Harnessing IOT to solve underpass flooding Challenges

Mid-Review 3

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GITAM (Deemed-to-be) University

Major Project
Project ID: C4

Project Team:

- **BU21EECE0100166** GALI NARENDRA
- **BU21EECE0100202** SAI JEEVAN
- **BU21EECE0100384** KULA SHEKHAR

Department of Electrical Electronics and Communication Engineering

Project Mentor:
DR. KAMALNATHAN
PROJECT COORDINATOR:
Dr. ARUN KUMAR

INTRODUCTION:

The integration of **Internet of Things (IoT)** technology offers a smart and effective approach to tackling this issue. By deploying **sensors, real-time data analytics, and automated control systems**, IoT enables early detection of water accumulation, proactive warning systems, and efficient drainage management. IoT-powered solutions can monitor water levels, activate drainage pumps automatically, and provide real-time alerts to authorities and commuters, ensuring safer and more resilient urban infrastructure

Abstract

Floods are among the most destructive natural disasters, causing severe damage to infrastructure, loss of lives, and economic setbacks. Traditional flood monitoring and control systems rely heavily on manual observation and outdated methods, which often result in delayed responses and increased vulnerability. To address these limitations, we implemented an **IoT-based Flood Monitoring System** that utilizes the **ESP8266 Wi-Fi module** to provide real-time monitoring, data collection, and automated response mechanisms.

The system integrates multiple sensors, including an **ultrasonic water level sensor, DHT11 temperature and humidity sensor, and rain sensor**, to continuously track water levels, environmental conditions, and rainfall intensity. These sensors are interfaced with an **ESP8266 microcontroller**, which processes the data and transmits it to a **cloud-based web dashboard**. This enables real-time visualization and remote access to critical flood data, allowing authorities and individuals to take proactive measures before floodwaters reach hazardous levels.

To enhance situational awareness, the system also includes an **OLED display** that provides on-site monitoring for local users. Additionally, an **automated relay mechanism** is implemented to trigger preventive actions, such as activating drainage systems, sounding alarms, or sending SMS/email alerts to concerned stakeholders. By leveraging IoT and wireless communication, the system ensures a faster response time and minimizes the impact of flooding.

