IoT Based Smart Flood Alert System: Framework for Proactive Disaster Management

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***Abstract*—Flooding is a major issue causing damage to people, infrastructure and the community in its entirety due to climate change, rapid urbanization and inadequate drainage system . A new system is needed. Current flood detection methods face gaps in accuracy, real-time data integration, and community-centered early warning delivery. We can implement a real time IoT alert and drainage system that immediately sends a message to the community and a pump system to drive the water elsewhere. The system uses sensors like water level sensor and ultrasonic sensor, which are connected to an Arduino to continuously detect and monitor rising water levels in real time. Data will be collected via the cloud and be sent to people for immediate analysis/implementation. The early warning notification of floods and the system will keep records of water levels over time on IoT platform. The system achieved high accuracy, timely alerts and reliable performance during the testing. Findings confirm reliability, proactive alert system through innovative IOT design integrated system. Future research should enhance flood detection with AI-driven prediction, IoT integration and community focused alerts, and community-focused alerts to ensure faster, more accurate, inclusive early warning systems.**

Keywords- **IoT, flood detection, early warning system, disaster management, smart cities**

I. INTRODUCTION

Flooding is one of the most recurrent and catastrophic natural disasters globally, resulting in vast damage to infrastructure, property, and human lives. Because floods vary greatly in their size, timing, location, and physical impact, it is often impossible to fully control or prevent them[1]. Climate change, rapid urbanization, and inadequate drainage systems have intensified the severity and frequency of flooding events in both developed and developing regions. The IoT based smart flood alert system plays an important role during flooding, as its effective operation helps the government and communities respond to flood situations more efficiently, thereby reducing the overall impact of the disaster[2].

Although it is impossible to completely prevent natural disasters, government agencies must take necessary measures to relocate people to safer areas, which can help reduce losses by up to 30%. In today's modern world, many systems are used for disaster forecasting and mitigation, and they send alerts to authorities in different regions. However, these systems often only manage to slow down the impact rather than fully prevent the damage[3]. The objectives of this paper are to design and evaluate a low-cost, reliable, and scalable IoT-based flood monitoring and alert framework. Specifically, the proposed system aims to (1) provide accurate real-time flood data, (2) ensure fast and community-centred dissemination of alerts, and (3) integrate automated response mechanisms to minimize flood damage.

Traditional flood detection and warning methods, such as manual monitoring and delayed alert systems, often prove insufficient. It involves a detailed evaluation of the damage caused by disasters, along with efforts to restore communication networks, transportation systems, water supply, and electricity in affected areas. One of the most effective nonstructural approaches to disaster management is providing early warnings to people before a disaster occurs. This allows authorities to plan and carry out rescue operations more efficiently and minimize operations more efficiently and minimize loss[4].. The proposed system is suitable for both urban and rural areas. Moreover, since most people now have access to the internet, they can easily monitor real- time updates and check for possible flood warnings through the web server[5].

II. LITERATURE REVIEW

Ongoing research efforts are focused on enhancing flood monitoring and early warning systems through the deployment of IoT technologies, remote sensing tools, and automated mechanisms aimed at improving response efficiency and reducing disaster impact[6]. Many researchers have developed flood warning systems for real-time monitoring and alerting in flood-prone areas. This study mainly focuses on detecting rising water levels and providing early warning alerts to nearby residents about potential flood events [5], [7]. Traditional flood detection methods, such as rain gauges and river water-level stations, provide useful data but often fail to deliver timely alerts for local communities.

The collected information passed to the microcontroller for further processing, and then the data connected to the server through Wi-Fi and allows sharing of the data to internet. The system was efficient due to its cooperation in the functioning of the operations such as monitoring, processing and communication for various background issues[5], [8].Remote sensing and satellite-based systems enhance flood mapping and risk assessment by providing wide-area coverage, including cloud-penetrating SAR imagery[9].

Community engagement is also critical, as studies in South African settlements have shown that local awareness and participation significantly enhance the effectiveness of flood alert systems[10],[11]. To address this, IoT-based systems with sensors have become popular. Ultrasonic sensors and water-level sensors allow continuous monitoring of water accumulation in drains and rivers, providing precise real-time [12], [7]. Therefore, combining ultrasonic and water-level sensors with automated pumps and alert mechanisms represents a practical, low-cost approach to smart flood management that directly addresses both monitoring and rapid response requirements.

III. METHODOLOGY

This project focuses on developing an IoT-based smart flood alert system that continuously monitors flood conditions and provides timely alerts to people in areas that are often affected by floods, helping them stay safe and prepared[6].

