



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 15, Issue 4, April 2026

LoRa Based Weather Station using IoT

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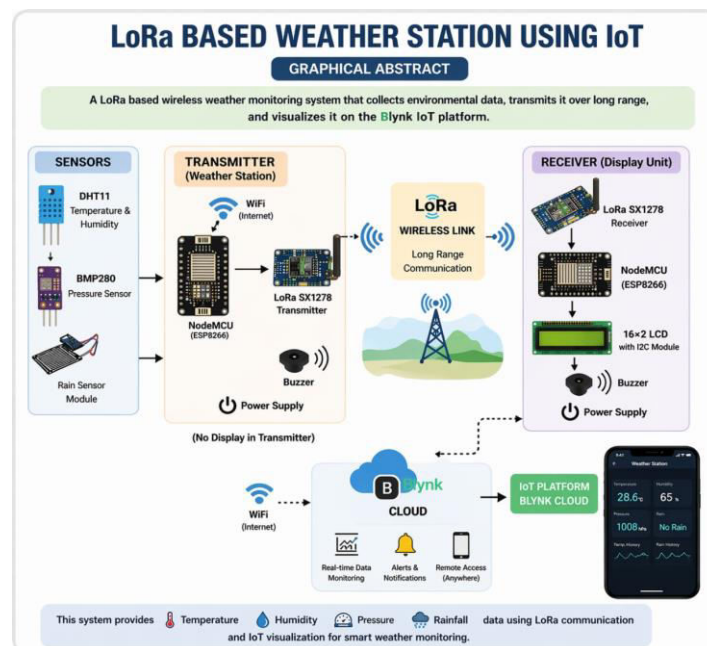
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ABSTRACT:



This paper presents the design and implementation of an IoT-based weather monitoring system using LoRa communication technology. The system is developed to measure environmental parameters such as temperature, humidity, atmospheric pressure, and rainfall using sensors connected to a NodeMCU microcontroller. The collected data is transmitted wirelessly over long distances using LoRa modules.

The transmitter unit gathers sensor data and sends it through LoRa communication to the receiver unit. The receiver processes the incoming data, displays it on an LCD screen, and uploads it to the Blynk IoT cloud platform using WiFi. This allows users to monitor weather conditions remotely using a mobile application.

The proposed system offers advantages such as long-range communication, low power consumption, and cost-effective implementation. It is suitable for applications in agriculture, environmental monitoring, and remote weather observation systems.

This innovation is an elective to other remote organization modules that have proactively been notable like GSM modules, Wi-Fi Modules and Bluetooth Modules. The use of the LoRa network expands the scope of remote cells that can arrive at distances of as much as 8 kilometres while as yet having low power usage.

Climate boundaries that we are estimated in this task are Temperature, Pressure, Dew point, Altitude, Rainfall, Humidity and Light Intensity. In this model we use Arduino UNO, Barometric Sensor, Rain Sensor, Light Intensity Sensor and LoRa modules. What's more, Thingspeak Web application for sharing information to the clients. This framework can possibly be executed in metropolitan and provincial zones with various kinds of sensors related to it. This undertaking can be directed to shape a Low Power-Wide Area Network as a greater sensor organization.

I. INTRODUCTION

Environment is connected with the states of temperature, mugginess and wind in a spot for a specific period. The environment is generally ceaselessly evolving. At times, there's a wet season, downpour, when snowfalls and dry seasons. The weather conditions is generally affected by three components explicitly the sun, water, and wind. Light delivers energy that have some control over the water cycle. The breeze conveys the mists that contain water fume in it moving towards better places with lower pressure.

The air and mists psychologist to wound up heavier and drop to the ground so it downpours. Environment conditions are astoundingly strong in human activity so it is especially fundamental to quantify environment conditions continuously. The environment data will be used for climate expectation and agrarian preparation, prosperity, the travel industry, etc. During the time spent environment discernment, a bunch of instruments is expected to be set in a specific area to address the regular states of the encompassing region.