Objective and Goals

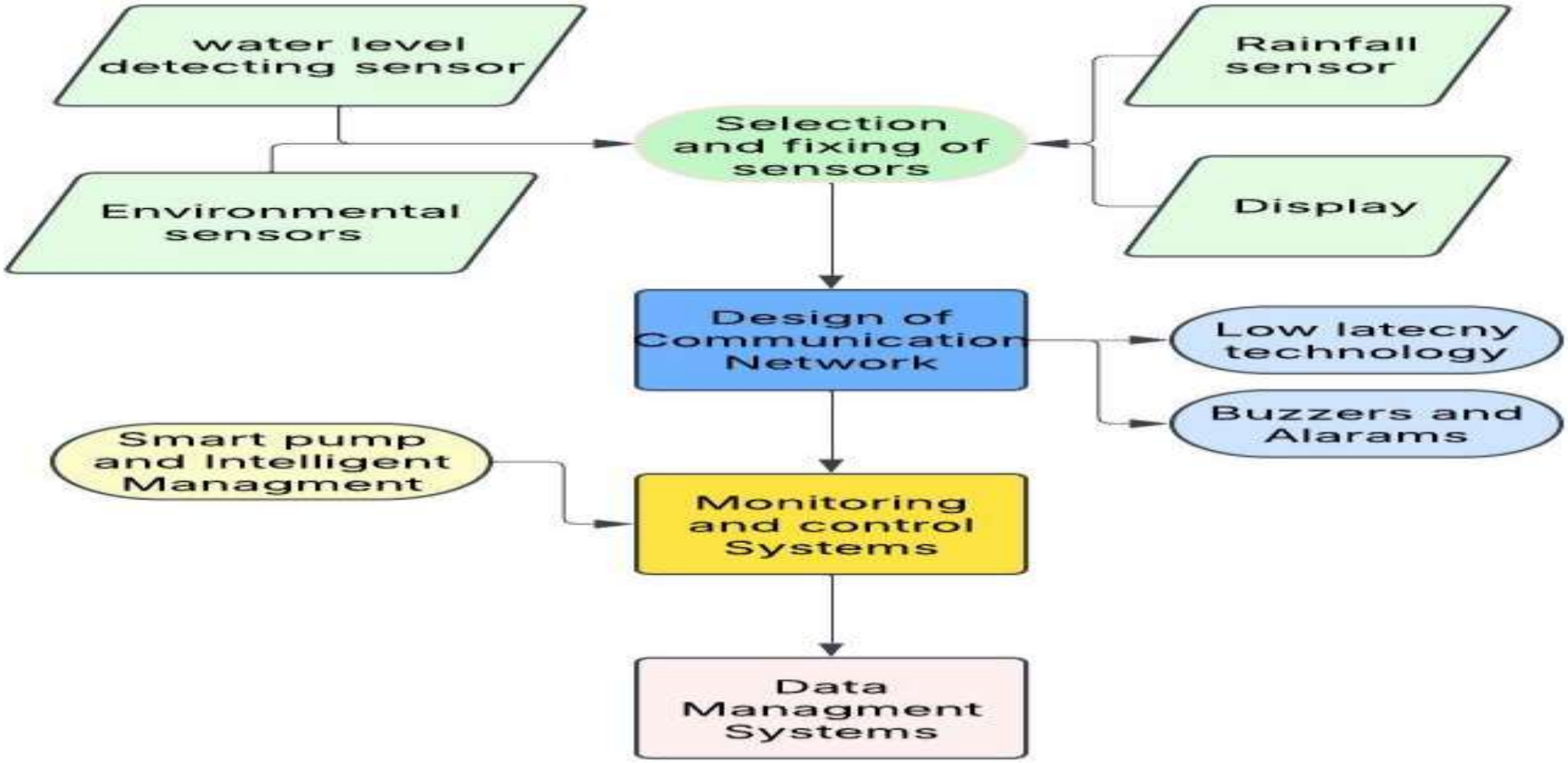
Objective

1. To develop a system that continuously monitors water levels, rainfall, temperature, and humidity in flood-prone areas using IoT sensors.
2. To create an alert mechanism that notifies citizens and authorities about potential flooding through visual (LEDs), audible (buzzers), and web-based notifications.
3. To implement an automated drainage system using relays to control pumps and prevent water accumulation in critical areas like underpasses.

