IoT based Smart Weather Monitoring with Flood and Earthquake Detection

Nachimuthu S.[1], Shubhakavee N.[2], Subitha S.[3], Umamaheswari M.[4], Vishal J S.[5]

[1]Assistant Professor, [2-5]UG Student, Department of ECE, Velalar College of Engineering and Technology, Erode, India.

E-mail: [1]nachi.velelar@gmail.com, [2]shubhakavee@gmail.com,[3] subitha0519@gmail.com,

[4]umamurugesan2327@gmail.com, [5]jsvishal146@gmail.com

Abstract

Weather monitoring is essential for understanding the changing climatic conditions. Traditional weather monitoring system are slow, labor intensive, and outdated, often prone to error and inaccurate predictions. To overcome these challenges and provide an up-to date weather information, the IoT (Internet of Things) has been implemented in weather monitoring. This research presents an IoT-based weather monitoring system integrated with sensors to ensure accurate weather monitoring, including flood and earth quake detection. The collected data, such as temperature, humidity, atmospheric pressure, rainfall, flood levels, and seismic activity, is transmitted through IoT protocols to a centralized repository (Cloud) and visualized in the Blynk App. Flood sensors are strategically positioned in flood-prone areas, continuously monitoring water levels to detect abnormal rises indicative of potential floods. Similarly, seismic sensors detect ground vibrations and seismic activity, providing early alerts for earthquakes. The proposed system offers a comprehensive approach to monitor the weather, contributing to enhanced preparedness and mitigation strategies for natural disasters.

Keywords: Internet of Things, Weather Monitoring, Flood, Earthquake Detection, Blynk App, Sensors.

DOI: https://doi.org/10.36548/jsws.2024.3.003
Received: 12.07.2024, received in revised form: 07.08.2024, accepted: 24.08.2024, published: 10-09-2024

1. Introduction

The integration of IoT technology into weather monitoring systems has significantly transformed the landscape of environmental data collection, analysis, and utilization [1,2]. This research introduces an innovative IoT-based weather station with flood and earthquake detection features, with the aim of enabling a comprehensive environmental monitoring and early warning systems against potential natural disasters [3-5].

Figure 1. Traditional Weather Monitoring Stations [10]

Figure 1 shows the traditional weather monitoring station, which includes a rain gauge, anemometers, temperature gauge, pyranometers, relative humidity, pyrheliometer with solar panels to power the sun tracker, and barometer. Conventional methods are large, prone to errors, slow, and provides inaccurate predictions if not properly maintained. This process is laborious process and include cost expenditure also.

The challenges in the conventional methods have been overcome by the development of compact weather monitors, made possible by the rise of IoT. By using IoT technology, the system improves the weather monitoring capabilities and the disaster preparedness measures. Through the seamless integration of smart sensors and IoT infrastructure, the proposed weather monitoring system offers invaluable insights into environmental conditions, enabling proactive responses to impending natural disasters. Its ability to detect and alert authorities and communities to flood and earthquake risks mitigates the impact of such events [6-9]. Overall, this research states the significance of IoT-enabled solutions in advancing environmental monitoring and disaster management efforts.

1.1 Objective

The research aims to develop a comprehensive monitoring and detection system for floods and earthquakes, with the use of IoT sensor to mitigate damages and enhance awareness.

2. Methodology

The methodology for this research involved a multifaceted approach. Initially, extensive studies were conducted to identify the most critical environmental factors to monitor, including temperature, humidity, atmospheric pressure, rainfall, flood levels, and seismic activity. A network of sensors was then strategically deployed across various geographical regions, considering factors such as terrain and historical data on natural disasters. IoT protocols were employed to ensure seamless data transmission to a centralized cloud server. The collected data were visualized using the Blynk app, enabling accurate weather monitoring and early warnings for floods and earthquakes. This comprehensive methodology ensured the effective design and implementation of the IoT-based weather monitoring system with smart disaster detection capabilities. The Figure .2 depicts the block diagram of the proposed.

