LoRaWAN** or **NB-IoT** (Narrowband IoT) communication technologies can improve the system's range and data transfer efficiency, particularly in remote or low-network coverage areas, ensuring reliable communication across urban environments.
4. **Real-Time Video Monitoring**: Adding a camera module for real-time video surveillance could further improve monitoring by allowing authorities to visually inspect manhole conditions, such as debris accumulation or vandalism, from remote locations.
5. **Integration with Smart City Infrastructure**: The system could be integrated with other smart city solutions, such as smart traffic management systems, emergency response networks, or smart utility grids. This would enable a more holistic approach to urban safety and infrastructure management.
6. **Advanced Power Management**: Exploring energy harvesting techniques, such as **solar panels** or **kinetic energy** from pedestrian or vehicle traffic, could help power the system sustainably and further extend battery life, especially in remote areas without reliable power sources.
7. **Mobile Application Integration**: Developing a mobile application to allow authorities and maintenance personnel to receive real-time alerts, view data remotely, and interact with the system in a user-friendly interface would improve response times and operational efficiency.
8. **System Scalability**: Expanding the system to cover a larger geographical area, integrating it with municipal management platforms, and making it capable of handling more manholes would ensure scalability for cities of different sizes.

The future development of this project has the potential to significantly improve urban infrastructure management, reduce the risk of accidents, and contribute to the creation of smarter, safer cities.