Disaster management solution

Group 1

Higher National Diploma in Software Engineering

IOT Coursework

24.2F

School of Computing and Engineering

National Institute of Business Management

Kurunegala

Title of the project - Tuition Management Information Android Application

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Name of the Program - Higher National Diploma in Software Engineering.

Name of the Institution - National Institute of Business Management.

Date of Declaration - 3/7/2025

The project is submitted in partial fulfilment of the requirement of the Higher National Diploma in Software Engineering of National Institute of Business Management.

Declaration

I certify that this project does not incorporate without acknowledgement, any material previously submitted for a Higher National Diploma in any institution and to the best of my knowledge and belief, it does not contain any material previously published or written by another person or myself except where due reference is made in the text. I also hereby give consent for my project report, if accepted, to be made available for photocopying and for interlibrary loans, and for the title and summary to be made available to outside organizations.

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Supervised By Date

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Introduction

Background

Natural disasters have become a recurring problem in Sri Lanka due to its tropical climate and diverse geography. The southwest and northeast monsoons often bring heavy rainfall, leading to floods in low-lying areas and landslides in hilly regions. According to the Disaster Management Centre (DMC), over 100,000 people were affected by floods and landslides in 2023 alone. Such disasters not only claim lives but also cause severe damage to infrastructure, agriculture, and housing, which significantly affects the economy.

Problem Context

Although organizations like the National Building Research Organization (NBRO) and the Department of Meteorology issue warnings, the communication of these warnings is often delayed or inaccessible to rural communities. Television and radio are not always effective, and many residents in remote areas do not receive the information on time. This gap in communication increases the vulnerability of communities during disasters.

Role of IoT in Disaster Management

The Internet of Things (IoT) provides an opportunity to revolutionize disaster management by enabling real-time monitoring of environmental parameters. Sensors can continuously track changes in soil conditions, water levels, and vibrations, transmitting this data to cloud servers for analysis. Alerts can then be disseminated through mobile applications, ensuring rapid communication to those at risk. IoT systems are cost-effective, scalable, and highly adaptable to localized conditions, making them suitable for developing countries like Sri Lanka.

Project Scope

This project focuses on floods and landslides, as they are the most common and devastating disasters in Sri Lanka. The system does not include tsunamis or earthquakes in its current scope, but it lays the foundation for future expansion. The report outlines the design of the IoT-based system, its implementation, testing, and the results achieved from the prototype.

Problem Definition

Existing Issues

- Lack of reliable detection methods in many vulnerable areas.
- Inadequate communication infrastructure to deliver timely warnings.
- Dependence on traditional media, which is not accessible to all residents.

Identified Gaps

- No localized IoT-based disaster management system is currently in use in Sri Lanka.
- Limited historical data on soil and rainfall conditions for predictive analysis.
- Difficulty in integrating residents into official disaster management communication channels.

These gaps highlight the urgent need for a system that not only detects disasters but also ensures effective and direct communication with residents.

Objectives of the Project

General Objective

To develop an IoT-based disaster management system capable of detecting floods and landslides and providing real-time alerts to residents.

Specific Objectives

- To design and implement a prototype using IOT sensors.
- To develop a mobile application that delivers timely alerts.
- To establish a backend system for processing and storing disaster-related data.
- To test the effectiveness of the system under simulated disaster conditions.

Expected Outcomes

- Improved disaster preparedness and reduced casualties.
- A functional prototype demonstrating feasibility.
- Stored data that can be used for future disaster predictions.

Literature Review

Global Approaches

Countries like Japan and the USA use advanced disaster management systems with seismic sensors, satellite monitoring, and predictive modeling. Japan's earthquake early warning system has proven effective in reducing casualties by providing seconds of warning before major quakes. In the USA, flood monitoring systems are integrated with weather forecasting models to issue timely alerts.

Disaster Management in Sri Lanka

Sri Lanka primarily relies on government institutions such as the NBRO and the Department of Meteorology. While SMS alerts are used in some cases, coverage is inconsistent, and not all residents receive these warnings on time. The lack of community-focused, real-time systems limits the effectiveness of current strategies.

