SCIENTIFIC RESEARCH REPORT

RESEARCH ON DEVELOPING A SENSOR NETWORK FOR MONITORING RAINFALL AND WATER LEVEL TO SUPPORT FLOOD SURVEILLANCE

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Abstract: This paper proposes a sensor system designed to monitor rainfall and water flow rates to assist in predicting flood risks in sensitive areas. The system uses a rain gauge to monitor rainfall and a flow sensor to measure water flow rates in rivers and streams. Sensor data is collected and processed by an Arduino controller, which then transmits the data over the Internet via Wi-Fi or GSM modules to a cloud server. The data is analyzed and displayed as real-time graphs to help authorities issue flood warnings promptly and accurately. The system can also automatically send alerts to mobile devices when thresholds are exceeded.

I. INTRODUCTION OF PROBLEMS

Flooding is one of the most devastating natural disasters, causing significant damage to lives and property. Despite flood monitoring systems being deployed in many areas over the years, they still face limitations regarding accuracy and early warning capabilities. Therefore, the development of a smart sensor network system capable of collecting and analyzing real-time data is essential. This system aims to provide timely alerts when unusual rainfall or water flow is detected, enabling authorities and residents to take proactive measures.

II. RELATED STUDIES

Traditional flood monitoring methods primarily rely on manual observation and reporting. However, these systems often encounter issues with response time and proactivity. Recently, with the advancement of IoT technology, several sensor systems have been developed to monitor rainfall, water level, and flow rates. While IoT-based systems provide continuous data collection and transmission to management centers over the Internet, they tend to be costly and

may require accuracy improvements. Especially in complex geographical areas, using renewable energy sources such as solar power for the system poses a significant challenge.