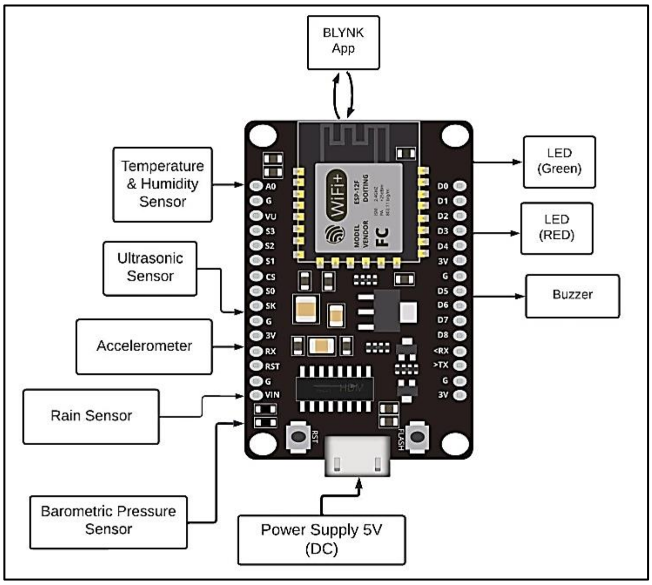


Figure 2. Block Diagram of the Proposed

The ultrasonic sensor is used to continuously measure the water levels. These sensors issue alerts or warning signals through the Blynk App when the water level is about to reach the maximum limit set. The accelerometer quickly detects the seismic activity and generates alerts using the Blynk App. Temperature, humidity and the rainfall sensors enables the weather station to monitor the temperature, humidity, and rainfall with a real-time data access through IoT. These features are integrated into single system, making it easier to stay informed. The user-friendly interface with the visualization of the collected data, and important alerts is provided by the Blynk App.

The research enables to make a better decision during disaster, thereby strengthening community resilience and improving disaster management by providing timely information to people and the authorities. Table 1 shows the hardware components used in the proposed.

Table 1. Hardware Components

S.No	Component Name
1	NodeMCU (ESP8266)
2	HC-SR04
3	DHT-11
4	BMP180
5	ADXL-335
6	RAIN SENSOR (YL-83)
7	3MM LED
8	BUZZER

1. NodeMCU

The NodeMCU is a development board and a firmware based on the ESP8266 chip. It has built-in Wi-Fi capabilities and provides additional features like a USB port for easy programming, voltage regulation, and a more convenient pin layout. In the proposed system, the NodeMCU allows programming the ESP8266 using the Arduino IDE.

2. HC-SR04

Ultrasonic sensors, commonly used for object detection, are used in the proposed work to monitor the water levels. When used for water level sensing, the ultra-sonic sensors are mounted above the water surface, positioned in a known height above the minimum expected water level. The level of the water is determined by subtracting the measured distance from this known height.

3. DHT-11

The temperature and humidity sensor is used for measuring the real-time temperature and humidity data in weather monitoring system.

4. BMP180

The barometric pressure sensor is used for measuring atmospheric pressure, and estimate the altitude. This enables to detect changes in the weather conditions, such as approach of storms.

5. ADXL-335

The ADXL335 Module is a 3-axis accelerometer that measures acceleration with a range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

6. Rain Sensor

Rain sensors (YL-83), provides real-time data on rain, and triggers alerts or records precipitation data.

7. 3mm LED and Buzzer

The 3mm green and red LED (Light Emitting Diode) and buzzer are used for triggering alerts in time of need.

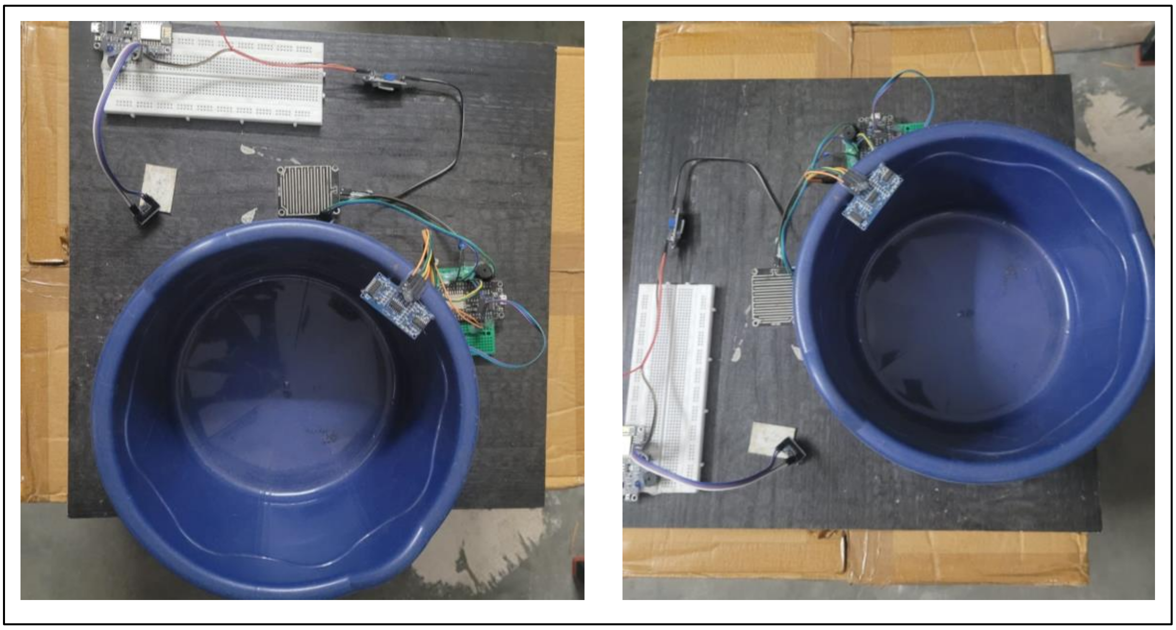
Table.2 illustrates the software components used in the work.

