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Review RRJoSST

Exploring GeoAlert: An IoT Approach to Weather Station Networks

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Abstract

The innovative project "Geo-Alert: IoT Based Weather Station" uses Internet of Things, or IoT, technologies to monitor and respond to environmental circumstances, such as flood hazards, weather variations, and seismic events. This system sends real-time data to the Blynk IoT cloud, enabling seamless remote monitoring and analysis. It does this by utilising a combination of specialised sensors, such as vibration sensors for earthquake detection, DHT11 and MQ series sensors for weather tracking, and Raindrop and Ultrasonic sensors for flood monitoring. By providing an integrated platform for the acquisition and accessibility of crucial environmental data, this initiative seeks to fortify early warning capabilities, disaster preparedness, and our comprehension of local weather dynamics and geological phenomena. The goal is to increase community safety and resilience to natural disasters.

Keywords: Remote data analysis, community resilience, disaster preparedness, environmental sensing, IoT weather monitoring

INTRODUCTION

Geo Alert is a cutting-edge Internet of Things (IoT) weather station that offers precise location-based and real-time weather data. With the use of a network of sensors, this sophisticated system keeps an eye on a number of meteorological characteristics, providing precise and current data for a given region. Temperature, humidity, air pressure, wind speed, and precipitation levels can all be measured by the sensors built into the GeoAlert Internet of Things weather station. The GeoAlert system utilises a strong alarm mechanism in the event of unfavourable weather or notable changes in meteorological data. This can entail sounding alerts like buzzers or sirens and turning on visual cues like LED panels or digital displays to alert people around. There has never been a greater pressing need for precise, up-to-date meteorological data than there is in this day and age, as extreme weather events and climate change are having a growing global impact on populations. Although they can be somewhat useful, traditional weather monitoring systems sometimes lack the granularity, accessibility, and timeliness needed for thorough weather forecasting and risk management. Here comes GeoAlert, a cutting-edge Internet of Things weather station that has the potential to completely change how we track and react to meteorological phenomena. In order to solve the difficulties associated with contemporary weather monitoring, we examine the features, advantages, and possible uses of GeoAlert in this review study. Furthermore, the GeoAlert weather station is linked to the Internet via cellular networks or Wi-Fi, which enables it to deliver real-time weather alerts to a specific mobile application. In essence, GeoAlert stands as a beacon of innovation, transcending the traditional confines of meteorological monitoring to usher in a new era of proactive weather intelligence. With its unwavering commitment to precision, timeliness, and user-centric design, GeoAlert epitomizes the convergence of technology and environmental stewardship, redefining the landscape of weather forecasting and community resilience in the process.

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OBJECTIVE

Primary Objective

To Establish an IoT-based weather monitoring system for real-time, location-specific meteorological data collection, ensuring accuracy and timely information dissemination.

Secondary Objective

To Enhance community resilience through proactive response mechanisms to adverse weather conditions, utilizing advanced connectivity for seamless communication with users via a dedicated mobile application, and contributing to meteorological research for improved forecasting and disaster preparedness.

Important Attributes and Skills

- *High Precision Sensors:* Meteorological parameters are measured with accuracy and dependability thanks to the high precision sensors that come with Geo Alert weather stations. To ensure accuracy and consistency throughout time, these sensors are subjected to stringent quality control procedures and calibration in accordance with international standards.
- *Real-time Data Transmission:* Geo Alert weather stations use wireless communication protocols like Wi-Fi, GSM, or LoRaWAN to provide real-time weather data to a cloud-based platform or centralised server. This makes it possible for meteorologists, first responders, and other interested parties to get current weather data at any time and from any location.
- *Personalised Alerts and Notifications:* With GeoAlert, users can establish personalised alerts and notifications according to predetermined cutoff points for meteorological conditions.
- This makes it possible to identify unfavourable weather patterns early on, such as storms, heat waves, or periods of intense rain, enabling communities to take preventative action to lower risks and save people and property.
- *Data Visualisation and Analysis:* Users can examine weather trends, patterns, and anomalies across time with the help of GeoAlert's user-friendly data visualization tools. Interactive maps, graphs, and charts make it easier to understand complicated meteorological data and enable decision-makers to respond to changing weather conditions with knowledge.
- *Scalability and Flexibility:* GeoAlert provides scalability and flexibility to accommodate the varied needs of users across several industries, whether it is implemented as standalone weather stations or integrated into pre-existing weather monitoring networks. GeoAlert may be customised to fit a broad range of applications and use cases, from transportation and agriculture to disaster relief and urban planning.