A. Selecting Component

The components were selected to build the project such as Water Level, Arduino Microcontroller, Ultrasonic Sensor, Pump, Buzzer, LED Matrix, LED light, Battery to supply pump and Solar panel[13], [8].

B. System Integration

In the project, the water level sensor detects when the water is at the top of storm drain then the ultrasonic sensor detects the level of water in the storm drain, the buzzer will start beeping along with LED. When the water level sensor is triggered it triggers the pump-to-pump water off the drain[6], [5].

C. Dashboard

The dashboard provides a visual interface to view real-time water level data, alert status, and notifications, allowing users to make quick decisions during emergencies[12].

D. Application

This system can be applied in real-life situations to help detect and respond to floods. It provides timely and accurate information about rising water levels. We successfully tested the system in real-time for water level measurement, and it immediately sends an alert when the water level increases. The system can continuously monitor flood conditions and send warning messages to people, helping them stay informed and safe[14], [8].

E. Testing and Validation

The IoT-based smart flood alert system was tested to check its accuracy and real-time response. The sensors successfully detected rising water levels, triggering immediate alerts through the buzzer, LED, and messages. The pump activated automatically to drain excess water, and the solar-powered battery ensured continuous operation. Overall, the system proved reliable and effective in providing timely flood warnings, making it a practical tool for disaster management[2], [6].

The simulation of the IoT-based smart flood alert system shows how all the components function together to identify and react to increasing water levels. In this setup, the ultrasonic and water level sensors constantly monitor and measure the water height in real time. The simulation also shows that when the water level returns to normal, the pump and alerts are deactivated, and the system resumes regular monitoring.

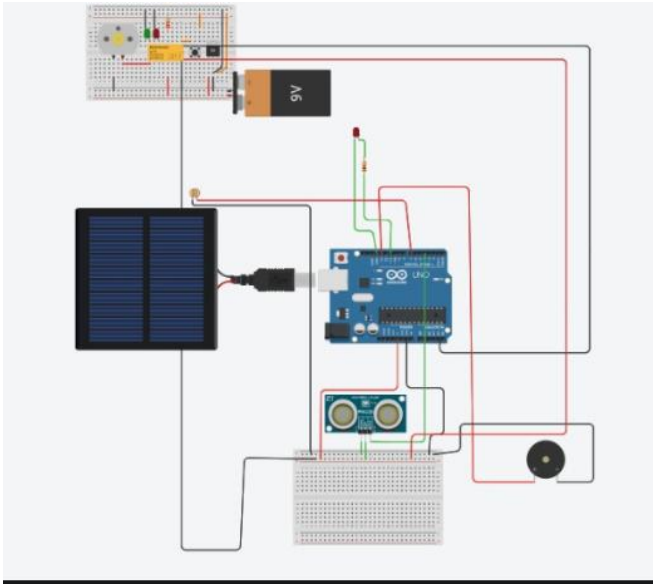

Figure 1:simulation of components.

The dashboard of the IoT-based smart flood alert system offers a simple and interactive way to monitor water levels in real time.

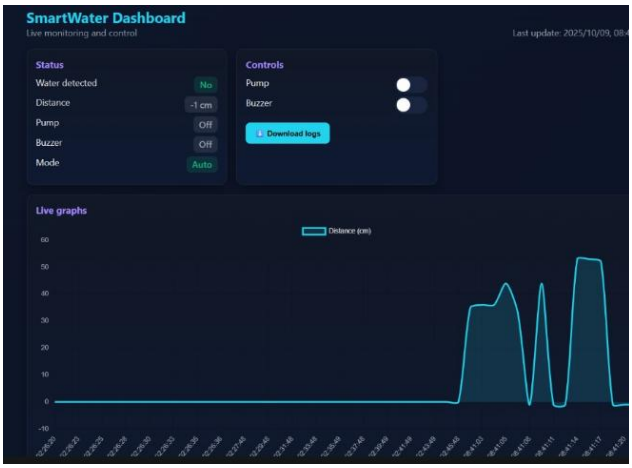

Figure 2: user dashoard

Figure 3: graph showing when we're pumping

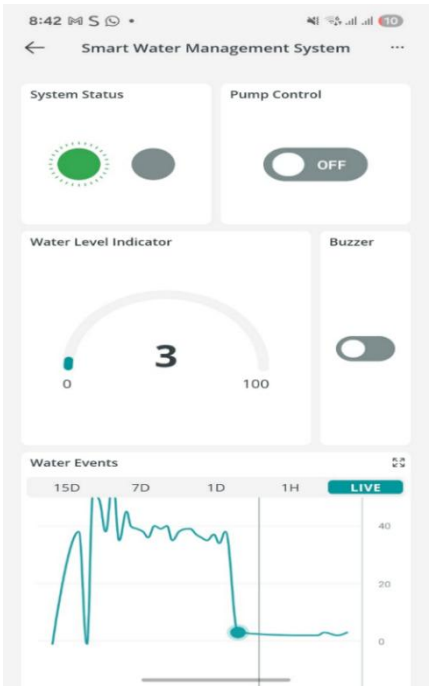

Figure 4: application in mobile tracing for live and controlling buzzer and pump.

