Smart Manhole Monitoring and Management System Using IoT

Submitted By

Student Name	Student ID
Arman Islam Payel	221-15-5493
Afia Mubashshara Tamanna	221-15-5552
Mst. Annika	221-15-6045
Najifa Alam Esha	221-15-6053

MINI LAB PROJECT REPORT

This Report Presented in Partial Fulfillment of the course **CSE234: Embedded Systems and IoT Lab in the Computer Science and Engineering Department**

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Project Title:

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Abstract:

This project presents an IoT-based manhole detection and monitoring system using the ESP8266 microcontroller integrated with ultrasonic sensors and MQ-2 gas sensors. The system is capable of monitoring manhole water levels and detecting harmful gases in real time. Data is transmitted to the Blynk cloud platform, where mobile notifications and alerts are generated automatically. The system has been deployed to monitor two separate manhole sites (DIU and Dattapara), providing a scalable, cost-effective, and efficient solution for urban safety and infrastructure management.

1. Introduction

Manholes in urban areas often pose risks due to flooding and the accumulation of toxic gases, which can lead to fatal accidents and severe maintenance challenges. Traditional monitoring methods rely on manual inspections, which are slow, unsafe, and inefficient. To address these issues, this project introduces an IoT-based manhole monitoring system using the ESP8266 microcontroller, ultrasonic sensors for water-level detection, and MQ-2 gas sensors for toxic gas monitoring. The system is integrated with the Blynk IoT platform to ensure real-time monitoring and instant alerting.

2. Objectives

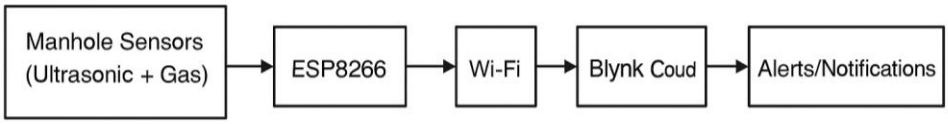
- Develop a real-time IoT-based monitoring system for manholes.
- Detect rising water levels in manholes using ultrasonic sensors.
- Detect harmful gases using MQ-2 gas sensors.
- Provide alerts and notifications via the Blynk IoT platform.
- Enable monitoring of multiple manholes from a single system.

3. System Architecture

3.1 Components Used

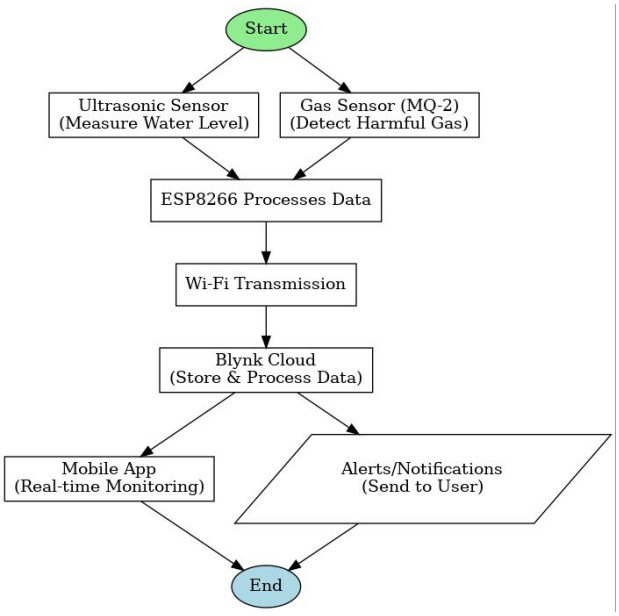
- Microcontroller: ESP8266 NodeMCU
- Sensors:
    - Ultrasonic HC-SR04 (for water-level detection) – two units for two manholes.
    - MQ-2 Gas Sensors (for methane and smoke detection).
- Cloud & App: Blynk IoT platform.
- Connectivity: Wi-Fi (using ESP8266).
- Power Bank/Battery: Power suply

