LORA Based Wireless Weather Monitoring System

Bhuvaneshvari R
Department of Electronics and Communication Engineering
Karpagam College of Engineering
Coimbatore, Tamilnadu, India
Rb.bhuvi13@gmail.com

Prawin Raj G
Department of Electronics and Communication Engineering
Karpagam College of Engineering
Coimbatore, Tamilnadu, India
iamprawin380@gmail.com

Prathish J
Department of Electronics and Communication Engineering
Karpagam College of Engineering
Coimbatore, TamilNadu, India
prathish0071@gmail.com

Arun Francis G
Department of Electronics and Communication Engineering
Karpagam College of Engineering
Coimbatore, Tamilnadu, India
ja.arunji@gmail.com

***Abstract* -The LoRa-based Wireless Weather Monitoring System is a cutting-edge project designed to revolutionize environmental data acquisition through the implementation of LoRa (Low Range) technology. This system addresses the need for efficient, long-range, and low-power solutions in weather monitoring. The project involves the deployment of sensor nodes equipped with high-precision instruments to measure key weather parameters like temperature, humidity, atmospheric pressure, and precipitation.Utilizing LoRa's extended range and low-power capabilities, these sensor nodes wirelessly transmit data to a central gateway, which acts as a hub for data aggregation. This gateway then communicates with a cloud-based server, where the collected weather data is stored and analyzed in real-time. The system's robust design ensures seamless communication over considerable distances while minimizing power consumption, making it ideal for applications in agriculture, meteorology, and environmental monitoring.One of the key advantages of this system lies in its user-friendly interface, allowing stakeholders to access real-time weather information. The scalability and adaptability of the system make it versatile for deployment in various settings. Additionally, the low-power design enhances the longevity of the sensor nodes, reducing maintenance requirements. Overall, this LoRa-based weather monitoring system offers a cost-effective, efficient, and sustainable solution for collecting and analyzing crucial environmental data, empowering decision-makers across diverse industries.**

***Keywords*- LoRa, Wi-Fi, IoT(Internet of Things).**

I. Introduction

A weather station integrates a suite of instruments designed for the continuous monitoring and recording of weather, climate, and environmental changes. The collected data is stored in a data logger, ready for subsequent analysis by researchers or users. Automated weather stations utilize sensors as measurement devices to precisely gauge fluctuations in weather conditions. Post data collection, the analysis can occur either locally at the station or be transmitted to a central data processing center for in-depth examination. While IoT-based weather stations leveraging GSM, Wi-Fi, Bluetooth, and Zigbee modules have made significant strides globally, there exists a noticeable gap in exploring LoRa technology adoption within Indonesia. LoRa stands out due to its lower power consumption compared to GSM/LTE modules and an impressive extended range of up to 8 km, surpassing the capabilities of Wi-Fi, Bluetooth, and Zigbee. This study is dedicated to crafting a model for a weather station network utilizing the Long Range (LoRa) module system. The measured weather parameters encompass not only air temperature, humidity, atmospheric pressure, precipitation, and wind speed but also other relevant factors for a comprehensive understanding. The initial model includes two end-nodes, and its inherent scalability allows for the seamless addition of nodes, facilitating extensive weather monitoring in a designated area. The collected information from these sensors is wirelessly transmitted via a LoRa gateway device seamlessly connected to a server, enhancing the efficiency and reach of the weather monitoring system. This approach not only ensures robust data collection but also positions the system for adaptability and growth in the ever-evolving field of environmental monitoring.

II. Existing Methods

Present-day weather monitoring systems commonly rely on technologies like GSM, Wi-Fi, Bluetooth, or Zigbee modules, facing challenges related to power consumption and limited operational range. In contrast, LoRa technology emerges as an efficient alternative, featuring significantly lower power usage and an extended range of up to 8 km. This makes LoRa well-suited for remote locations and challenging terrains, overcoming the limitations of traditional systems. With its adaptability for low-power, wide-area networks, LoRa is gaining international recognition in weather monitoring applications. It offers improved reliability, efficiency, and cost-effectiveness for real-time, long-range environmental data collection, establishing LoRa-based systems as promising solutions across diverse environmental conditions.