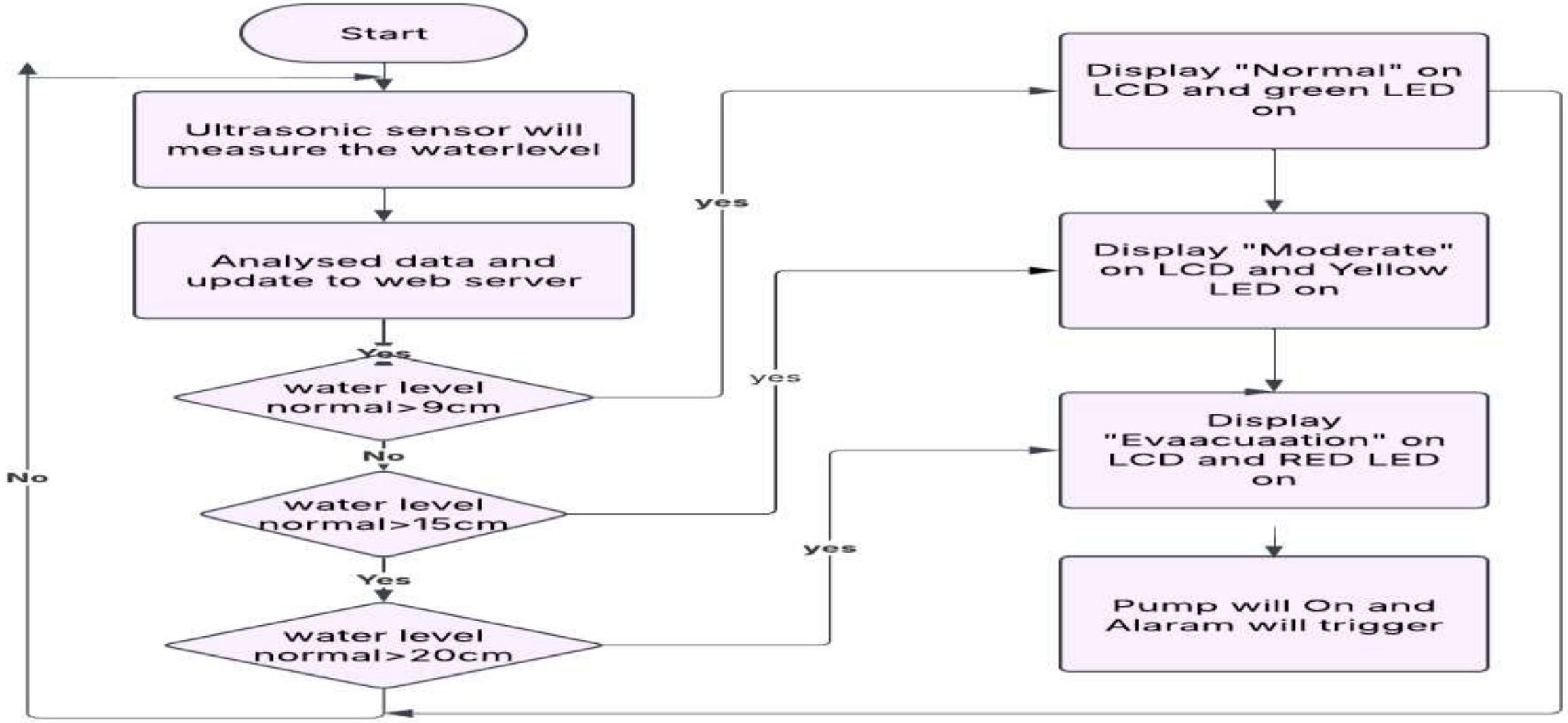
Goals

- Reduce the risk of injury or loss of life by providing timely flood warnings and enabling quick evacuation
- Enable the public to access real-time flood data and make informed decisions during emergencies
- Provide authorities with accurate and real-time data to improve flood management strategies and resource allocation.
- Ensure the smooth flow of traffic by preventing water accumulation in underpasses and other critical areas

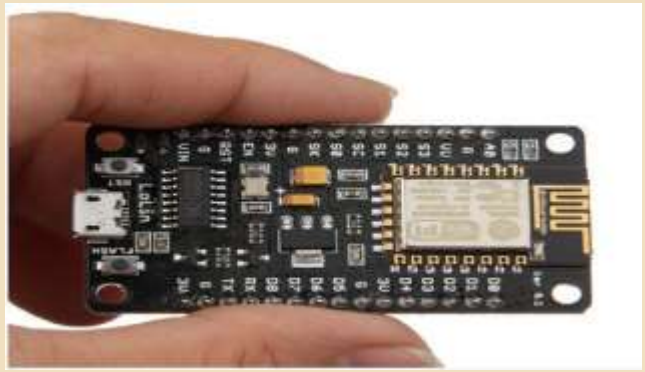
Structural Diagram



Behavioural Diagram



Sensors we used



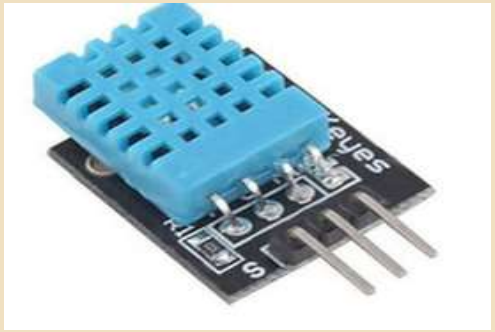
Microcontroller: NodeMCU ESP8266

Used for data processing and communication.

Integrates Wi-Fi connectivity for real-time data transmission.

LM393 Water Level Sensor

Detects water levels in real time.



