JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

MONITORING AND PREDICTION SYSTEM OF SEWER NETWORKS USING IOT

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Abstract - The vision of a smart city encompasses improved sanitation and enhanced public services. One critical aspect of this vision is the integration of intelligent underground infrastructure. Effective monitoring of sewer networks is essential to maintain urban hygiene and public health. Traditional manual inspection methods are often inefficient, leading to delayed issue detection and resolution. To address these limitations, an Internet of Things (IoT)-based system has been developed, incorporating a wireless sensor network with multiple sensor nodes. This cost-effective and low-maintenance solution enables real-time monitoring and automatically notifies the concerned authorities via SMS whenever predefined thresholds are exceeded at any manhole. The system not only minimizes health hazards for sanitation workers but also promotes public safety and operational efficiency.

Keywords – IoT, UV sensor, Gas sensor, Tilt sensor, Arduino, GSM module

1. INTRODUCTION

Manholes serve as essential access points in sewer systems for routine inspection, cleaning, and maintenance. In modern urban environments, particularly metropolitan areas, underground drainage systems are widely implemented. It is vital for municipal bodies to ensure these systems are well-maintained, as any negligence may result in groundwater contamination, posing serious health risks through the spread of infections. Additionally, blockages—especially during the rainy season can lead to severe disruptions in daily life.

To tackle these issues, there is a need for an automated system capable of detecting drainage anomalies and notifying the concerned departments in real-time. This project focuses on building an IoT-based solution that monitors sewer conditions by using water level sensors, gas sensors, and tilt sensors. These sensors help in identifying overflow situations, the presence of hazardous gases, and unauthorized or accidental displacement of manhole covers.

When sensor readings exceed defined thresholds, the system sends immediate SMS alerts via a GSM module to the responsible authorities. This eliminates the dependency on manual inspection, which is not only time-consuming but also

risky due to the harmful environment inside sewer lines. The goal is to develop a cost-effective, automated solution that ensures better monitoring, minimizes human risk, and enhances the overall sanitation infrastructure of the city.

2. PROBLEM STATEMENT

The current underground drainage systems lack intelligent monitoring mechanisms. As a result, issues like rising water levels, toxic gas accumulation, and unauthorized or accidental displacement of manhole covers often go undetected until they escalate into serious problems. Manual inspection methods are inefficient, slow, and expose workers to hazardous environments. Moreover, early warnings about drainage blockages, sewer overflow, or potential hazards are not promptly available, causing delays in action and posing risks to public health and safety.

To address these challenges, the proposed system aims to:

- Continuously monitor water levels, gas presence, and manhole lid status using sensors.
- Provide real-time alerts to authorities through GSM-based SMS notifications when abnormal conditions are detected.
- Reduce the dependency on manual inspection and improve response time during emergencies.
- Offer a low-cost, reliable, and scalable solution for proactive sewer network monitoring through IoT integration.
- Enhance public safety by enabling early detection and preventive action against drainage failures.

3. OBJECTIVES

- To implement continuous monitoring of drainage water levels using UV-based sensors to detect early signs of overflow or blockages.

- To identify the presence of hazardous gases and detect any displacement or tampering of manhole covers through gas and tilt sensors.

- To enable automated SMS notifications to municipal authorities via a GSM module whenever abnormal conditions are recorded.

- To present real-time data visualization through a mobile application built with Flutter, enhancing accessibility and quick decision-making.

- To deliver a low-cost, reliable, and easily deployable IoT solution for proactive sewer network monitoring and urban infrastructure management.

4. METHODOLOGY

The system architecture is centered around the Arduino Nano, which serves as the primary control unit. Multiple sensors are interfaced with the Arduino, including a UV sensor for monitoring sewer water levels, a gas sensor for detecting toxic gases, and a tilt sensor for identifying the displacement or opening of manhole covers. The Arduino continuously processes data from these sensors, comparing the readings against preset threshold values. If any sensor value surpasses its limit, the system immediately triggers an SMS alert to the designated municipal authorities through a GSM communication module. Additionally, the real-time sensor readings are transmitted and displayed within a Flutter-based mobile application, enabling remote and continuous monitoring. This integrated setup ensures a responsive, cost-effective, and reliable solution for managing and maintaining underground drainage networks.