Role of IoT

Research has shown IoT to be an effective tool in monitoring environmental changes. In India, IoT-based flood monitoring systems have been piloted in Kerala, where water level sensors transmit data to centralized servers. Similarly, Indonesia has tested landslide monitoring systems using tilt sensors and accelerometers. These examples highlight the feasibility of low-cost, community-focused solutions.

Research Gap

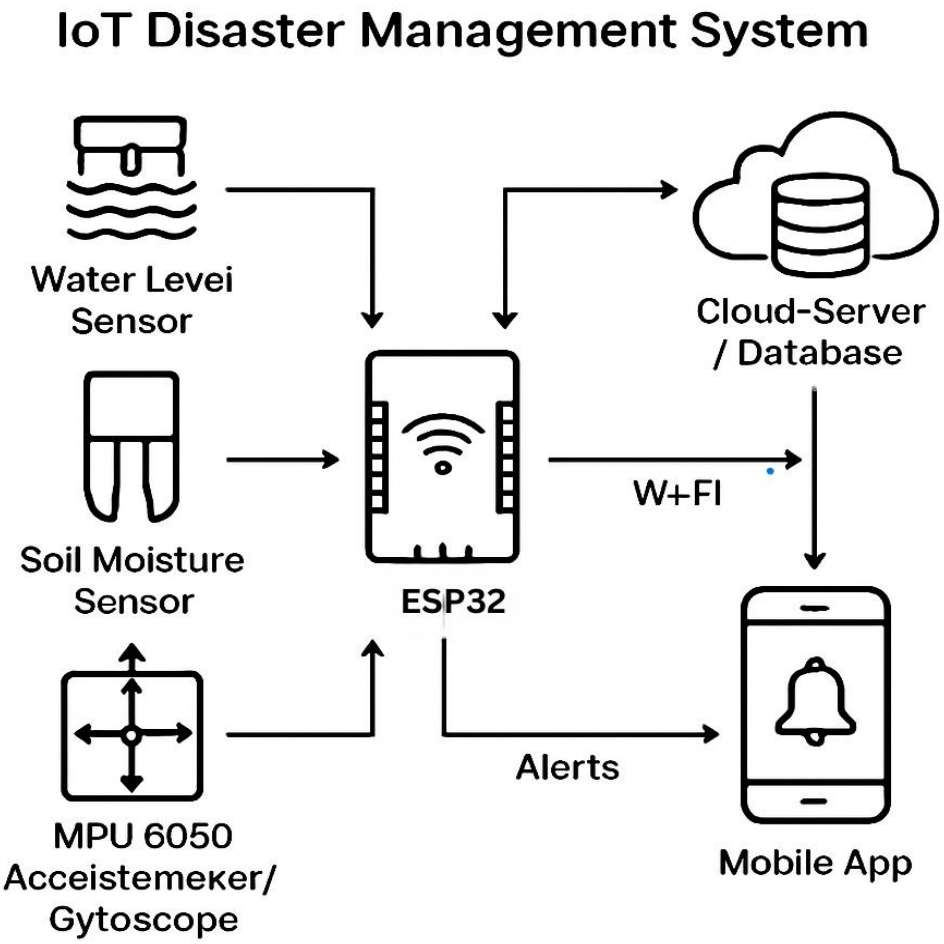
Despite successful international implementations, Sri Lanka lacks a localized IoT disaster management solution that directly connects residents to real-time data. This project addresses that gap by combining IoT sensors with a mobile application tailored for Sri Lankan communities.