BLOCK DIAGRAM

Block Diagram of working GeoAlert Based Weather Station is shown in Figure 1.

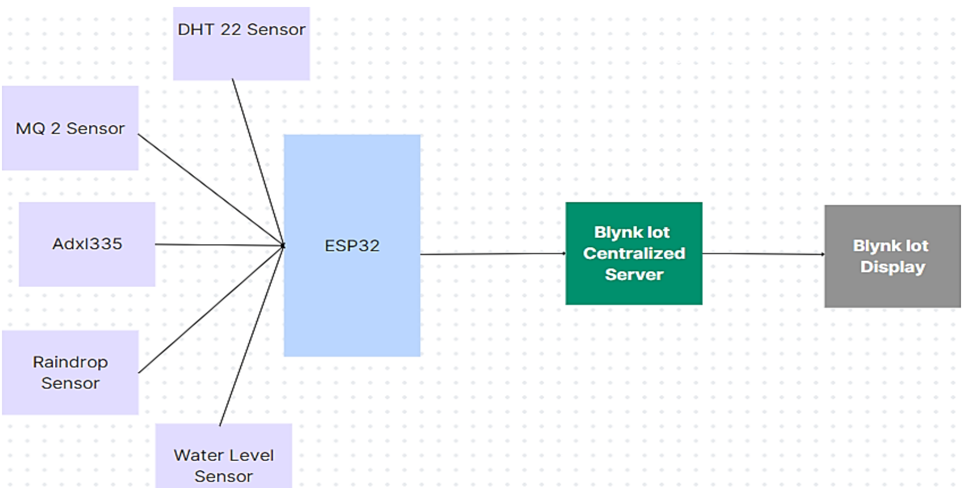

Figure 1. Block Diagram of GeoAlert IoT Based Weather Station.

METHODOLOGY

Data collection through sensors encompasses a diverse range of functionalities, each serving a specific purpose in environmental monitoring systems. For example, the Raindrop Sensor measures the quantity of raindrops that land on its surface to determine the intensity of the rainfall, giving useful information on precipitation. Rivers and reservoirs are only two examples of the many bodies of water that can have their water levels measured thanks to ultrasonic sensors. By emitting ultrasonic waves and calculating their bounce-back time, these sensors offer insights into water levels. The DHT22 Sensor records crucial temperature and humidity data, making it indispensable for weather monitoring. Similarly, MQ Series Sensors play a vital role in monitoring air quality by detecting various gases, thus contributing significantly to weather monitoring efforts. Additionally, Vibration Sensors detect ground movements, proving essential for earthquake monitoring. To guarantee accuracy and dependability, all sensor data is collected and evaluated by a microcontroller unit (MCU), such the Arduino. The MCU conducts threshold checks for flood conditions, abnormal weather parameters, and seismic activity, generating alerts when predefined thresholds are exceeded. These alerts can manifest in various forms, including notifications, warnings, or signals, depending on the detected parameters.