III. IMPLEMENTATION SOLUTION

A. System Overview

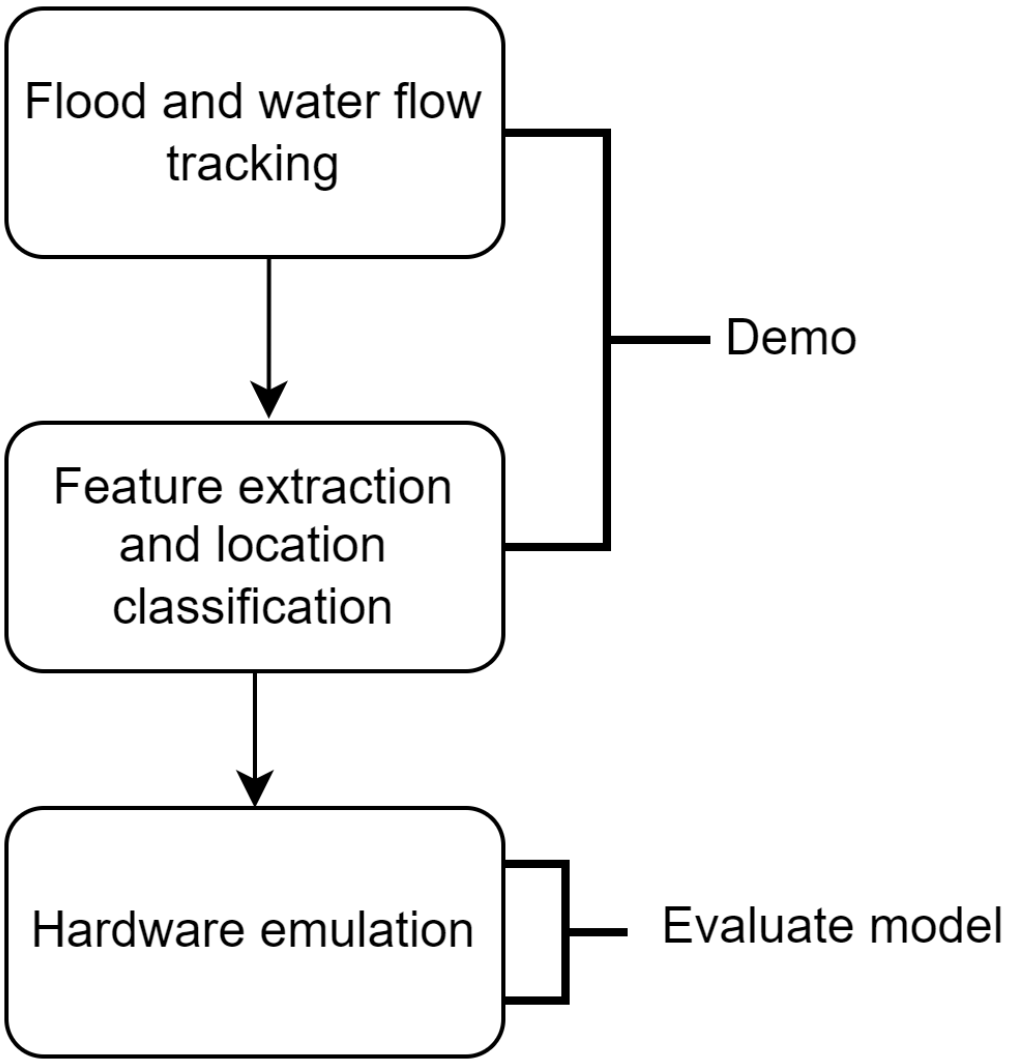

Figure 1. System Simulation

B. System Details

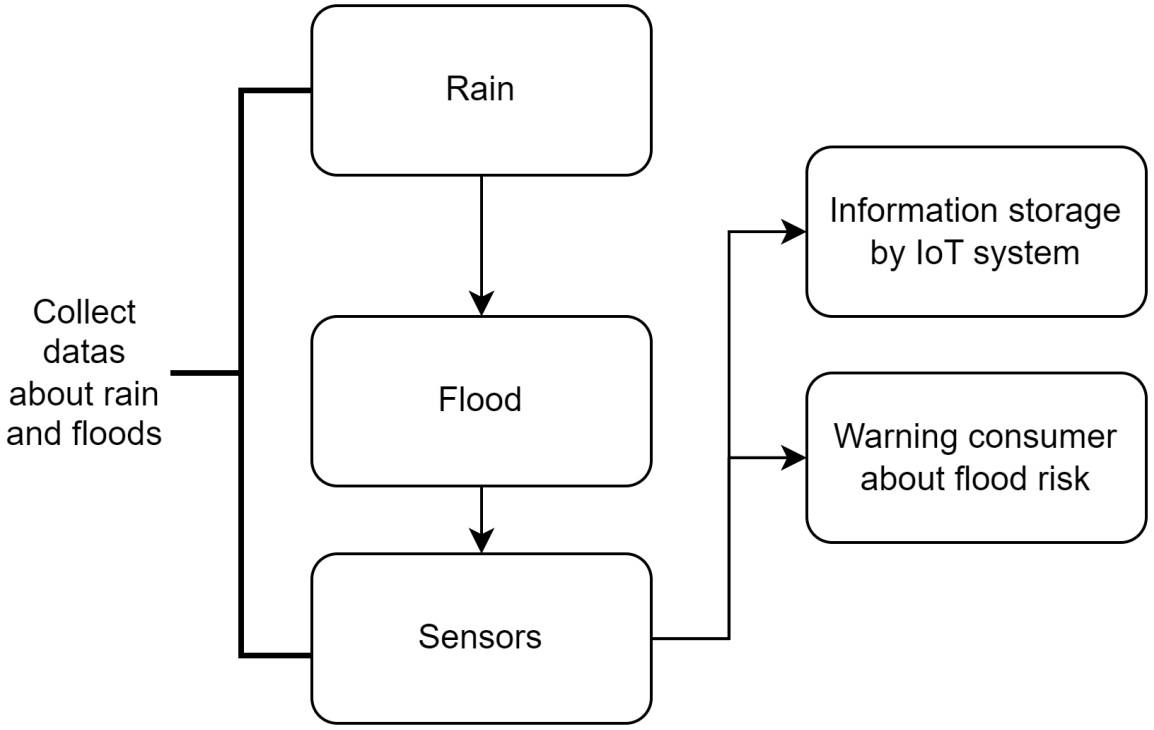

Figure 2. Detailed Operational Diagram

1. System Components

Hệ thống bao gồm các thành phần chính sau đây:

- Rain Gauge: A specialized sensor for measuring rainfall over a set period, which helps assess the severity of heavy rainfall—a primary cause of flooding.