System Design and Methodology

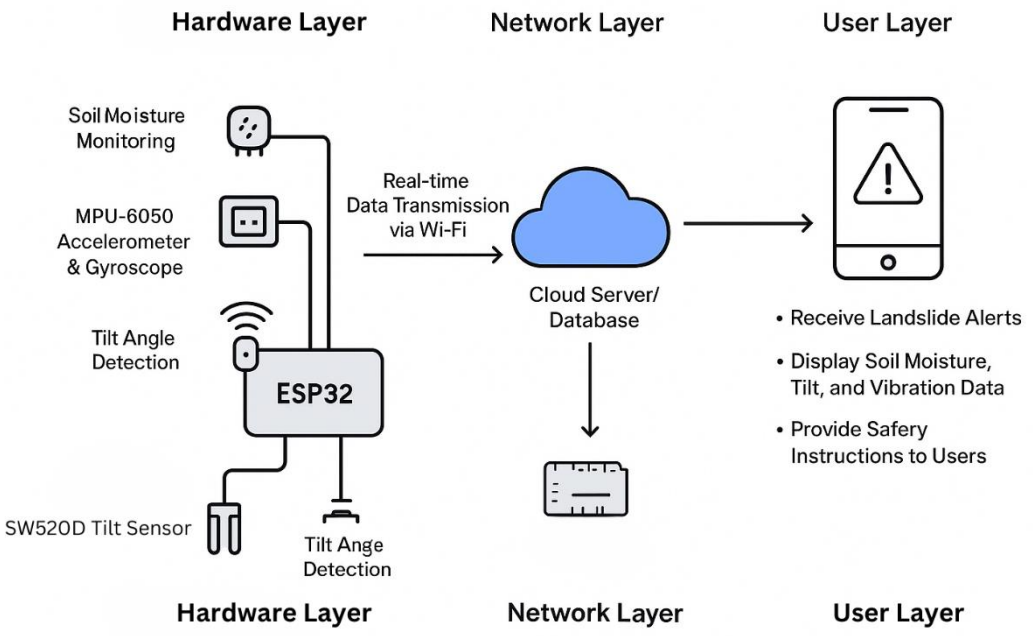
System Architecture

The system integrates IOT devices with a backend server and a mobile application. Sensors monitor environmental conditions and transmit data to the cloud. The server processes the data and determines whether thresholds are exceeded. If a potential disaster is detected, alerts are pushed to the mobile application.

Flood System Architecture Diagram



Landslide System Architecture Diagram



Hardware Components

- **Water Level Sensor (MD0207):** Detects rising water levels.
- **Soil Moisture Sensor:** Monitors soil saturation before floods or landslides.
- **MPU-6050 Accelerometer and Gyroscope:** Detects ground vibrations.
- **SW520D Tilt Sensor:** Detects angle changes indicating soil shifts.

Software Components

- **Backend**: Implemented with NodeJS and a REST API for data processing.
- **Database**: Firebase for storing sensor data.
- **Mobile Application**: Developed using Android Studio, with push notification features

Data Processing and Alerts

Thresholds were defined for each sensor. When readings exceeded these thresholds, alerts were triggered automatically. Notifications were sent through Firebase Cloud Messaging (FCM) to the mobile application.