3.2 Block Diagram



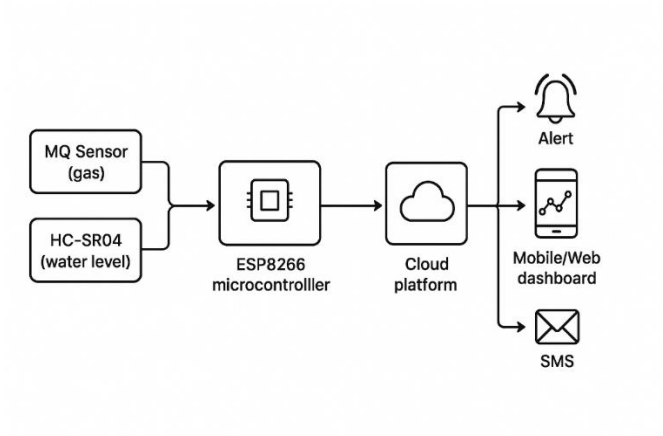
Block Diagram

3.3 Flow Chart

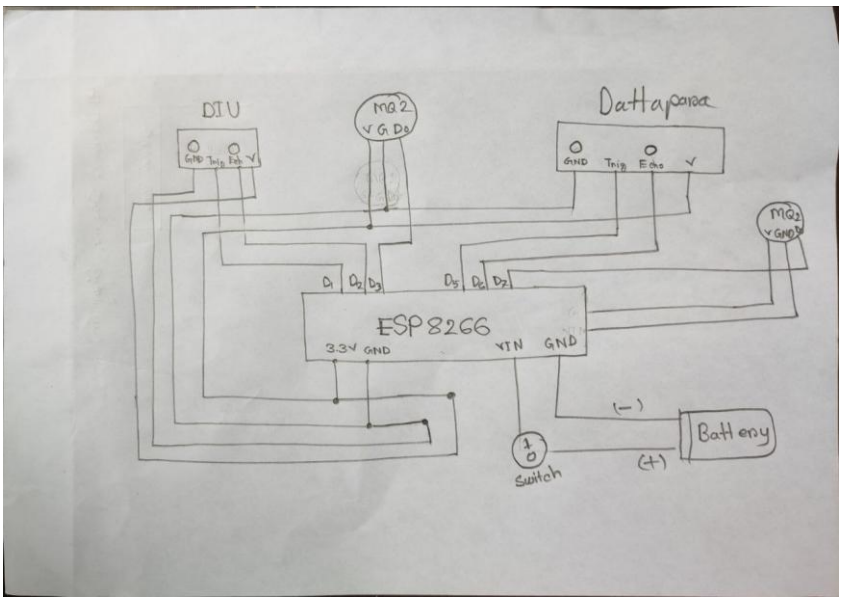


Flow Chart

3.4 UI Design



3.5 Wireframes:



4. Methodology

4.1 Hardware Design

- Two ultrasonic sensors were connected to the ESP8266 to measure water levels in two manholes (DIU and Dattapara).
- Two MQ-2 gas sensors were connected to detect the presence of harmful gases.
- The ESP8266 was programmed to process sensor data and send it to the Blynk cloud.

4.2 Software Design

- Code written in Arduino IDE using ESP8266WiFi and BlynkSimpleEsp8266 libraries.
- Thresholds set for water level at 70% capacity.
- Gas detection handled through MQ-2 digital outputs.
- Real-time monitoring and event logging are handled through the Blynk app.

4.3 Communication Protocol

- ESP8266 sends data to the Blynk Cloud via Wi-Fi.
- Alerts (water >70% or gas detected) are triggered by Blynk.logEvent() and sent to the mobile app instantly.

5. Implementation

5.1 Sensor Data Acquisition

- Water Levels: Ultrasonic sensors continuously measure water depth. Data is converted into percentages based on manhole height (10 cm in the test setup).
- Gas Detection: MQ-2 sensors detect smoke/methane presence, sending a digital HIGH

signal when gas is detected.