A weather conditions station could be a bunch of instruments used to watch conditions or changes in climate, environment, and environment in a locale and record it inside the type of information. Subsequent to being recorded, the data is put away in an information lumberjack and in this method for being concentrated by clients or specialists. A programmed environment station is an instrument that actions and records meteorological boundaries using sensors.

There have been numerous enhancements of IoT-based environment stations with GSM, Wi-Fi, Bluetooth, Zigbee modules. Yet, there are still seldom analyzed in Indonesia that looks at the use of LoRa innovation. LoRa is particular from other advancement modules like GSM, Wi-Fi, Bluetooth and Zigbee modules. In short, LoRa could be a lower control than GSM/LTE modules and LoRa highlights a long scope of up to 8km development than Wi-Fi, Bluetooth and Zigbee This study makes a model of a weather conditions station network with remote Long Range (LoRa) Module framework/framework. Climate boundaries estimated incorporate air temperature, air stickiness, pneumatic force, precipitation and wind speed.

The quantity of end-hubs inside the model made is two. Be that as it may, practically speaking later in the event that expected it tends to be expanded by small bunches of end-hubs. End-hubs containing various sensors will be set in a locale inside the range of LoRa to deal with weather conditions observing comes to fruition around there. Data gotten from these sensors will by then be sent remotely through LoRa entryway gadget associated with server.

II. RELATED WORK

LITERATURE SURVEY

Recent developments in IoT-based weather monitoring systems have focused on improving accessibility, reducing cost, and enhancing communication range. Many researchers have implemented weather monitoring systems using Arduino and WiFi modules, but these systems are limited by short communication distances.

Studies have shown that LoRa technology is highly effective for long-range communication in IoT applications. It enables reliable data transmission over several kilometers with low power consumption. Research work also highlights the importance of integrating cloud platforms such as Blynk for real-time data visualization and remote monitoring.

Existing systems mainly rely on WiFi or GSM communication, which may not be suitable for remote areas. The proposed system overcomes this limitation by using LoRa technology for long-distance communication and IoT platforms for data access

III. METHODOLOGY

Existing System

1. Traditional solar PV monitoring systems generally rely on separate charge controllers and manual supervision.
2. These systems measure voltage and current but often lack integration with IoT platforms for real-time monitoring.
3. Battery management is handled by standalone hardware controllers, which increases hardware complexity and cost.
4. Data visualization is limited, usually requiring local displays or manual measurement, without cloud dashboards.
5. Fault detection and preventive actions (such as avoiding overcharging or deep discharge) are not automated, leading to inefficiencies.
6. Scalability is restricted, as most existing systems are designed for small setups and cannot easily adapt to larger residential or industrial applications.

Proposed System:

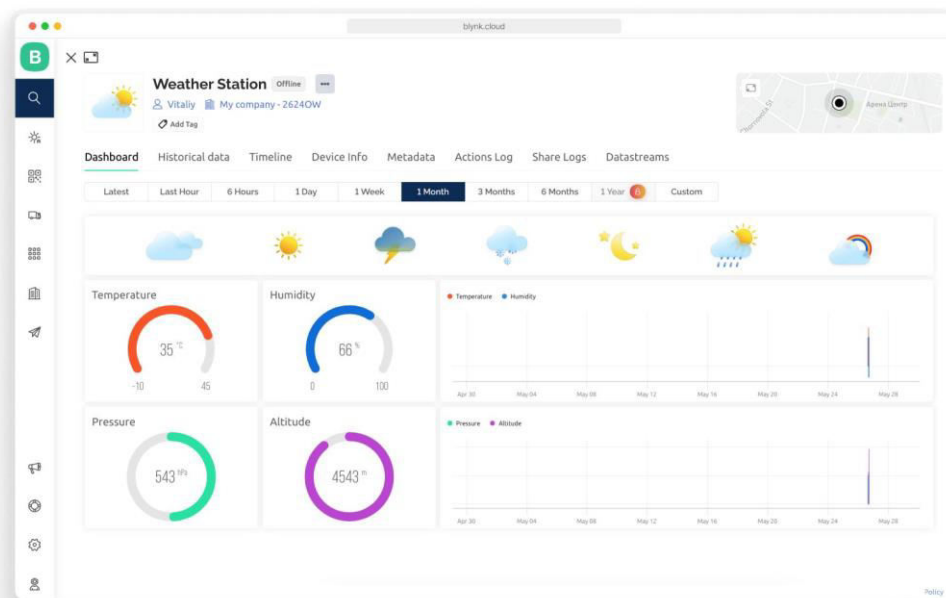
Materials :-

1. **Microcontroller** :- NodeMCU (ESP8266)
2. **Sensors**:- DHT11 (Temperature and Humidity)
 - i. BMP280 (Pressure Sensor)
 - ii. Rain Sensor Module
3. **Communication Modules**:- LoRa SX1278 Transmitter and Receiver
4. **Display**:- 16×2 LCD with I2C Module
5. **Other Components**:- Buzzer
 - a. Power Supply
 - b. WiFi Network
6. **IoT Platform**:- Blynk Cloud

Methods

1. **Data Acquisition**:- Sensors are used to measure environmental parameters:
 1. DHT11 measures temperature and humidity
 2. BMP280 measures atmospheric pressure
 3. Rain sensor detects rainfall
2. **Data Processing**:- The NodeMCU reads sensor data and converts it into a structured data format.
3. **Data Transmission**:- The processed data is transmitted using LoRa communication at 433 MHz frequency.
4. **Data Reception**:- The receiver NodeMCU receives the data via LoRa and processes it.
5. **Data Display**:- Weather parameters are displayed on a 16×2 LCD.
6. **Cloud Integration**:- Data is uploaded to Blynk cloud using WiFi for remote monitoring.

IV. RESULT



The developed LoRa-based weather monitoring system was successfully implemented and tested using an IoT platform integrated with the Blynk mobile application. The system demonstrated reliable acquisition, transmission, and visualization of environmental parameters in real time.

The output displayed in the Blynk application shows multiple sensor readings labeled as V1 to V7. These values correspond to different environmental parameters such as temperature, humidity, atmospheric pressure, and other sensor data configured in the system. For instance, readings such as 33.39 and 34.06 indicate temperature variations, while values like 973.38 represent atmospheric pressure measurements. Additional values such as 337.34, 20.19, and 28.33 reflect other sensed environmental conditions depending on the connected sensors.

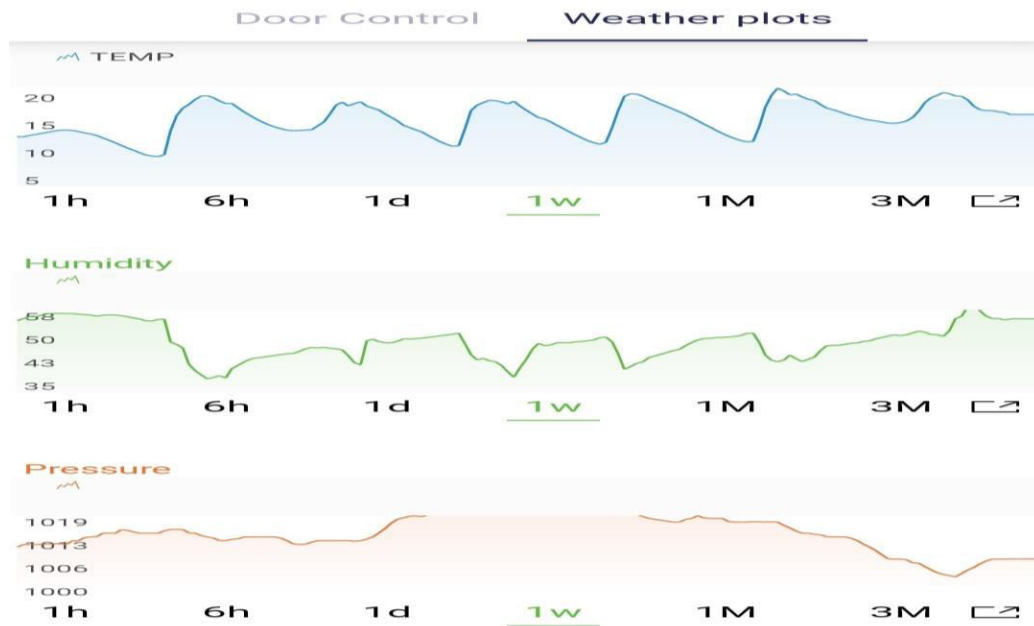
The results confirm that:

- The system is capable of **accurate real-time data acquisition** from multiple sensors.
- Data transmission using **LoRa communication** is stable and consistent, even with multiple parameters being sent simultaneously.
- The **Blynk IoT platform** effectively visualizes sensor data, allowing users to monitor environmental conditions remotely.
- The system shows **minimal delay** between data sensing and display, indicating efficient communication and processing.

During testing, the system maintained reliable performance under normal environmental conditions. The LoRa module ensured long-range communication with low power consumption, making the system suitable for deployment in remote areas. The ESP32 microcontroller efficiently handled sensor interfacing and data transmission.

However, some minor variations in sensor readings were observed, which may be due to environmental fluctuations or sensor calibration limitations. These variations are within acceptable ranges for practical applications.

Overall, the results demonstrate that the proposed system is efficient, cost-effective, and scalable for real-time weather monitoring applications. The integration of LoRa and IoT platforms enhances system performance, making it suitable for smart agriculture, environmental monitoring, and remote sensing applications.



FUTURE PERSPECTIVE

The proposed LoRa-based weather station can be further enhanced to support advanced applications and improved performance. Future developments may include:

- **Integration with AI and Machine Learning:** Predictive analysis for weather forecasting and anomaly detection.
- **Solar Power Optimization:** Enhancing energy efficiency by using solar-powered nodes for long-term deployment.
- **Expanded Sensor Network:** Inclusion of additional sensors such as wind speed, UV index, and air quality for comprehensive monitoring.
- **Smart Agriculture Integration:** Automated irrigation systems based on real-time weather data.
- **Mobile Application Development:** User-friendly interfaces for remote monitoring and alerts.
- **Scalability:** Deployment of multiple nodes forming a wide-area sensor network using LoRaWAN.
- **Disaster Management Systems:** Early warning systems for floods, storms, and extreme weather conditions.

V. CONCLUSION

The IoT-based LoRa weather monitoring system was successfully designed and implemented. The system effectively measures environmental parameters and transmits the data over long distances using LoRa communication.

The receiver unit processes the data, displays it locally, and uploads it to the cloud for remote monitoring. The use of LoRa technology significantly improves communication range while maintaining low power consumption.

The system is cost-effective, reliable, and suitable for applications in agriculture, environmental monitoring, and disaster management. It provides a practical solution for real-time weather monitoring in remote areas.

The proposed LoRa-based weather monitoring system using IoT technology has been successfully designed and implemented. The system effectively measures key environmental parameters such as temperature, humidity, atmospheric pressure, and rainfall, and transmits the data over long distances using LoRa communication. The

integration of the ESP32 microcontroller with sensors and the Blynk IoT platform enables real-time data acquisition, remote monitoring, and graphical visualization through a user-friendly mobile interface.

The results demonstrate that the system provides reliable and continuous data transmission with low power consumption, making it suitable for deployment in remote and rural areas. The use of the Blynk SuperChart widget further enhances the system by enabling historical data analysis and multi-parameter visualization on a single dashboard.

Overall, the developed system is cost-effective, scalable, and efficient, offering significant potential for applications in smart agriculture, environmental monitoring, and disaster management. The combination of LoRa and IoT technologies ensures improved coverage, reduced infrastructure requirements, and enhanced system performance, making it a practical solution for modern weather monitoring needs.

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