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Design and Analysis of a Smart Drainage Alert System Using IoT Sensors

Shubh Agarwal
shubh2agarwal0426@gmail.com
Delhi Public School, Uttar Pradesh

ABSTRACT

In the past years, urban flooding due to clogged drains has been a persistent problem in many Indian cities. Even well-planned areas like Gurugram that lie in the NCR region faced extreme waterlogging during monsoons. This research presents a low-cost Smart Drainage Alert System that uses IoT sensors to monitor water levels and detect possible blockages. The proposed model uses an ultrasonic sensor to detect rising water levels, connected to a microcontroller and cloud platform for live data tracking. When the water levels exceed a set threshold limit, the system sends an alert to the user via a mobile application. A small-scale prototype demonstrates that IoT-based monitoring can provide affordable, effective drainage management for communities.

Keywords: *IoT, Smart Drainage System, ESP32, JSN-SR04T Ultrasonic Sensor, MIT App Inventor, Real-Time Flood Monitoring, Smart City Infrastructure.*

1. INTRODUCTION

1.1 Background

In the past years, heavy monsoon rains have caused severe water loggings in urban residential areas due to lack of monitoring of blockages in drainage systems by garbage or foreign objects. In my own city Ghaziabad, clogged drains lead to frequent street floodings as well as damage to local homes. Prior systems generally relied on human oversight, which routinely appeared slow or inconsistent in time.

1.2 Objective

The goal of this project is to design and test a smart drainage alert system that uses IoT sensors to:

i. Detect rising water levels in drains
ii. Identify solid waste or blockages
iii. Send real-time alerts to a mobile application

1.3 Relevance

This study contributes to smart city and green infrastructure initiatives, aligning with India's goals for sustainable urban management.

2. LITERATURE REVIEW

IoT-based flood and drainage systems have been explored by various researchers: Kumar et al. (2021) developed an ultrasonic flood detector but lacked mobile connectivity. Singh & Rao (2022) proposed a GSM-based drainage model, but it had high cost and limited network range. This project focuses on a low-cost Wi-Fi model with community-level alerts, using open-source hardware.

3. METHODOLOGY

3.1 System Design

The invention aiming at sewage draining channel water evacuation, provides an IoT-based monitoring approach for rising water level in the drainage ditch and intelligent alarm when precipitated water exceeds the setting point. This includes an ultrasonic sensor and Arduino Uno-based microcontroller, which measures the difference between the water surface level and that of a sensor signal. The sensor readings decrease when the water level is increasing, which indicates it may be going to overflow. The Arduino takes care and sends this data to an in-house mobile app created with MIT App Inventor using a wifi module. The water level readings are shown in the app, also the user gets a notification when the water level exceeds a certain limit. Such a system can be used to detect flooding risks in advance and take action before the respective municipality or its inhabitants are flooded.

3.2 Prototype Development

The prototype was developed based on a JSN-SR04T ultrasonic sensor connected to an ESP32 microcontroller. The waterproof sensor was installed on a small scale drain model to detect the changing liquid levels in testing. The ESP32, was developed on Arduino IDE and used to make the measurement of distance between sensor and water surface, engineering conversion in the form of received data and transmitting it to interface MIT App Inventor through an HTTP connection. The bespoke mobile app, built with MIT App Inventor, comprised a dashboard that displayed the instantaneous water level and sent an alert notification upon crossing a pre-programmed threshold for safe level.

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3.3 Working Principle

i. The drain is also installed with an ultrasonic sensor JSN-SR04T at the top to measure water depth in real time.
ii. The sensor transmits the distance measurement data to the ESP32 microcontroller, which processes these readings in real time.
iii. The ESP32 checks the water level according to its threshold value in the program.
iv. The system updates the reading as normal if the water level goes below the minimum level.
v. When the water level exceeds this value (flood warning or clogged drain), the ESP32 triggers an alert condition.
vi. The live data and alert signal are then transmitted to the MIT App Inventor mobile phone application using its inbuilt Wi-Fi via an HTTP connection or web server.
vii. The current water level readings are displayed on an easy-to-use interface of the MIT App.
viii. If a high-water event occurs, the status text is forced to change by the software, or an alert message can be displayed to inform the user.
ix. The system runs as a loop with 24×7 monitoring, allowing early warning of flood risks by way of drainage water levels.

3.4 Data Collection

Water Level (cm)	Ultrasonic Reading (cm)	Alert Trigger	Observation
2	18	No	Normal flow
4	10	No	Moderate water
6	5	Yes	Overflow warning
8	3	Yes	Flood risk

4. RESULTS AND ANALYSIS

The mobile app received alerts through the prototype successfully detecting rising water levels, when the water level reached more than 5cm. The detection-alert interval was less than 2 seconds. It was demonstrated by the system that monitoring via sensors could detect overflow situations early and if deployed on a large scale, community flooding could be avoided.

5. DISCUSSION

5.1 Strengths

i. Low-Cost and Scalable Design
ii. Real-Time Monitoring and Alerts
iii. Smart City Integration Potential

5.2 Limitations

i. No Automatic Cleaning Mechanism
ii. Limited Wi-Fi Range
iii. Dependence on Power Supply

5.3 Future Scope

i. Integrate AI to predict flooding probability
ii. Link multiple drains into one city map
iii. Use solar-powered sensors for rural deployment

6. CONCLUSION

This piece illustrates how IoT-based smart drainage systems actually operate to avoid urban floods. The team built a prototype from open-source technology and low-cost sensors, and it just works—it is an effective early warning system that can grow with the needs of a city. This kind of installation is exactly in line with India's Smart City Mission and prods cities in the direction of stricter, more resilient infrastructure in the future.

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