4.1 BLOCK DIAGRAM AND CONSTRUCTION

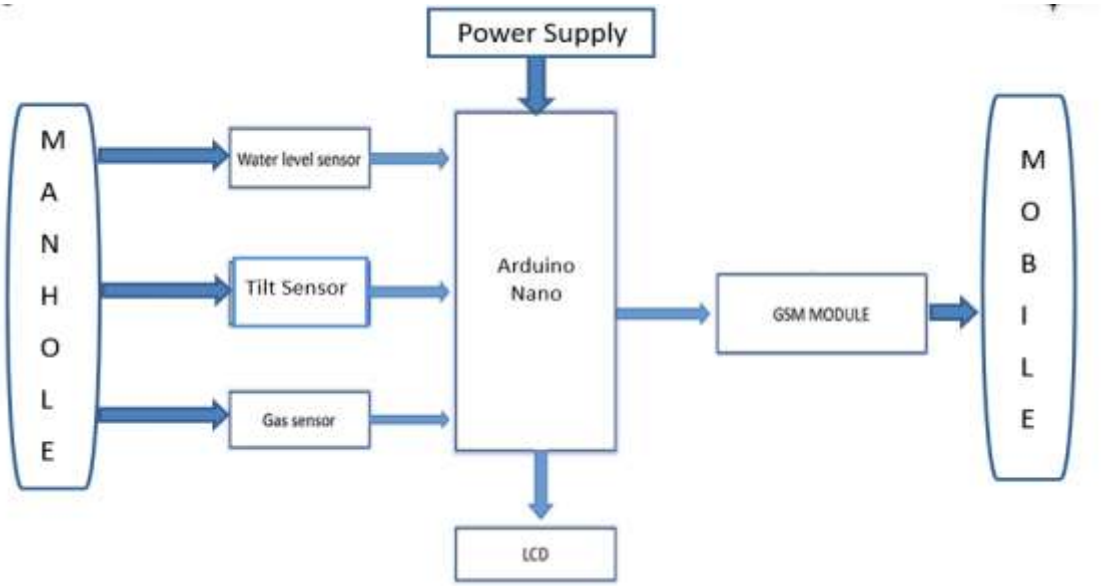


Fig:4.1 Block Diagram of proposed system

The above fig 4.1 is the block diagram of proposed system which reflects the entire process and flow of our system.

4.2 COMPONENTS USED

4.2.1 Arduino Nano :

As a compact real-time monitoring devices such as sewer predicting and monitoring systems, the Arduino Nano microcontroller board is based on the ATmega328P and its small light-weight size makes very efficient for scanning specific areas. This board also has 16MHz clock speed, can operate multi sensors at once, has 14 digital IO pins and 8 analog inputs. It can be main power source through USB or external adapter, providing easy access for placement in manholes.

For this project the Arduino Nano acts as the main controller for the IoT system connected to the UV water level, gas detection and tilt sensor. The controller can iteratively process the data collected from each sensor and each time limit is crossed; an alert is generated through SMS using GSM module. The architecture allows for easy implementation of low energy routing methods at set intervals to reduce power consumption, thus making Arduino IDE programming very convenient.

Main Highlights:

- Microcontroller: ATmega328P
- Working Voltage: 5V
- Optimal Input Voltage: 7V to 12V

- Digital I/O Pins: 14 (6 enable PWM output)
- Analog Input Ports: 8
- Flash Memory: 32 KB
- SRAM: 2 K

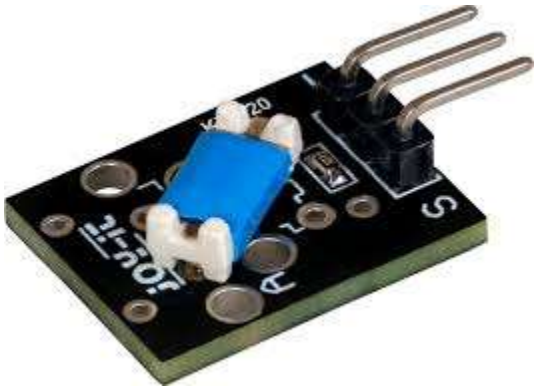
4.2.2 MQ5 Gas Sensor :

The MQ5 Gas Sensor detects harmful gases. It is useful in the monitoring of sewer networks. Gas Sensors are used to detect the presence of deadly gases such as Methane or carbon monoxide within manholes. The sensor generates a signal of electricity due to some reaction with certain gases. The amount of gas present determines the signal strength: the more the gas, the stronger the signal. This project disables dangerous fumes by alerting the relevant personnel in real time through GSM communication networks. This goes a long way in averting danger and ensuring public safety.