5.2 Mobile Application Features

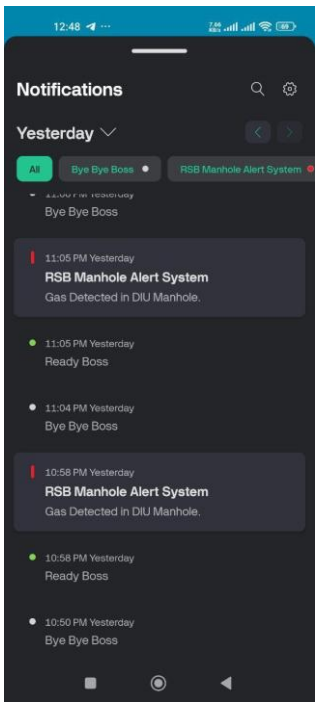
- Real-time dashboards on the Blynk app.
- Water-level readings shown as percentages.
- Gas detection status (Safe / Gas Detected).
- Visual indicators: green (safe) and red (gas detected).
- Notifications and logs for critical alerts.

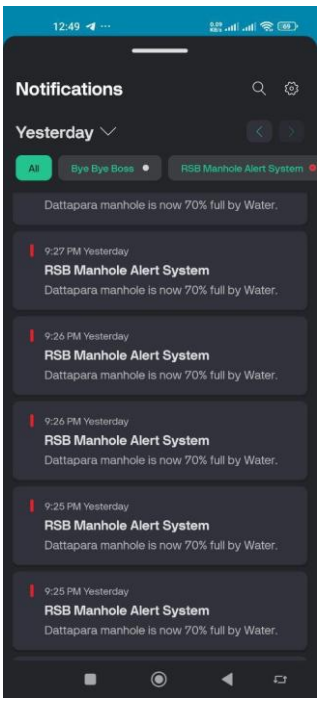
5.3 Security Features

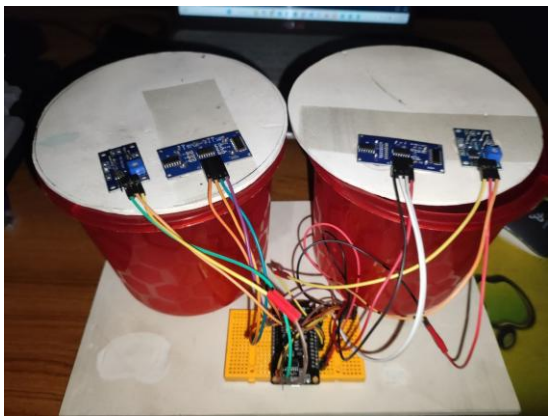
- Blynk authentication token ensures secure device-to-cloud communication.
- Data is encrypted during transmission.

6. Results

- The system successfully monitored two manholes simultaneously.
- Water levels above 70% triggered alerts instantly on the Blynk app.
- Gas detection was reliable, with clear visual and text-based alerts.
- Data updates were stable with low latency (approx. 2 seconds).
- The Blynk mobile interface made monitoring convenient and user-friendly.







7. Challenges and Solutions

- **Wi-Fi Connectivity Issues:** Solved by using auto-reconnect in the ESP8266 firmware.
- **False Gas Alarms:** Reduced by sensor calibration and averaging.
- **Power Constraints:** Prototype powered via USB; for deployment, a solar-based system is proposed.

8. Future Scope

- Add more gas sensors (CO, CO_2, H_2S) for better hazard detection.
- Integrate solar-powered ESP8266 units for autonomous operation.
- Use AI-based predictive analysis for early hazard forecasting.
- Expand to city-wide smart manhole monitoring networks.

9. Conclusion

The ESP8266-based IoT manhole monitoring system was successfully developed and tested. It can detect high water levels and harmful gases in real time, and send alerts via the Blynk platform. The system improves safety, reduces manual inspections, and provides a scalable smart-city solution. With future upgrades such as AI and renewable power integration, this project has strong potential for real-world deployment.

10. References

1. Espressif Systems, *ESP8266EX Datasheet*, 2020.
2. Blynk IoT Documentation, https://blynk.io
3. Massimo Banzi, *Getting Started with Arduino*, Maker Media, 2014.
4. MQ-2 Gas Sensor Datasheet, Hanwei Electronics, 2019.
5. M. S. Mahmoud and A. S. El-Deen, *IoT Monitoring and Detection Systems for Manhole Hazards*, IEEE Access, 2020.