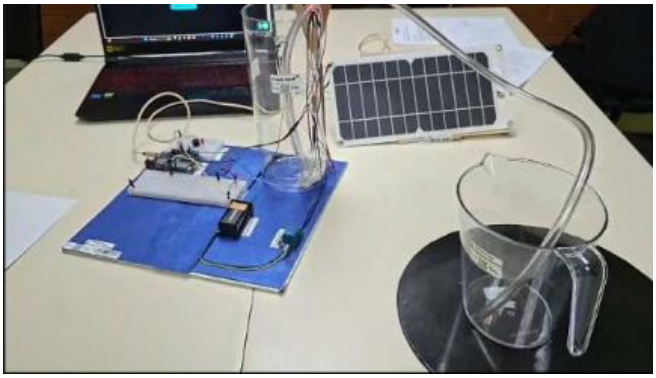

Figure 5: hardware system

The IoT-based smart flood alert system automatically sends alert messages when the water level goes above the safe limit, warning people in time to take action and stay safe.

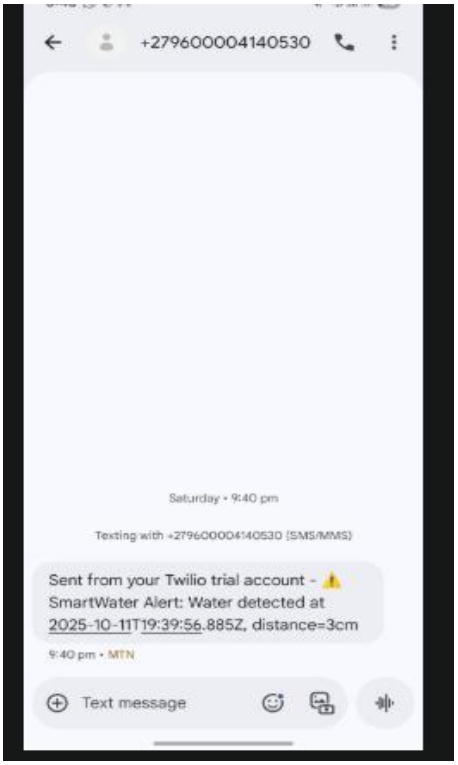

Figure 6: messages sent to notify people.

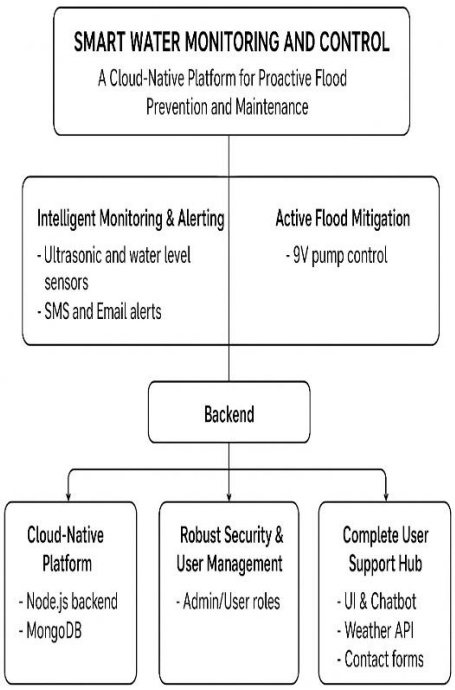

Figure 7: summary of backened

Figure 8: code

IV. PROJECT OVERVIEW

The "Smart Water Monitoring and Control" project is a complete, full-stack IoT solution designed to tackle urban flooding in communities like Durban. It moves far beyond a simple monitor by providing a cloud-native platform for real-time alerts, user-centric support, and active flood mitigation. The system is architected as a professional, scalable application with a clear separation of roles, robust security, and a user-friendly interface, all deployed live on the internet[8].

V. CORE FEATURES

1. Intelligent Monitoring & Alerting:

* A dual-sensor system (ultrasonic and water level) monitors the storm drain 24/7.

* When a critical threshold is reached, the backend instantly dispatches SMS and Email alerts to all registered users.

2. Active Flood Mitigation:

* The system doesn't just warn; it acts. A secure Admin Dashboard allows authorized users to remotely activate a 9V pump to begin pumping water out of the drain, actively mitigating the flood[8].