III. Developed System

In the developed system, The sensors are linked to the microcontroller, establishing a connection with LoRa. We conceived and consolidated the entire concept into a device, integrating all necessary components into a unified unit. The sensors connected to the microcontroller detect various weather parameters such as temperature, humidity, air pressure, dew point, rainfall, and altitude, displaying the readings on both the serial screen and web server. In this configuration, the LoRa gateway is connected to NodeMCU or ESP32, facilitating the transfer of data to the server.

A. Block diagram

The LoRa-based Weather Monitoring System employs a comprehensive block diagram configuration to enable efficient environmental data acquisition. At the core of the system is a network of sensors, including those for temperature, humidity, air pressure, dew point, rainfall, and altitude. These sensors are intricately connected to a microcontroller, forming the sensory input layer. The microcontroller serves as the central processing unit, managing the gathered data.

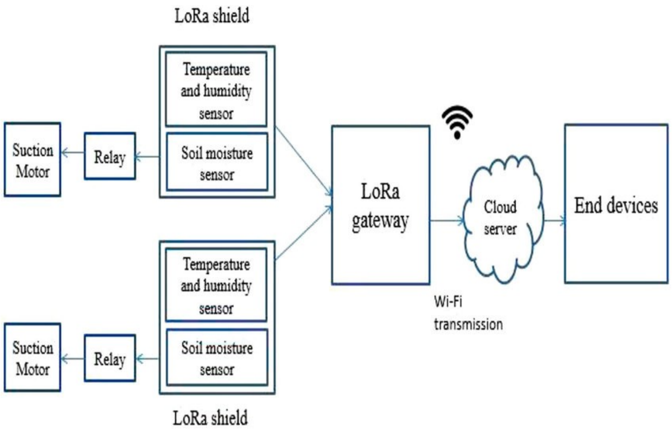

Figure 1. Developed Design

B. Methodology

The following block diagram illustrates the operation of the project, where diverse components are linked to a Micro Controller, and various sensors are integrated with it. Specifically, the Sensor-Node block diagram depicts the connection of multiple sensors for capturing atmospheric data. This data is then transmitted via LoRa to be communicated to theGateway-Node.

The preceding block diagram illustrates the initial phase of the project. The project is structured into two primary segments:

1.Sensor Node: This section involves connecting various components to the Micro Controller (Arduino), with different sensors interfacing with it. These sensors collect environmental data, specifically climatic conditions, using individual sensors. The gathered data is then transmitted to the MCU (Arduino), which subsequently communicates this information to the Receiver module through the LoRa component. The entire system is powered by a battery integrated with Arduino. This set of components is designed to be deployed in environmental locations to capture diverse weather readings. Given the potential exposure to precipitation, precautions are taken by placing the rain sensor outside the protective cover, while the remaining components are shielded.

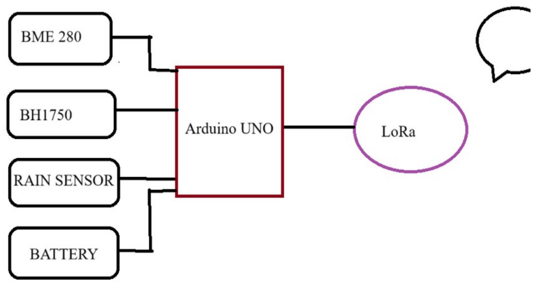

Figure 2. Sensor node block diagram

2.In Gateway : we find two key components: Esp32 and LoRa. The communicated data from the LoRa-enabled Sensor Node is received by the Gateway Node LoRa, which then transmits it to the web through ESP32. Users can conveniently access and observe the data via a web browser or platforms like Thingspeak. A LoRa-based Weather Station necessitates both Sender and Receiver circuits for wireless communication. The Sender Circuit, termed Sensor Node, gathers data, while the Receiver Circuit, termed Gateway, processes and relays this information. This Weather Station, equipped with sensors like BME280-Barometric Pressure Sensor, BH1750-Light sensor, and a Rain Sensor, monitors environmental parameters such as Temperature, Humidity, Pressure, Altitude, Dew Point, Rainfall, and Light Intensity.