4.2.3 Water Level Sensors (HC-SR04) :

The water level sensor is useful in monitoring the change in “drainage” water levels inside Manholes. The UV water level sensor is different, its sensors continuously measure the height of water and check if there is overflow or blockage. So, when the water level goes beyond a certain mark, the sensor will give a value in the form of electricity that passes to the Arduino Nano. When the system has been programmed to recognize either high or low water levels, it passes alerts through its GSM module and updates the Flutter application for mobile phones. This avoids blocked sewer lines, and flooding.

4.2.4 Tilt Sensor: KY-020 Mercury Tilt Sensor



The KY-020 Mercury Tilt Sensor is designed to detect changes in the orientation or angle of an object. In this project, it is mounted on the manhole cover to identify any unauthorized openings, tampering, or displacement. The sensor operates using a glass tube that contains a small droplet of mercury. When the sensor tilts beyond a certain angle, the mercury bridges two internal contacts, completing an electrical circuit and generating a digital output. This output is processed by the Arduino Nano, which triggers the GSM module to send alert messages and updates the status live on the Flutter mobile application. This system ensures rapid detection of manhole disturbances, enhancing both safety and monitoring capabilities.

4.2.5 SIM900A GSM module

The SIM900A GSM module is a compact and efficient device designed to enable wireless communication in embedded systems. Within our smart sewer monitoring project, it is used to transmit immediate alerts to officials when irregularities like gas leaks, high water levels, or unauthorized manhole cover movements are detected. Operating over 900/1800 MHz GSM bands, it ensures consistent connectivity for sending SMS notifications from almost any location.

It interacts smoothly with the Arduino Nano through a serial UART connection, using simple AT commands for communication. Known for its low energy consumption and stable network performance, the SIM900A is well-suited for IoT applications where continuous monitoring is required. Even in underground or signal-challenging environments, this module maintains reliable data transmission, making sure that emergency messages are delivered without delays.

Core Features:

- Supports 900/1800 MHz GSM networks for stable communication.
- Facilitates SMS, voice calling, and GPRS-based data transfer.
- Communicates via UART using standard AT commands.
- Compact and easy to integrate with microcontrollers like Arduino Nano.
- Energy-efficient for long-duration projects.
- Excellent network reception, even in remote or semi-enclosed areas.

Incorporating the SIM900A module into the system ensures that all emergency alerts are transmitted promptly, strengthening the reliability and responsiveness of the entire sewer monitoring setup.

4.3 WORKING

In this project, the Arduino Nano serves as the brain of the smart sewer monitoring system, coordinating input from multiple sensors. A UV-based water level sensor keeps track of sewage levels inside the manhole to detect any overflow or blockage. The gas sensor monitors the surrounding air for dangerous gas concentrations, while the tilt sensor (KY-020 mercury switch) checks if the manhole cover is tampered with or displaced. When any abnormal reading is detected — such as a rise in water level, gas leakage, or unauthorized opening of the lid — the Arduino processes the information and immediately sends an SMS alert through the GSM module to notify the municipal authorities. At the same time, real-time sensor data is continuously updated and displayed on a Flutter-based mobile application for remote monitoring. This system ensures early detection of critical issues, reduces manual inspections, enhances worker safety, and provides a fast response to prevent accidents or environmental hazards.

5. SYSTEM SPECIFICATIONS

SOFTWARE	HARDWARE
Arduino IDE	Arduino nano
Mobile Application	HC-SR04 UV sensor
Thingspeak Server	MQ5 Gas sensor
	KY-020 Mercury Tilt sensor
	SIM900A GSM module
	LM2596 tilt switch sensor