3. Professional Cloud-Native Platform:

* This is not a local simulation. The entire platform is custom-built and deployed on Onrender, running a Node.js backend and MongoDB cloud database.

* A GitHub CI/CD pipeline is used for professional, version-controlled deployment.

4. Robust Security & User Management:

* The platform features a complete Admin/User role-based system.

* New users must register through a secure workflow that includes Email OTP (One-Time Pin) Verification, ensuring all alerts are sent to valid contacts.

5. Complete User Support Hub:

* The website includes a polished UI, an integrated AI Chatbot ("Flood Management Assistant") for FAQs and safety tips, a live Weather API, and direct contact forms (Email, WhatsApp, and Call).

Key Future Enhancement: The "Active Debris Purge" System

This innovative upgrade is designed to transform the project from mitigation to active intervention.

The Idea: While the current pump mitigates a flood by removing water, this enhancement will allow it to fix the root cause: the clog.

How it Works: A 12V 3-way motorized valve will be added to the pump's outlet. When an Admin diagnoses a clog (e.g., high water but no rain), they can trigger the "Unclog Mode" from the dashboard.

The Action: The valve will divert the pump's full power into the drain pipe through a high-pressure nozzle, creating a powerful jet to actively dislodge and clear the blockage. This transforms the system into a true, remote-controlled maintenance tool, which is a major innovation.

VI. CONCLUSION

This project highlights the potential of using an alert system to help reduce the risks caused by flooding. The proposed prototype was successfully tested and performed as expected. It can send alert messages to users, including information about the time and speed of the water rise, helping to predict how quickly flooding is occurring. With the growing use of the Internet of Things (IoT) worldwide, this system displays real-time water level data on a web server[6].

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REFERENCES

1. Shankar, B.M., et al. *Internet of things based smart flood forecasting and early warning system*. in *2021 5th International Conference on Computing Methodologies and Communication (ICCMC)*. 2021. IEEE.
2. Zahir, S.B., et al. *Smart IoT flood monitoring system*. in *journal of physics: conference series*. 2019. IOP Publishing.
3. Nandhini, B. and C. Selvaganapathi, *Smart Flood Monitoring and Alert System using IoT.* International Journal of Innovative Research in Engineering, 2023. **4**(3): p. 6-10.
4. Prakash, C., A. Barthwal, and D. Acharya, *FLOODWALL: a real-time flash flood monitoring and forecasting system using IoT.* IEEE Sensors Journal, 2022. **23**(1): p. 787-799.
5. Subashini, M., et al. *Development of smart flood monitoring and early warning system using weather forecasting data and wireless sensor networks-a review*. in *2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV)*. 2021. IEEE.
6. Siddique, M., T. Ahmed, and M.S. Husain, *Flood Monitoring and Early Warning Systems--An IoT Based Perspective.* EAI endorsed transactions on internet of things, 2023. **9**(2).
7. Chaduvula, K., B.R. Markapudi, and C.R. Jyothi, *Design and Implementation of IoT based flood alert monitoring system using microcontroller 8051.* Materials Today: Proceedings, 2023. **80**: p. 2840-2844.
8. Burut, J., et al., *Smart Flood Warning System with ESP32-Based IoT Control.* Asian Journal of Vocational Education And Humanities, 2025. **6**(1): p. 21–27-21–27.
9. Zahri, R., et al., *FLOOD EARLY WARNING SYSTEMS (FEWS) IN ENHANCING DISASTER RISK REDUCTION AND COMMUNITY RESILIENCE: A SYSTEMATIC REVIEW.* Journal of Law, 2025. **10**(40).
10. Byaruhanga, N., D. Kibirige, and G. Mkhonta, *Understanding South Africa's Flood Vulnerabilities and Resilience Pathways: A Comprehensive Overview.* Water, 2025. **17**(17): p. 2608.
11. Raphela, T.D. and N. Ekeke, *Resilience and the dissemination of flood disaster early warning messages in a township in South Africa.* Frontiers in Communication, 2025. **10**: p. 1503016.
12. Vadivel, M., et al., *Real-Time Coastal Flood Risk Assessment Using IoT-Integrated Satellite Data and Machine Learning Models for Predicting Flooding Events and Informing Resilient Coastal Planning for Durban Coastal Region, South Africa.* Journal of African Earth Sciences, 2025: p. 105856.
13. Jamali, A. and J.P. Giman. *Performance analysis of IOT based flood monitoring framework in sub-urban*. in *2021 IEEE 7th International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA)*. 2021. IEEE.
14. Merz, B., et al., *Causes, impacts and patterns of disastrous river floods.* Nature Reviews Earth & Environment, 2021. **2**(9): p. 592-609.