Data is sent from the MCU to an IoT gateway, which serves as a communication link to the Blynk IoT cloud, once it has been processed and warnings have been generated. IoT data is received, stored, and managed by the Blynk cloud platform, which also offers an intuitive interface for data analysis and visualisation. Through a smartphone application or online interface, users can remotely access the Blynk IoT cloud, enabling real-time monitoring of environmental conditions, alarms, and historical data. Users can also configure alerts to be sent to their mobile devices using notifications. The following is a more detailed description of each component of the system:

Hardware

ESP32

- ESP32 Specifications shown in Figure 2.
  - *Microcontroller:* ESP32 dual-core Tensilica LX6 processor.
  - *Clock Frequency:* Up to 240 MHz.
  - *Wireless Connectivity:* Wi-Fi 802.11 b/g/n, Bluetooth v4.2.
  - *Memory:* 520 KB SRAM, 16 MB Flash.
  - *GPIO Pins:* 36 GPIO pins for versatile digital and analog input/output.
  - *Analog-to-Digital Converter (ADC):* 12-bit SAR ADC with up to 18 channels.

Figure 2. NodeMCU ESP32.

MQT-135 Sensor

- MQ-135 Specifications shown in Figure 3.
  - *Operating Voltage:* 5V DC
  - *Power Consumption:* ~800mW
  - *Heater Voltage:* 5V±0.2V AC/DC
  - *Heater Resistance:* 33Ω ± 5%
  - *Preheat Time:* Over 24 hours
  - *Load Resistance:* Adjustable via onboard potentiometer

Figure 3. MQT-135 Sensor.

DHT 22 Sensor

- DHT22 Sensor Specifications shown in Figure 4.
    - *Operating Voltage:* 3.3V to 6V DC
    - *Current Consumption:* 2.5mA (during data communication)
    - *Temperature Measurement Range:* -40°C to 80°C
    - *Humidity Measurement Range:* 0% to 100% RH
    - *Temperature Accuracy:* ±0.5°C
    - *Humidity Accuracy:* ±2% RH

Figure 4. DHT 22 Sensor.

Raindrop Sensor

- Raindrop Sensor Specifications shown in Figure 5.
    - *Operating Voltage:* Typically 3.3V to 5V DC
    - *Operating Current:* Varies by model but generally low
    - *Detection Principle:* Conductivity-based (measures the resistance between two conductive strips)
    - *Sensitivity Adjustment:* Some models may feature sensitivity adjustment through a potentiometer
    - *Signal Output:* Analog or Digital (High/Low) signal indicating the presence of rain
    - *Interface:* Typically provides a simple digital or analog output that can be read by microcontrollers

Figure 5. Raindrop Sensor.

Adxl335 Sensor

- Adxl335 Sensor Specifications as shown in Figure 6.
  - *Supply Voltage:* 1.8V to 3.6V
  - *Current Consumption:* 320 μA (in measurement mode)
  - *Sensitivity:* Typically, 300 mV/g (for the ±3g range)
  - *Output Resolution:* 10-bit (per axis)
  - *Output Voltage Range:* 0.5V to (VDD – 0.5V)
  - *Output Type:* Analog voltage proportional to acceleration on each axis

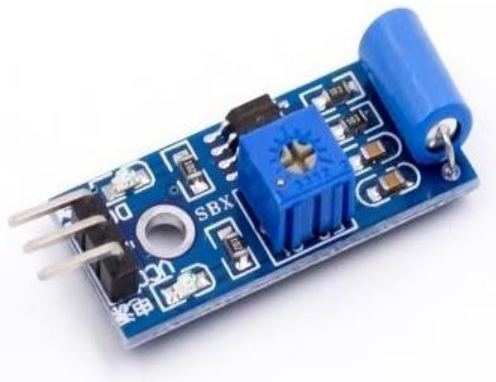

Figure 6. Adxl335 Sensor.

Water Level Sensor

- Water Level Sensor Specifications shown in Figure 7.
  - *Operating Voltage:* Typically, 5V DC or 3.3V DC.
  - *Current Consumption:* Low power consumption for efficient operation.
  - *Detection Method:* Various methods such as capacitance, resistive, ultrasonic, or pressure-based.
  - *Measuring Range:* The range over which the sensor can accurately detect water levels.
  - *Accuracy:* The precision of the sensor in measuring water level **Software-**

Figure 7. Water Level Sensor.