Table 2. Software Components

S.No	Component Name	Purpose
1	Arduino IDE	Used for programming ESP8266
2	BLYNK	Visualize the data collected and generate alerts

3. Results and Discussion

The weather monitoring system integrated multiple components, such as ultrasonic sensors, temperature and humidity sensors, barometric pressure sensors, accelerometers, rain sensors, 3mm LEDs, and buzzers, to ensure effective monitoring and alerting. The ESP8266 is programmed using the Arduino IDE to manage the sensor data collection, processing, and integration with the Blynk App. It manages tasks such as reading sensor values, triggering alerts, and controlling LEDs and the buzzer. The Blynk App provides a user-friendly interface for managing alerts and displaying data in real time. Through internet communication, the NodeMCU transfers data on rainfall, seismic activity, water levels, humidity, and temperature with the Blynk App. Based on a predetermined limit, the Blynk App sends alerts and presents this data in a visual form. The Figure 3 a, b below shows the prototype of the proposed system.



(a) **(b)**

Figure 3 (a), (b). Prototype of the Proposed System

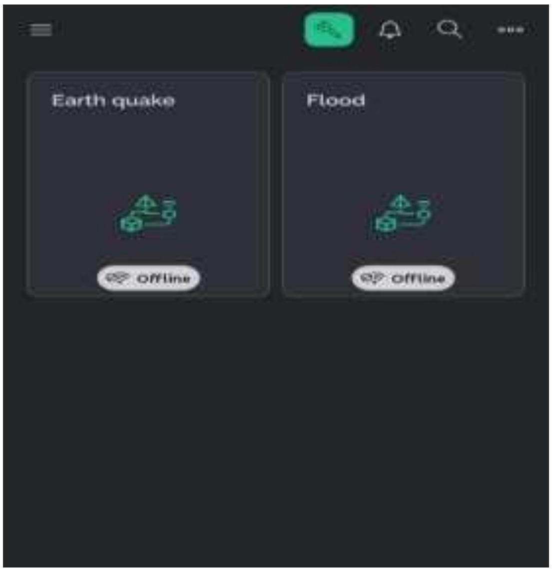
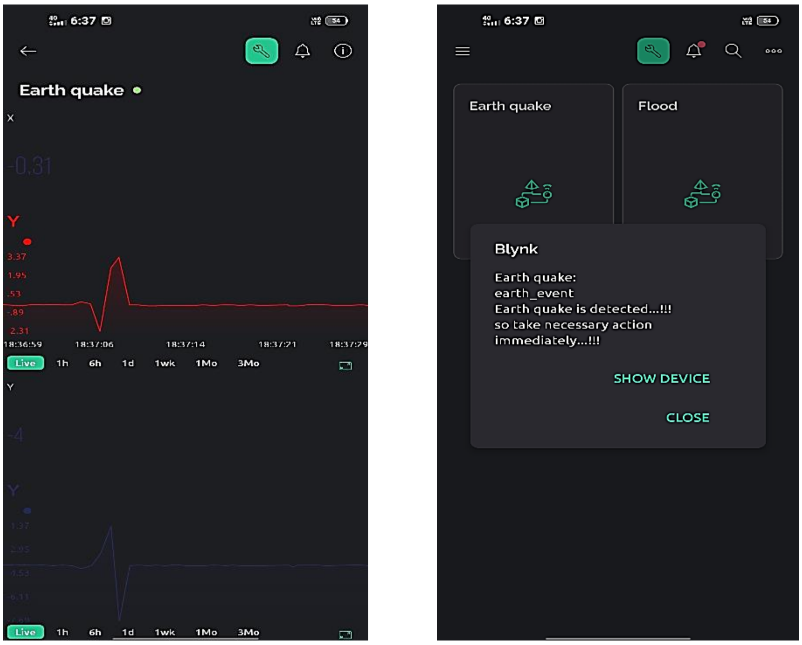