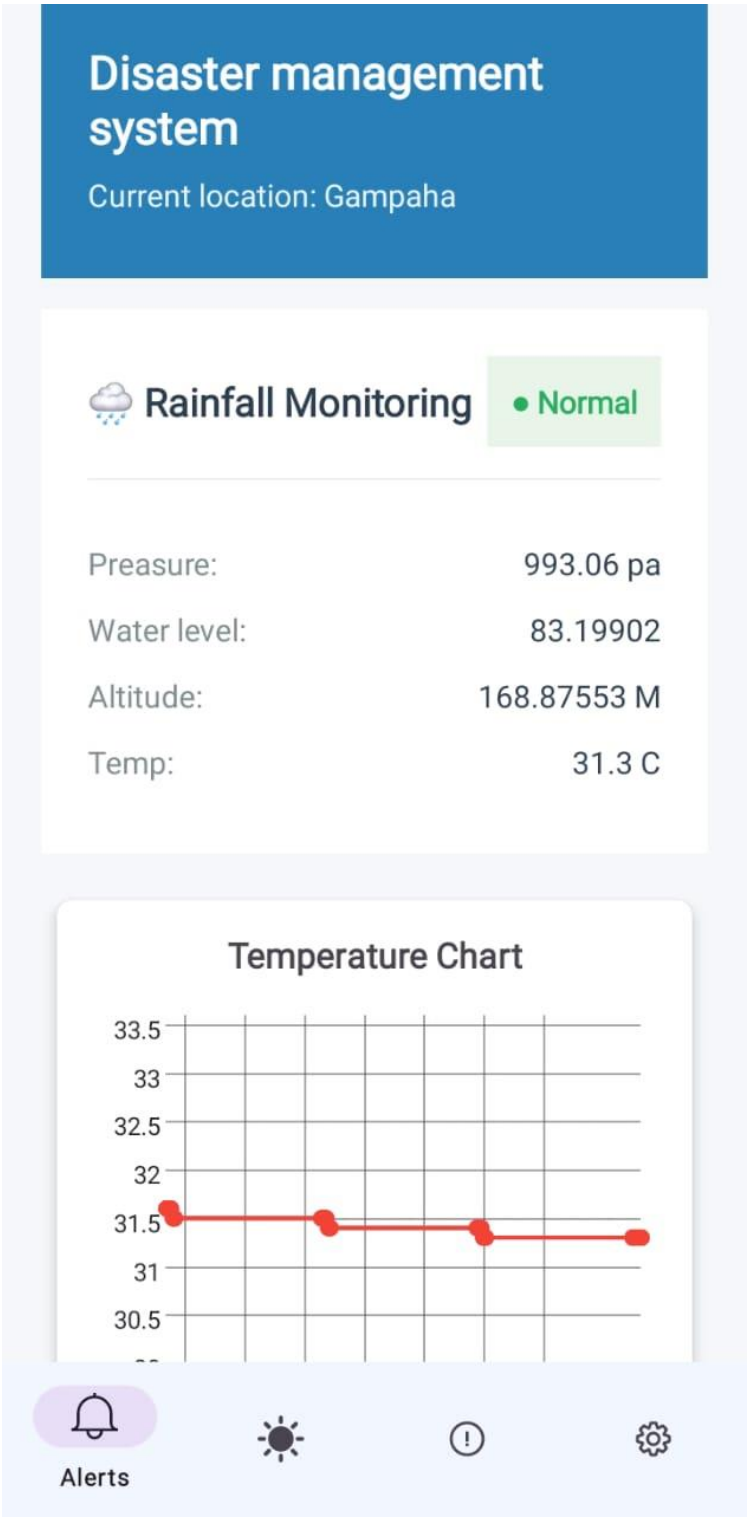
Implementation

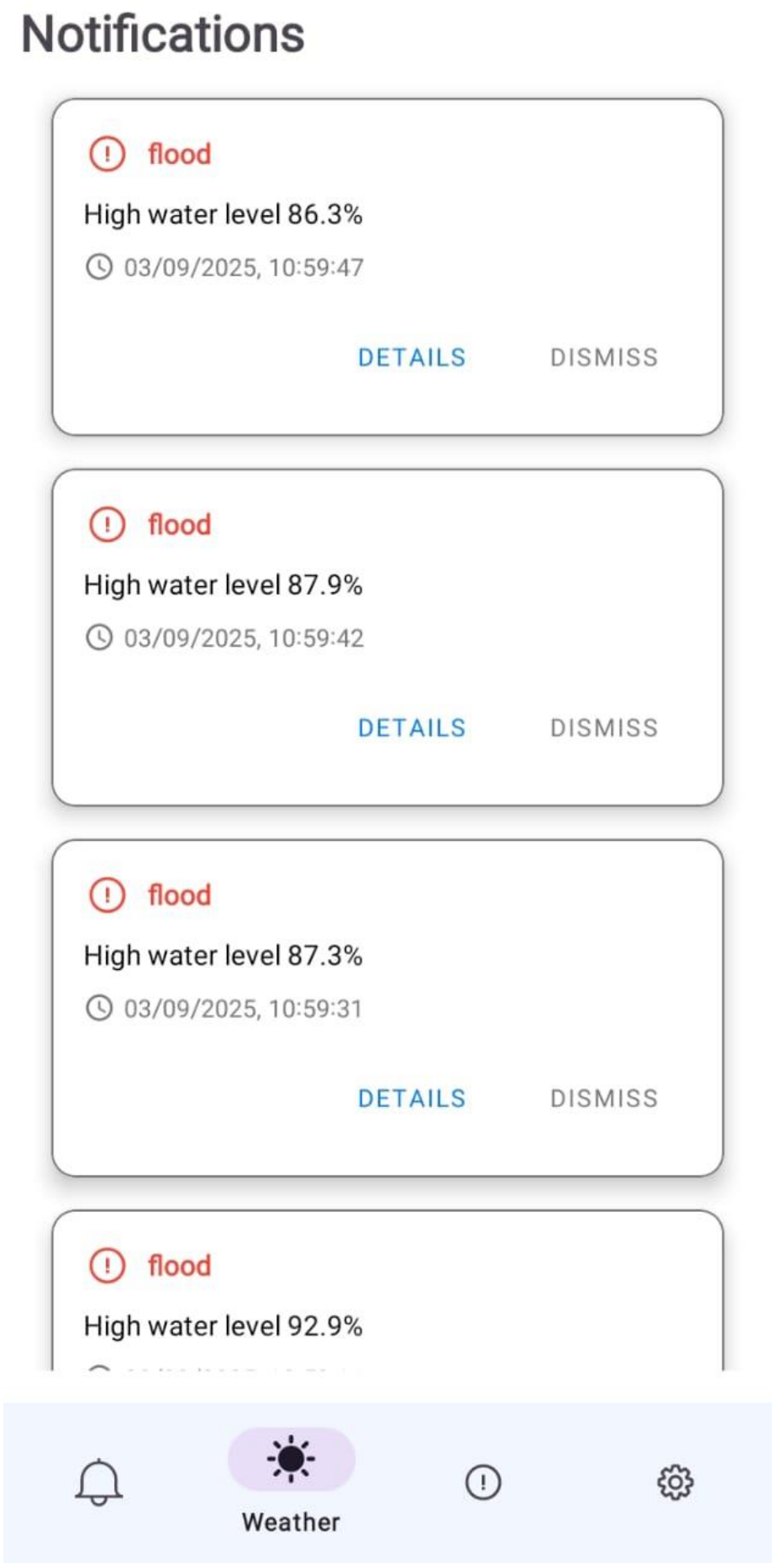
Prototype Development