1-BLYNK

Blynk is a well-liked and adaptable platform for creating mobile and Internet of Things (IoT) applications. It offers a simple and intuitive method for developing unique apps for managing and keeping an eye on Internet of Things devices as shown in Figure 8. Blynk is known for its simplicity, flexibility, and compatibility with a wide range of hardware platforms

- Key Features:
    - Drag-and-Drop App Builder
    - Wide Hardware Compatibility
    - Cloud Connectivity
    - Security

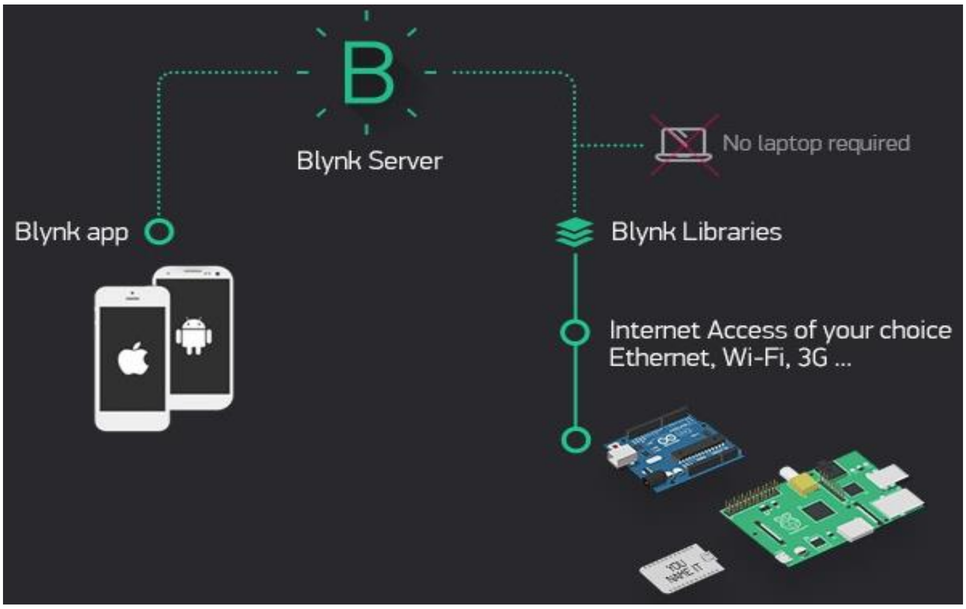

Figure 8. Blynk App.

2- Arduino IDE – For Programming the Entire Project

The Arduino Software (IDE) stands as a cornerstone in the world of open-source development, providing an accessible platform for writing and uploading code to Arduino boards. With its easy-to-use interface, even individuals with no programming knowledge can easily learn how to code. With a vast community of enthusiasts and developers, the IDE fosters collaboration and innovation, enabling users to explore a myriad of projects and application.

Simulation

Results of Simulations with reference to hardware prototype circuit is shown in Figure 9.