DHT11 Sensor

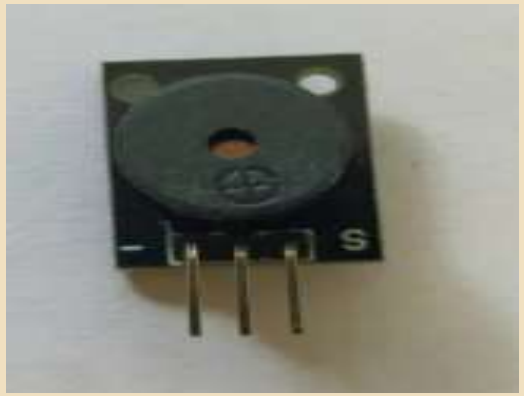
Measures temperature and humidity.

Rain Sensor

Detects rainfall intensity.

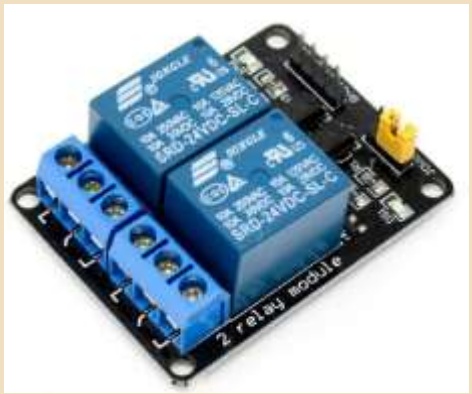
LEDs (Green, Yellow, Red)

Provide visual alerts based on water level thresholds



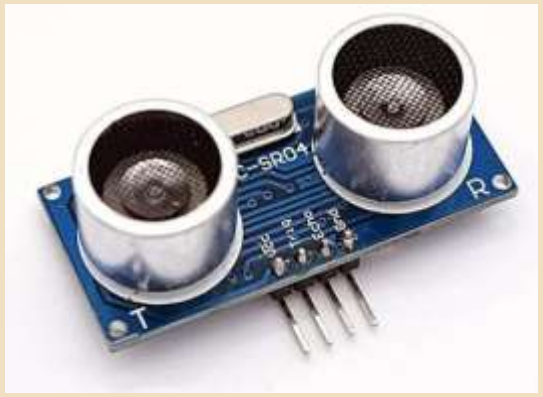
Buzzer

Provides audible alerts for immediate warnings



Relay Module

Controls the automated drainage system (water pumps).



Ultrasonic Sensor

It continuously monitors the water level

Organic Light Emitting Diode

It displays the values

Key Steps in the Approach

1. **Data Collection**:

Sensors continuously monitor environmental parameters:

Water Level: Detects rising water levels in underpasses and low-lying areas.

Temperature and Humidity: Provides additional context for flood prediction.

Rainfall Intensity: Helps predict potential flooding during heavy rains.

2. Data Processing

The **NodeMCU ESP8266** processes the sensor data and compares it against predefined thresholds.

Green LED indicates safe conditions.

Yellow LED indicates rising water levels.

Red LED and buzzer activate, signaling immediate evacuation.

3. Data Transmission

Processed data is transmitted to the **web server** via the **Wi-Fi module**.
The web server updates in real-time, allowing the public to monitor flood conditions.

4. Automated Response:

When water levels exceed safe thresholds, the system activates pumps to remove excess water