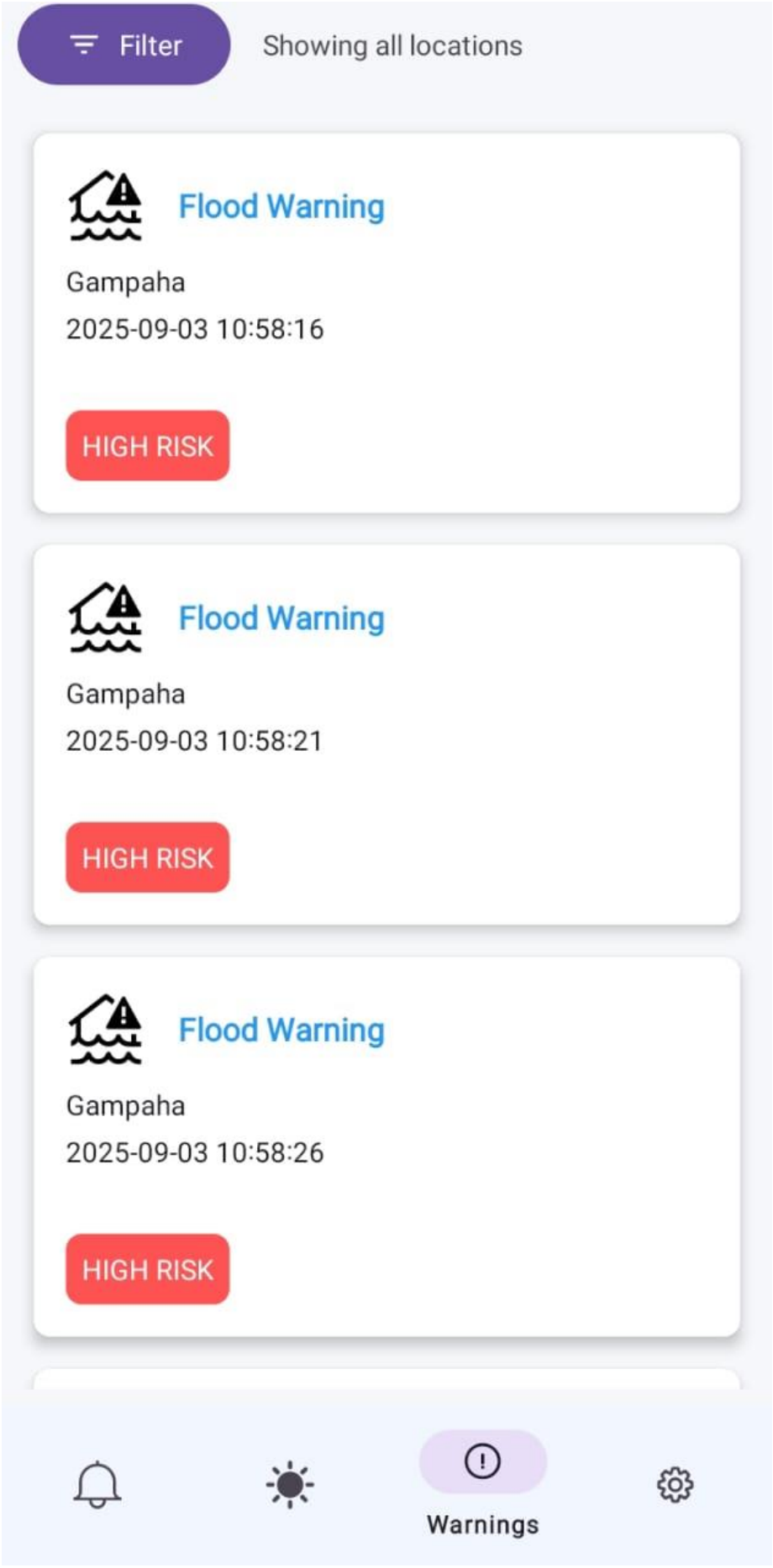
The prototype was built using Arduino microcontrollers connected to the selected sensors. Test environments were created to simulate floods (using water containers) and landslides (using soil beds with varying moisture and tilt).