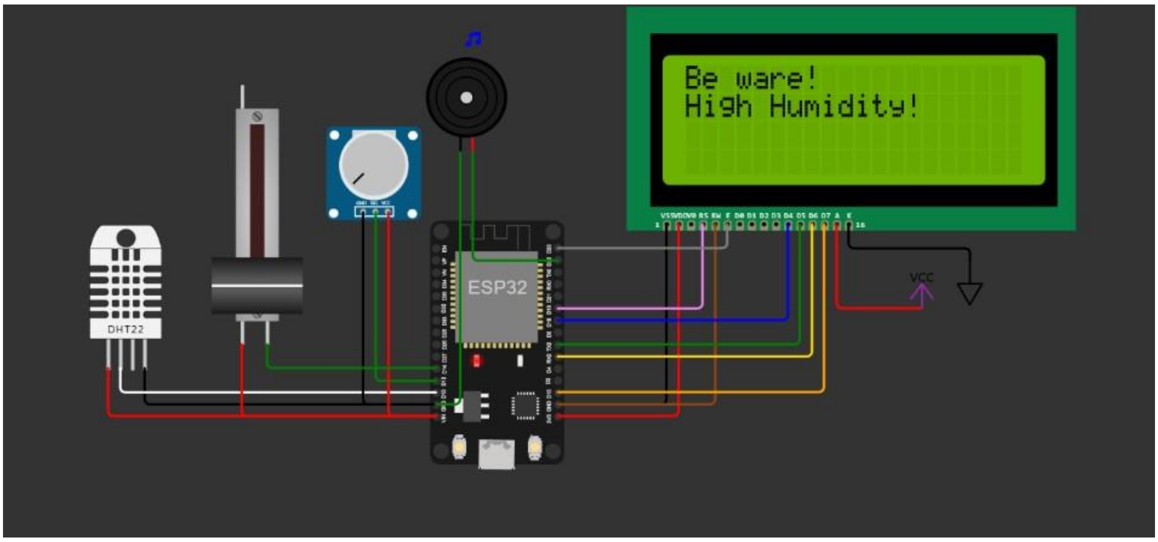

Figure 9. Hardware prototype connected circuit

RESULT

The implementation of GeoAlert, an IoT-based weather station, demonstrates a comprehensive approach to environmental monitoring and disaster preparedness. Through a network of sensors including raindrop, ultrasonic, DHT22, MQ series, and vibration sensors, the system efficiently collects data on various weather parameters and ground conditions. This data is processed by a microcontroller unit (MCU), which monitors flood conditions, weather parameters, and seismic activity in real-time. When predetermined thresholds are exceeded, notifications are sent immediately to guarantee rapid action in the event of potential threats. Data transmission from the MCU to the Blynk IoT cloud facilitates seamless integration with the IoT ecosystem, providing users with remote access to real-time environmental data and alerts. By providing an intuitive interface for statistical analysis and visualisation, the Blynk cloud platform enables users to make well-informed decisions based on precise and current information as shown in Figure 9. Remote monitoring capabilities via mobile applications or web interfaces enable users to stay informed about environmental conditions, receive alerts, and access historical data anytime, anywhere. The GeoAlert system not only enhances situational awareness but also enables proactive measures to mitigate risks and ensure the safety and well-being of communities.

With GeoAlert, there is a paradigm shift in weather monitoring and management. It provides a complete, dependable, and easily accessible solution to the problems caused by extreme weather occurrences and climate variability. Through the use of IoT technology, GeoAlert enables people, groups, and institutions to reduce risks, make educated decisions, and increase their capacity to withstand the effects of climate change. GeoAlert is a source of innovation and optimism as we continue to face the effects of climate change, empowering us to adapt, prosper, and live in a world that is changing quickly.

The results are shown in Figure 10 to Figure 12. Three parameters were considered: temperature, Humidity and methane. Time gap for observation s are kept as 1hour, 6 hour, 1day, 1 week, 1 month and 3 months.