5. Alert Mechanism:

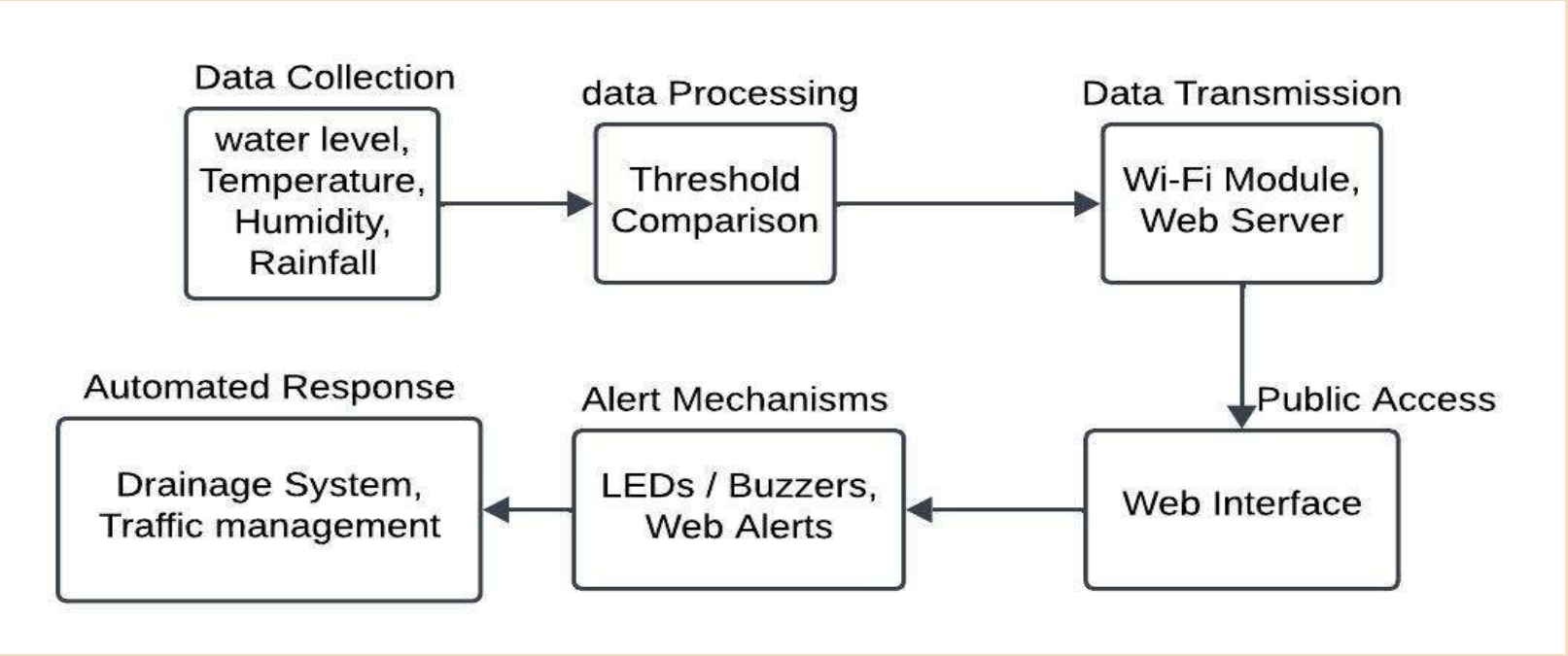
LEDs and buzzers provide immediate warnings to people in the vicinity.

The web server displays real-time flood data and sends alerts to users with internet access.

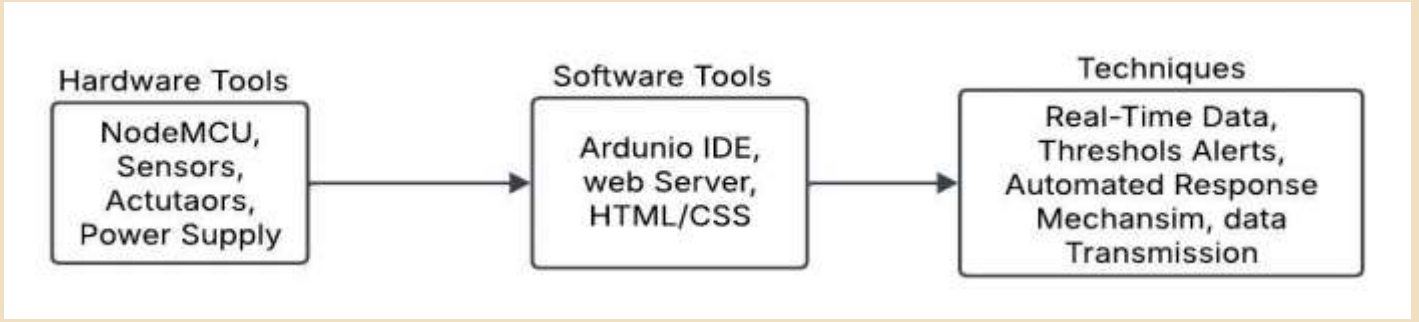
6. Public Accessibility:

The web server is designed to be user-friendly, allowing the public to access real-time flood data from any device with internet connectivity.