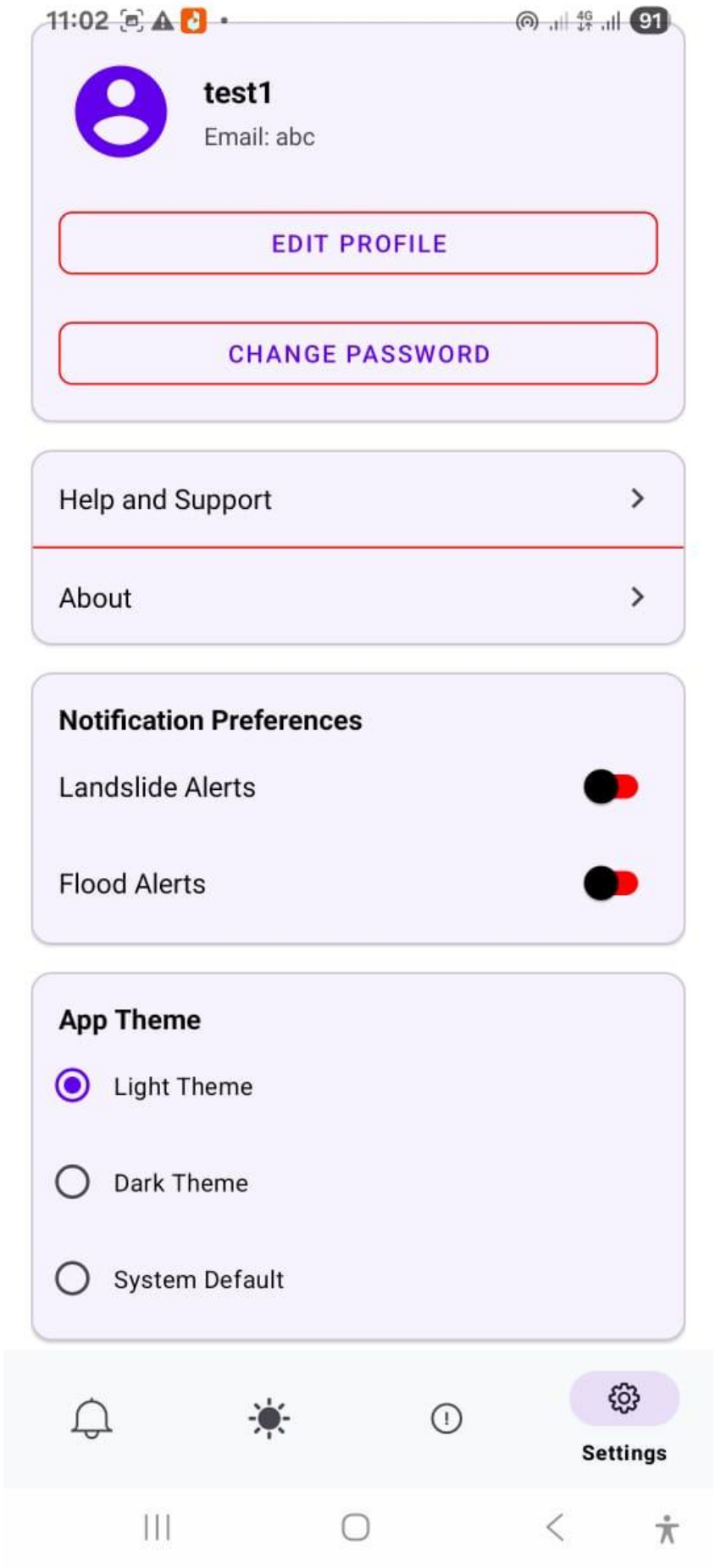
Mobile Application

- A dashboard displaying current status.
- Push notifications for alerts.
- Showing all Flood and Landslide Alerts.
- Settings Panel


Disaster management system
Current location: Gampaha
Rainfall Monitoring
Normal
Preasure:
993.06 pa
Water level:
83.19902
Altitude:
168.87553 M
Temp:
31.3 C
Temperature Chart
33.5
33
32.5
32
31.5
31
30.5
Alerts


Notifications
flood
High water level 86.3%
03/09/2025, 10:59:47
DETAILS
DISMISS
flood
High water level 87.9%
03/09/2025, 10:59:42
DETAILS
DISMISS
flood
High water level 87.3%
03/09/2025, 10:59:31
DETAILS
DISMISS
flood
High water level 92.9%
Weather


Filter
Showing all locations
Flood Warning
Gampaha
2025-09-03 10:58:16
HIGH RISK
Flood Warning
Gampaha
2025-09-03 10:58:21
HIGH RISK
Flood Warning
Gampaha
2025-09-03 10:58:26
HIGH RISK
Warnings


11:02
91
test1
Email: abc
EDIT PROFILE
CHANGE PASSWORD
Help and Support
About
Notification Preferences
Landslide Alerts
Flood Alerts
App Theme
Light Theme
Dark Theme
System Default
Settings

Create Account

Full Name

Address

City

Contact Number

Email

Family Members

Password

Confirm Password

Create Account

Integration

All components were integrated through Wi-Fi communication. Sensor data was sent to the server, processed, and notifications were sent to the mobile application in near real time.

Testing and Results

Testing Process

Tests were conducted to evaluate flood detection, landslide detection, and mobile application performance.

Results and Analysis

- **Flood Detection**: Water level sensors successfully triggered alerts when water exceeded thresholds.
- **Landslide Detection**: Soil moisture and tilt sensors responded accurately to changes.
- **Mobile App**: Alerts were received within 3–5 seconds of detection.

Limitations

- Sensor accuracy was affected by noise.
- Network connectivity issues caused occasional delays.
- Prototype conditions could not fully replicate real-world disasters.

Discussion

The results indicate that the IoT-based system is effective for disaster management. Compared to traditional methods, it provides faster and more direct communication. However, challenges such as sensor durability, large-scale deployment costs, and connectivity must be addressed for real-world use.

Conclusion and Future Work

This project successfully demonstrated the potential of IoT for disaster management. The prototype detected floods and landslides under simulated conditions and provided timely alerts through a mobile application.

Future improvements include:

- Integration with government disaster management systems.
- Deployment of industrial-grade sensors.
- Use of AI for predictive analytics.
- Expansion to cover tsunamis and earthquakes.

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