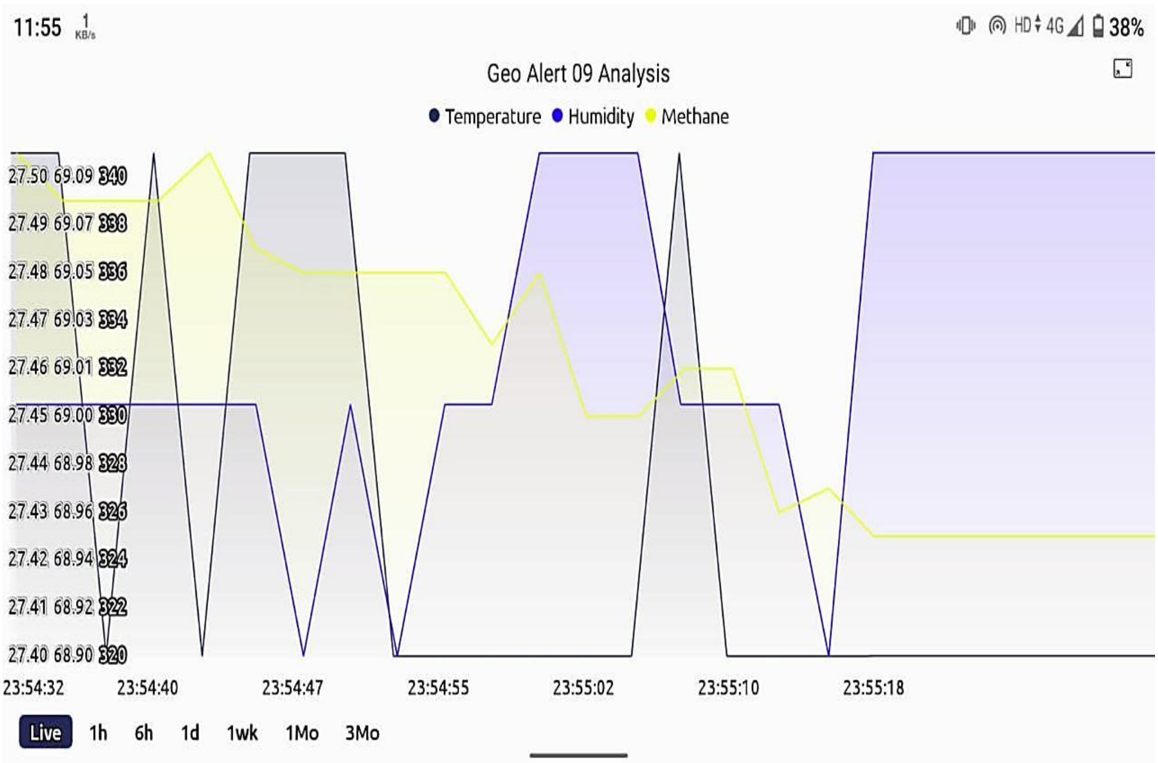

Figure 10. Live simulation for different time.