Data is displayed in an easy-to-understand format, including water level percentages, temperature, and humidity.



Approach



Tools and Techniques

Arduino code for LEDS

Moisture level ≤ 500:
•**Green LED ON**
•LCD shows **"System Normal"**

500 < Moisture level ≤ 750:
•**Yellow LED ON**
•**Relay (pump) ON**
•LCD shows **"Water Detected! Pumping Water...“**

Moisture level > 750:
•**Red LED ON, Buzzer ON**
•**Relay (pump) ON**
•LCD shows **"Critical Water! Pump Activated!"**

Esp8266 PINS

Water level sensor – A0, 3V, GND
DHT11 – D6, GND, 3V
Relay 1,2 – D0, D7
Green Light – D2, GND
Yellow Light – D3, GND
Red Light – D8, GND
OLED – D1, D4, GND, 3V

Unused Pins
TX, RX

Result:

The system provides **real-time monitoring** of water levels, temperature, and humidity in urban underpasses and low-lying areas.

The system includes an **automated drainage system** that activates pumps to remove excess water when water levels exceed predefined thresholds

A user-friendly web server allows the public to access real-time flood data from any device with internet connectivity.

The system is designed to be **low-cost** and **easy to maintain**, making it suitable for widespread deployment in urban and rural areas.

Impact:

Enables authorities and the public to track flood conditions in real time, improving preparedness and response.

Reduces the risk of flooding and minimizes property damage in critical areas.

Increases community awareness and preparedness by providing timely and accurate flood information.

Ensures timely warnings to the public and authorities, enabling quick evacuation and response

Prototype video

Conclusion

The **IoT-based Flood Monitoring System** successfully addresses the critical challenges of urban flooding by providing a **real-time, automated, and cost-effective solution** for flood detection and response. By integrating multiple sensors with the **ESP8266 microcontroller**, the system delivers accurate and timely data on water levels and environmental conditions. This data is transmitted to a **cloud-based web dashboard**, enabling remote monitoring and real-time visualization for authorities and the public. Additionally, the system includes an **OLED display** for on-site monitoring, ensuring accessibility in areas with limited internet connectivity.

The implementation of **automated response mechanisms**, such as activating drainage systems, and sounding alarms, significantly reduces response times and minimizes flood damage. The system's **low-cost and scalable design** makes it suitable for widespread deployment in both urban and rural flood-prone areas. Furthermore, its **environmental durability** ensures reliable performance under harsh weather conditions, enhancing its practicality for real-world applications.

By leveraging IoT technology, this project provides a **comprehensive and innovative solution** for flood monitoring and management. It empowers communities and authorities with the tools needed to take **proactive measures**, ultimately reducing the risk of loss of life, property damage, and economic setbacks caused by flooding. The system's success demonstrates its potential to contribute significantly to **smart city development** and **disaster risk reduction**, making it an essential tool for improving safety and resilience in flood-prone regions.

FUTURE WORK

The **IoT-based Flood Monitoring System** has demonstrated significant potential, but there are several areas for future improvement and expansion. One key area is the **integration of machine learning algorithms** to enhance flood prediction capabilities. By analyzing historical and real-time data, the system could provide **early warnings** and predictive insights, improving disaster management efficiency. Additionally, exploring **alternative communication methods** such as GSM or LoRaWAN could address limitations in areas with poor Wi-Fi connectivity, ensuring broader coverage and reliability.

Another area for future work is the **incorporation of additional sensors**, such as soil moisture and wind speed sensors, to provide a more comprehensive understanding of flood conditions. This would further improve the system's accuracy and predictive capabilities. Furthermore, **enhancing the system's energy efficiency** through solar power integration or low-power modes could make it more sustainable and suitable for remote deployments.

Finally, **scaling the system for large-scale deployment** in multiple regions and integrating it with existing urban infrastructure (smart traffic systems) could maximize its impact. These advancements would make the system an even more robust and versatile tool for flood monitoring and disaster risk reduction

THANK YOU

Have a Great Day !