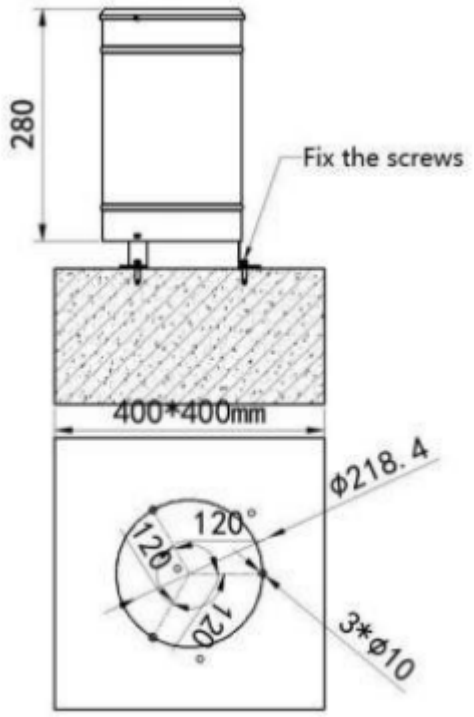

Figure 4. Structure and design of the rainfall sensor

- Flow Sensor: This sensor measures the water flow rate in rivers and streams, allowing us to predict changes in water flow, particularly when water levels rise due to heavy rain.
- Arduino Controller: Serving as the central processor, it collects data from sensors and processes it before sending it to the IoT system. Arduino was chosen for its flexibility and compatibility with common sensors.
- IoT Communication: The system uses Wi-Fi modules (like ESP8266 or ESP32) or GSM to transmit data from the controller to the management server. These modules ensure continuous connectivity between the system and the server, even in remote areas without fixed network connections.
- Power Source: The system utilizes either battery or solar power. The solar energy solution allows the system to operate sustainably in remote areas where access to power is limited.

2. Operating Mechanism

The system operates through the following main steps:

- Data Collection: The rain gauge and flow sensor continuously collect data from the deployment areas.

- Data Processing: The data is sent to the Arduino for processing and calculation, then transmitted over Wi-Fi or GSM to the server.
- Data Transmission: Real-time data is sent to the cloud server, where analysis tools process and display it as real-time graphs.
- Alerting: If rainfall or water flow rate exceeds the permissible threshold, the system automatically sends alerts to users via mobile applications or SMS.

3. Data Analysis

Data is processed and analyzed through cloud servers or specialized monitoring applications. Parameters monitored include cumulative rainfall, flow rate, and flood risk level. These data are presented as graphs for easy monitoring and decision-making by managers.

IV, EXPERIMENTAL RESULTS

- The system was tested in areas with extreme weather conditions, yielding positive results. The sensors demonstrated stable operation and high accuracy in detecting heavy rainfall and sudden increases in flow rates. When rainfall or flow exceeded hazardous levels, the system promptly issued alerts, allowing disaster management agencies to respond in time.

- Preliminary test results are as follows:

Parameter	Result
Rain sensor accuracy	95%
Flow sensor accuracy	93%
Alert transmission time	5 seconds after detecting a threat
Continuous operation time	24/7 (thanks to solar power)
Data transmission method	Via Wi-Fi module (ESP8266 or ESP32) or GSM
Alert format	Notifications via app or SMS

+ Rain gauge accuracy: 95%
+ Flow sensor accuracy: 93%
+ Alert time after detecting risk: 5 seconds
+ Continuous operation time: 24/7 (due to solar power usage)

- EVALUATION AND LIMITATIONS

+ Advantages:

+) Autonomous operation without human intervention.

+) Fast processing speed and immediate alert capability.
+) Use of renewable energy (solar power) enables operation in remote areas.

+ Limitations:

+) Dependent on Internet connectivity for data transmission.
+) High initial cost due to the use of IoT modules and solar power systems.
+) Periodic maintenance is required, especially in harsh weather conditions.

+ CONCLUSION

The sensor network system for monitoring rainfall and water levels provides an effective and modern solution for disaster surveillance, particularly floods. With continuous monitoring and early warning capabilities, this system helps reduce losses of life and property caused by natural disasters. The system also has potential for expansion and application in various high-flood-risk areas.

ACKNOWLEDGMENTS

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REFERENCES

RS485
Rainfall Sensor User Guide