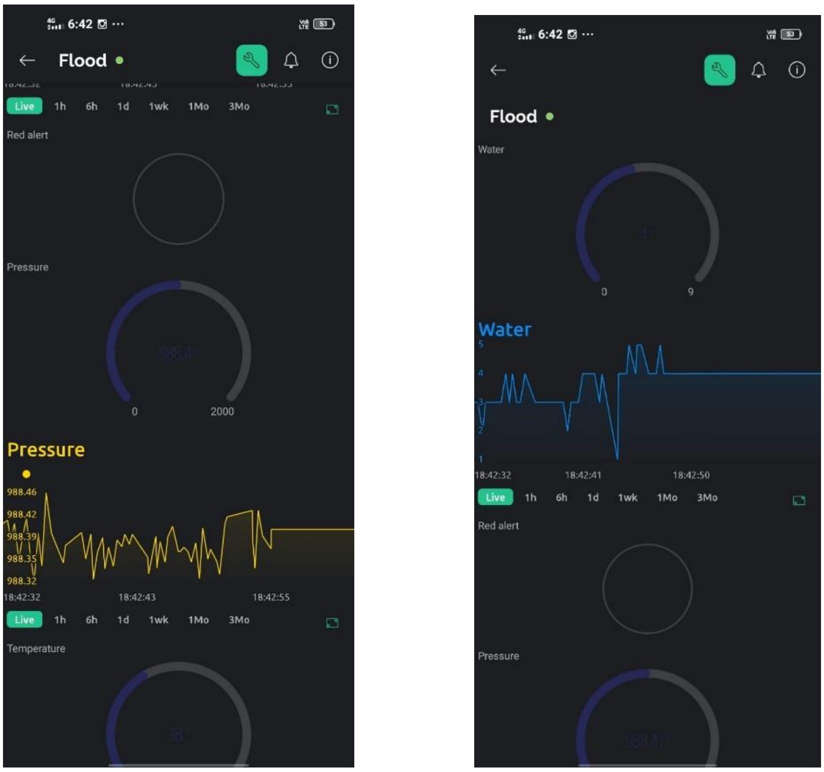
Figure 4. Blynk Application

The above Figure 4 depicts the Blynk app used for visualizing and sending alerts for the weather conditions monitored. The earthquake and the flood monitoring system can be remotely controlled over Wi-Fi network. The Blynk application successfully displays the status of the weather conditions and alerts. The Figures 5-9 depicts the result observed in Blynk APP



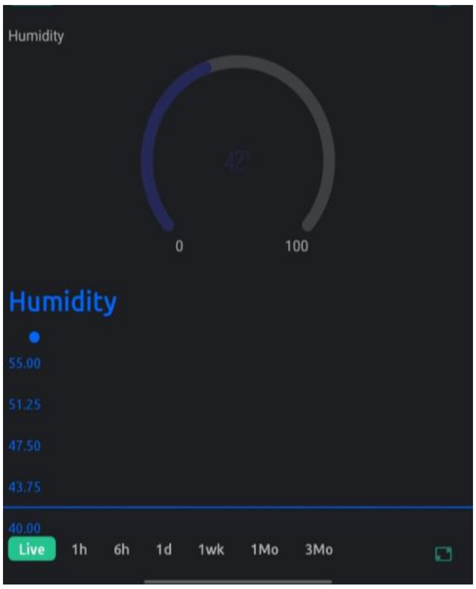
(a) (b)

Figure 5 (a), (b). Earthquake Detection and Alert



(a) (b)