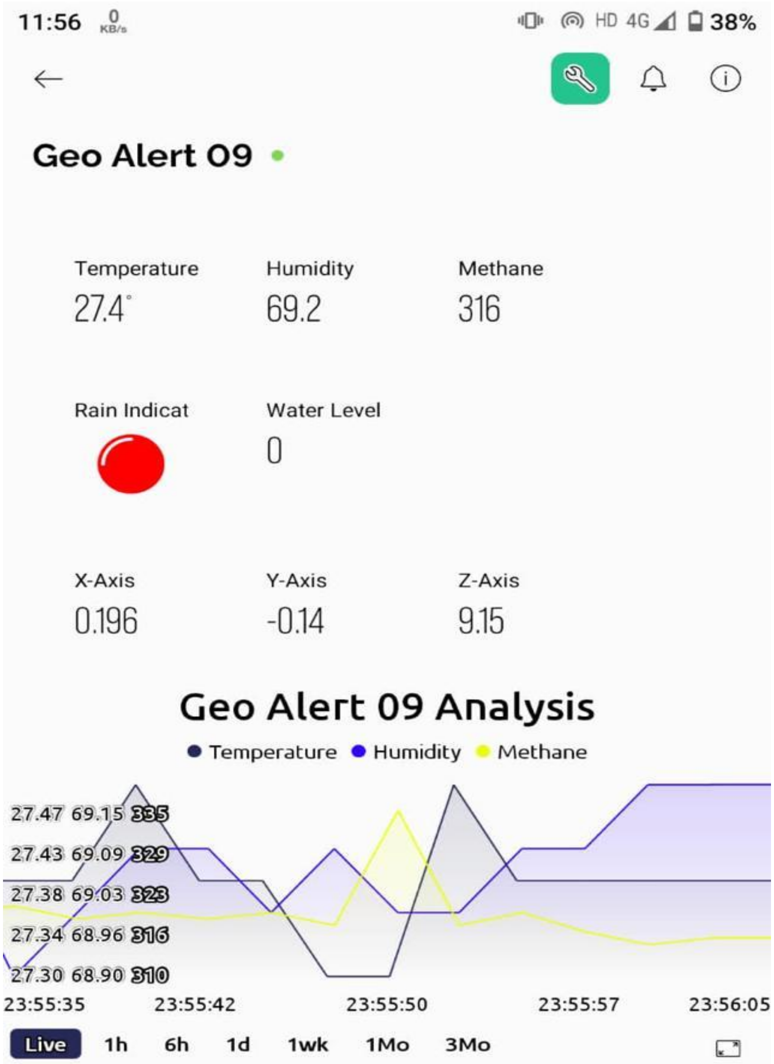

Figure 10. 3-D coordinates values.

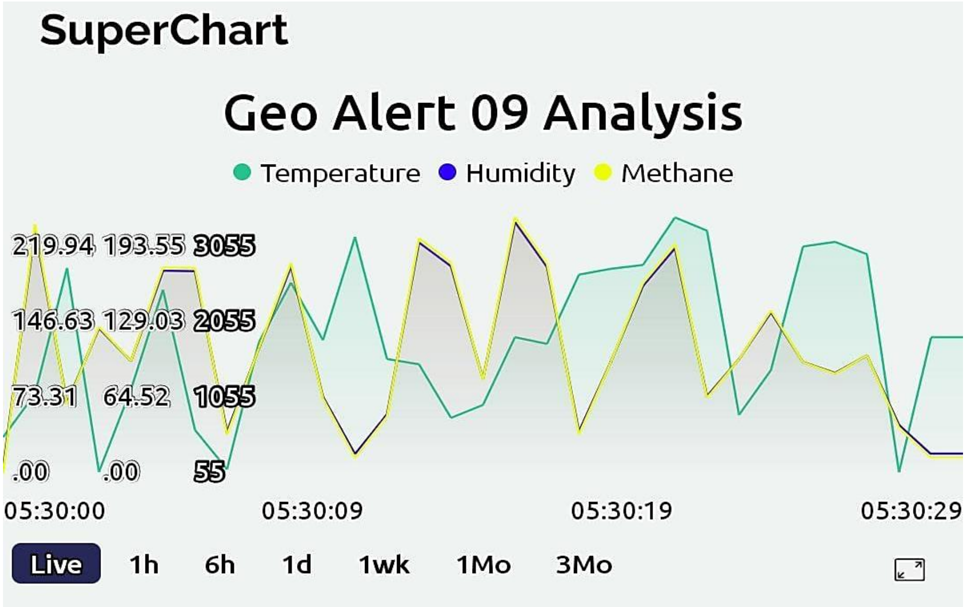

Figure 11. superchart geo alert analysis.