6. RESULT

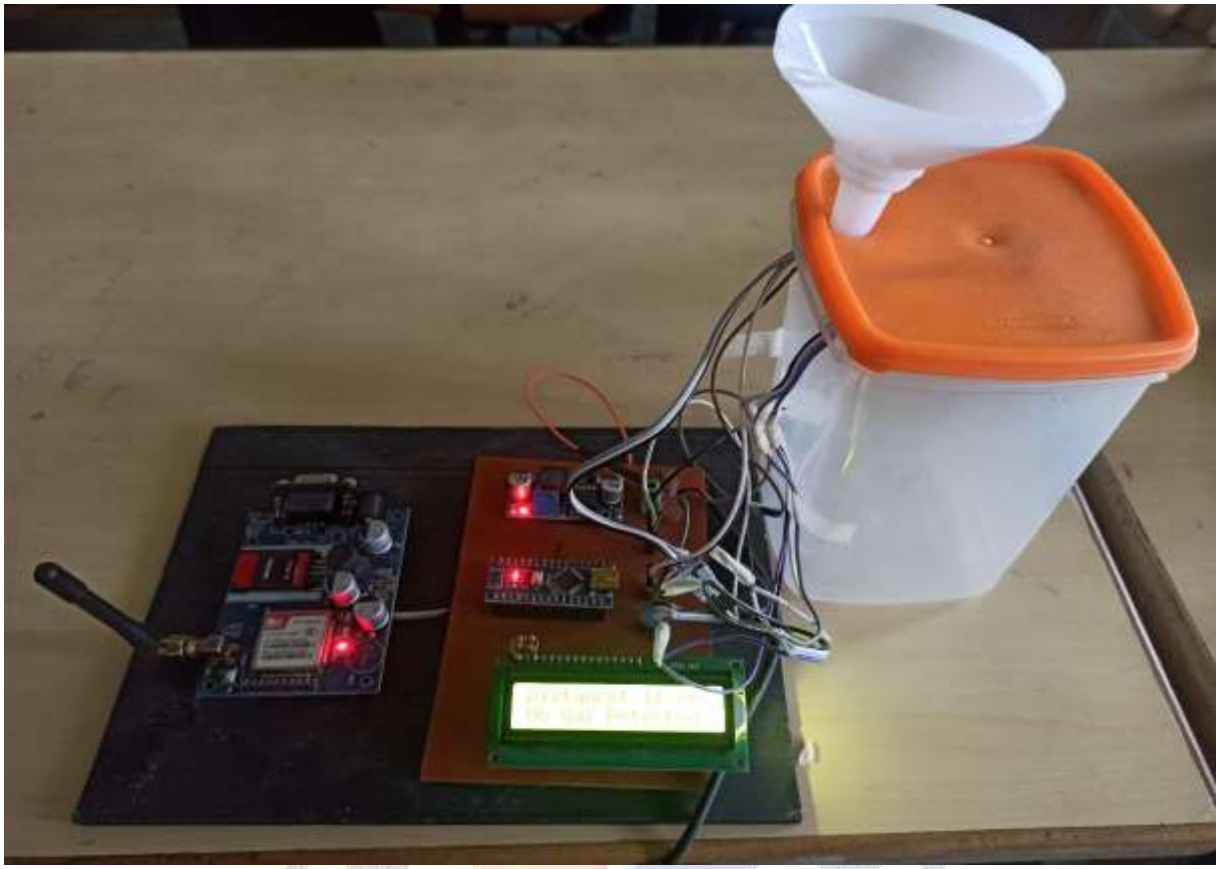


Fig: 6.1 Assembled proposed system with components

As shown in fig.6.1, the developed Smart Sewer Monitoring and Alert System integrates the Arduino Nano with essential sensors to continuously track manhole conditions. The UV-based water level sensor detects rising sewage levels, the gas sensor identifies hazardous gas concentrations, and the KY-020 tilt sensor monitors unauthorized movement of the manhole cover. When any abnormal condition is detected, the Arduino Nano processes the sensor data and instantly triggers an alert through the GSM module, sending warning messages directly to the concerned authorities as shown in fig.6.2. Simultaneously, real-time data updates are displayed on a user-friendly Flutter mobile application as shown in fig.6.3, offering a clear and organized view of all manholes being monitored. Each type of warning is visually categorized with distinct icons for quick recognition, helping authorities to respond promptly. The system successfully demonstrated high accuracy in detecting critical situations, providing a fast and reliable method to improve public safety and reduce risks for maintenance workers.