Figure 6(a),(b). Flood Alert



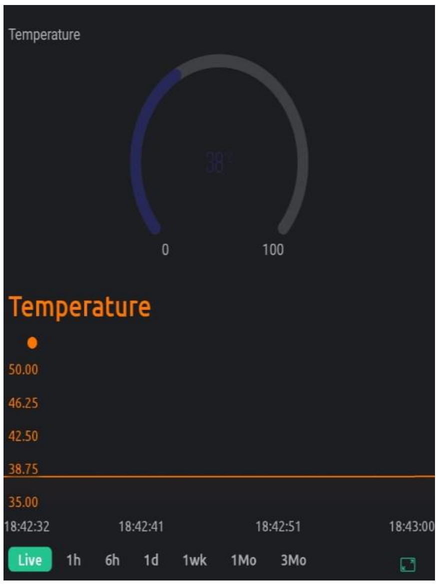


Figure 7. Output for Humidity

Figure 8. Output for Temperature

By continuously monitoring pressure, humidity, and temperature levels and analyzing patterns, the Blynk app can provide users with early warnings and recommendations to prepare for and respond to impending disasters, thereby enhancing safety and resilience in vulnerable areas.

Figure 9. Output for Rain

The app can be programmed in future to send alerts to users when rainfall exceeds certain thresholds, prompting them to take preventive measures such as clearing drains or moving valuables to higher ground. Additionally, the app can integrate with weather forecasts to provide users with advance notice of impending rainstorms, enabling them to make informed decisions and stay safe during adverse weather conditions.

4. Conclusion

The IoT based smart weather monitoring system is integrated with multiple components, including ultrasonic sensors, temperature and humidity sensors, barometric pressure sensors, accelerometers, rain sensors, 3mm LEDs, and buzzers, all managed by ESP8266 to ensure accurate monitoring and alert generation. Additionally, the system uses the Blynk app to visualize the data collected and generate alerts. The results observed through the Blynk app demonstrates the capability of the system to gather the weather conditions, visualize the data, and generates alerts. Future work will integrate the machine learning approaches to analyze the data collected and provide more informed decisions

References

[1] Pierleoni, Paola, Roberto Concetti, Simone Marzorati, Alberto Belli, and Lorenzo Palma. "Internet of things for earthquake early warning systems: a performance comparison between communication protocols." IEEE Access 11 (2023): 43183-43194.

[2] Velez, Raychell, Diana Calderon, Lauren Carey, Christopher Aime, Carolynne Hultquist, Greg Yetman, Andrew Kruczkiewicz, Yuri Gorokhovich, and Robert S. Chen. "Advancing Data for Street-Level Flood Vulnerability: Evaluation of Variables Extracted from Google Street View in Quito, Ecuador." IEEE Open Journal of the Computer Society 3 (2022): 51-61.

[3] Kim, Seonhyeong, Irshad Khan, Seonhwa Choi, and Young-Woo Kwon. "Earthquake alert device using a low-cost accelerometer and its services." IEEE Access 9 (2021): 121964-121974.

[4] Prakash, Chandra, Anurag Barthwal, and Debopam Acharya. "An IoT-based system for monitoring and forecasting flash floods in real-time." Journal of Earth System Science 132, no. 4 (2023): 159.

[5] Li, Dong, Junfei Zhang, Cunwen Wang, Yang Chen, and Decheng Ge. "Assessing rockburst hazards using a self-developed real-time microseismic monitoring system in a deep-sea goldmine." IEEE Access 7 (2019): 134360-134371.

[6] Math, Rajinder Kumar M., and Nagaraj V. Dharwadkar. "IoT Based low-cost weather station and monitoring system for precision agriculture in India." In 2018 2nd international conference on I-SMAC (IoT in social, mobile, analytics and cloud, Palladam, India. IEEE, 2018. 81-86

[7] Munawar, Hafiz Suliman, Ahmed WA Hammad, and S. Travis Waller. "Remote sensing methods for flood prediction: A review." Sensors 22, no. 3 (2022): 960.

[8] Chamoli, Bhanu Pratap, Ashok Kumar, Da-Yi Chen, Ajay Gairola, Ravi S. Jakka, Bhavesh Pandey, Pankaj Kumar, and Govind Rathore. "A prototype earthquake early

warning system for northern India." Journal of Earthquake Engineering 25, no. 12 (2021): 2455-2473.

[9] Subashini, M. J., R. Sudarmani, S. Gobika, and R. Varshini. "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), Tirunelveli, India. IEEE, 2021. 132-135.

[10] https://www.essearth.com/compact-weather-sensors-and-traditional-weather-sensors/