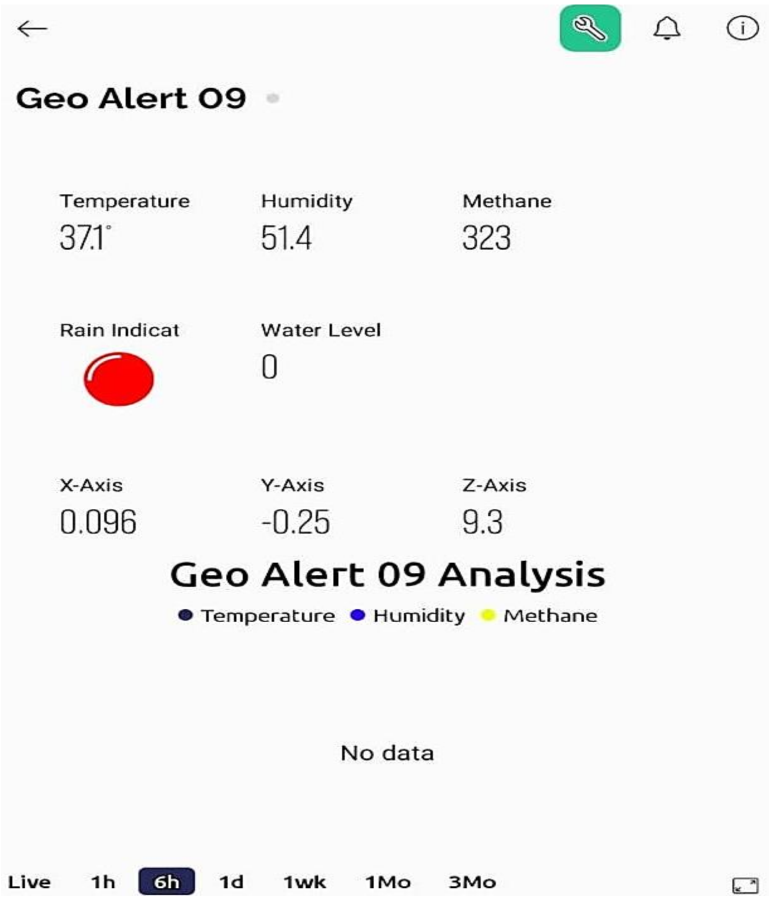

Figure 12. Geo alert observation after 6 hours

CONCLUSION

The "Geo-Alert: IoT-Based Meteorological Station" initiative represents a noteworthy progression in environmental surveillance and readiness for emergencies. The project meets the critical demand for real-time data collecting and analysis by utilising IoT technologies. Through meticulous design and implementation, the system effectively monitors environmental conditions, focusing on flood detection, weather tracking, and earthquake monitoring. Accurate gathering and processing of data are ensured through the integration of specialised sensors, a microcontroller unit, and an IoT gateway. Utilization of the Blynk IoT cloud platform enables remote monitoring and data analysis, enhancing accessibility for users.

Acknowledgement

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REFERENCES

1. Karthik, K. R. (2019). "IoT-based Smart Agriculture: An Extensive Review." International Journal of Scientific Research in Science, Engineering and Technology, 5(4), 1–8.
2. Sivaram, T. V. (2018). "Flood Disaster and Management: A Review." International Journal of Engineering and Technical Research, 6(7), 14–19.

3. Dewan, A. (2017). "Climate Change and India: Issues and Priorities." Indian Journal of Science and Technology, 10(7), 1–10.
4. Mandal, B., & Maiti, A. S. (2016). "Early Warning and Disaster Management in India: An Overview." International Journal of Disaster Risk Reduction, 17, 198–209.
5. Nayak, Rajashree. (2018). "Smart City Development in India: A Review." International Journal of Scientific Research and Management, 6(1), 162–167.
6. Bhattacharyya, S. K., & Keshari, A. K. (2015). "Data Management for Sustainable Development.
7. Tobiska WK. Space weather management. In47th AIAA Aerospace Sciences Meeting including The New Horizons Forum and Aerospace Exposition 2009 (p. 1494).
8. Nagatsuma T. System for Issuing and Distributing Space-Weather Reports. Journal of the Communications Research Laboratory. 2001 Jun;48(2):63–70.
9. Joselyn J, Heckman G, Zwickl R. The Space Weather Program at the NOAA Space Environment Center. InSpace Programs and Technologies Conference 1995 (p. 3569).
10. Podolskaia ES. REMOTE SENSING DATA FROM SPACEFOR ROAD IMAGE RECOGNITION IN THE FORESTRY. Вопросы лесной науки. 2023;6(1):90–104.
11. Joselyn JA. State of the Art in Space Weather Services and Forecasting: An introduction to space weather operations in the USA. Space Storms and Space Weather Hazards. 2001:419–36.
12. Yap SC. *Proximity Based Information Delivery Mobile Application* (Doctoral dissertation, UTAR).