Fig:6.2 SMSAlerts

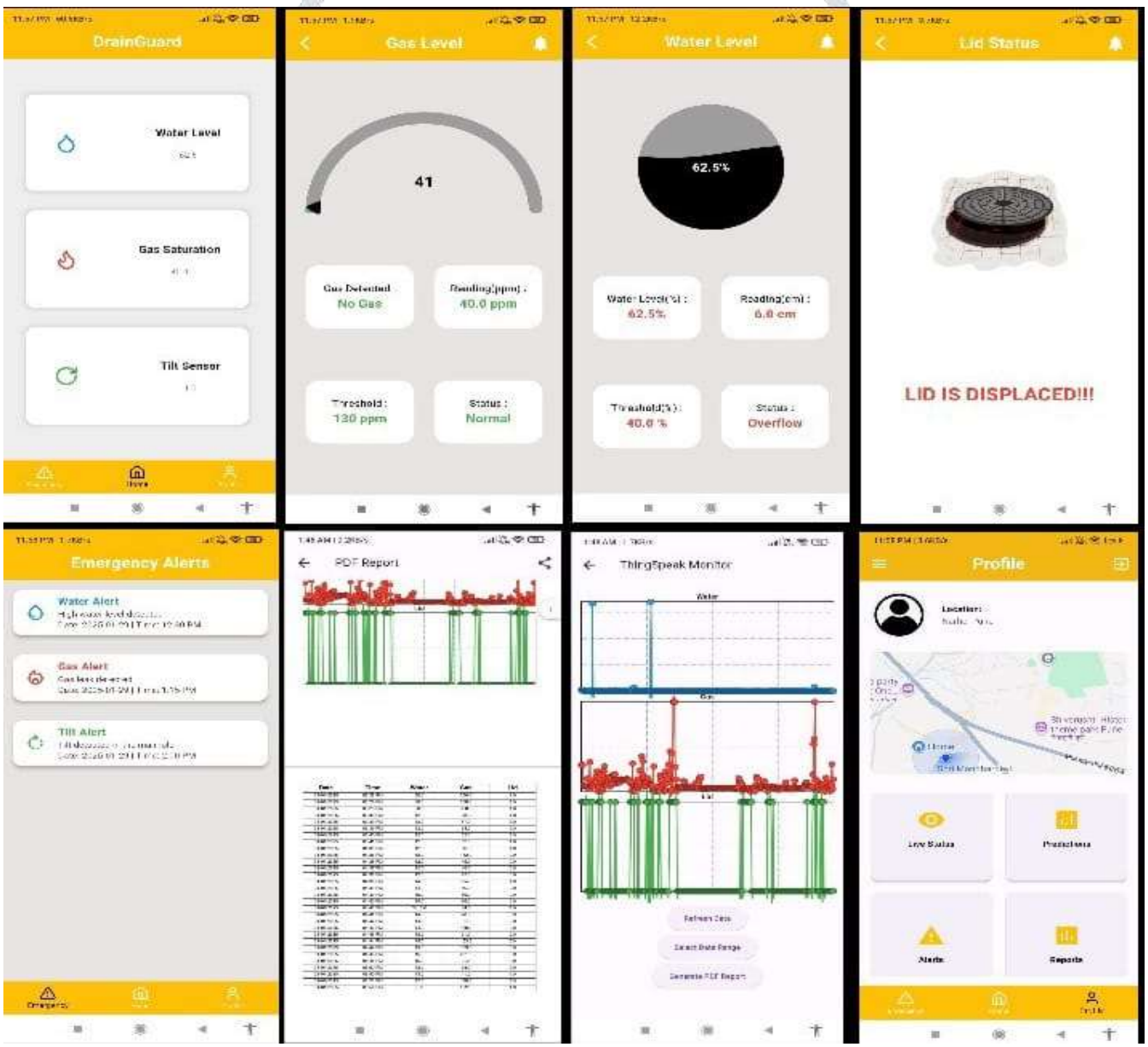


Fig: 6.3Mobile App UI

CONCLUSION

The developed Smart Sewer Monitoring and Alert System successfully offers a practical solution for real-time monitoring of sewer networks. Using Arduino Nano as the central controller along with water level sensors, gas detectors, and a tilt sensor, the system effectively identifies blockages, harmful gas leaks, and unauthorized manhole openings. The integration of the GSM module ensures that immediate alerts are sent to the concerned authorities, while the Flutter mobile application provides real-time status updates for faster decision-making. Through systematic testing and deployment, the system proved to be accurate, reliable, and capable of operating efficiently in challenging environments. This project contributes to improving public safety, reducing manual inspection risks, and supporting better maintenance of urban drainage infrastructure. Overall, it stands as a low-cost, scalable, and smart solution for modern city management.

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