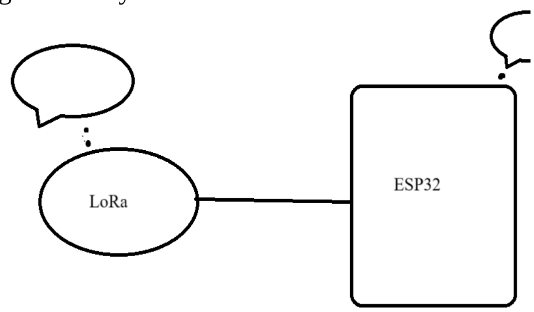

Figure 3. Entryway node block diagram

a) Arduino serves as the control circuit for the Sensor Node, where sensors (BME280, BH1750, Rain Sensor) and the LoRa module are connected according to the circuit diagram.

b) The BME280 sensor records Temperature, Humidity, and Atmospheric Pressure, sending the data to Arduino.

c) The BH1750 sensor measures Light Intensity in lux units and transmits this information to Arduino.

d) The Rain Sensor FC-37 gauges precipitation levels in the area, providing a percentage value (0% for no precipitation).

e) Arduino processes this data and transfers it to the LoRa module, which then communicates it to the Receiver LoRa module.

f) ESP32 functions as the control circuit for the Gateway Node, where LoRa receives data from the Sensor Node.

g) The data is further processed for the web through Thingspeak and a local web server.

h) This process generates a URL, enabling users to monitor weather readings, as displayed in the results.

i) Additionally, Thingspeak creates a chart depicting these readings for enhanced visualization.

IV.IMPLEMENTATION

In this circuit, the Micro-Controller is intricately connected to all the necessary components using jumper wires on the breadboard. The power supply for this circuit is sourced from a battery. Notably, it's crucial to acknowledge that this circuit lacks waterproofing, necessitating protective coverage against precipitation. All connections were meticulously secured by soldering the wires to ensure a robust and error-free setup. Loose connections can introduce errors in the data retrieved from sensors, underscoring the importance of securing them tightly for optimal performance.

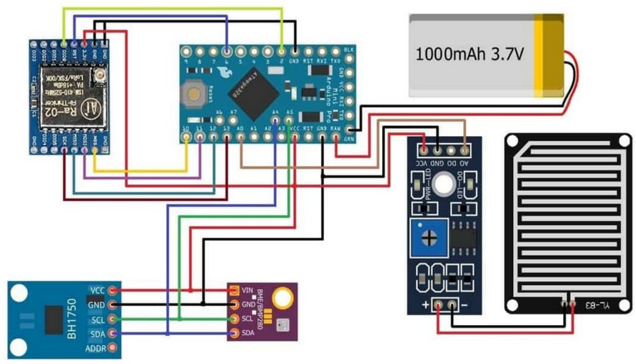

Figure 1. Circuit design

In this circuit, we integrate LoRa with ESP32 to collect data from the LoRa transmitter. As the recipient, we utilize a LoRa module coupled with the ESP32 development board. The ESP32 is notable for its built-in Wi-Fi module and BLE-Bluetooth module. Consequently, we incorporate the Wi-Fi module to facilitate data transfer to users through a web server, Thingspeak, or by utilizing the Blynk application. This strategy enhances versatility in data dissemination, catering to various user preferences and application scenarios.

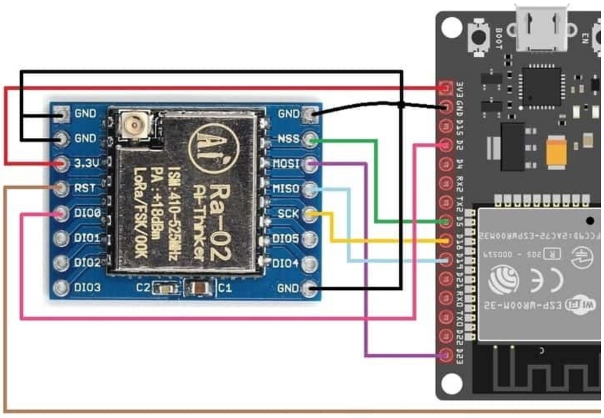

Figure 2.Gateway design

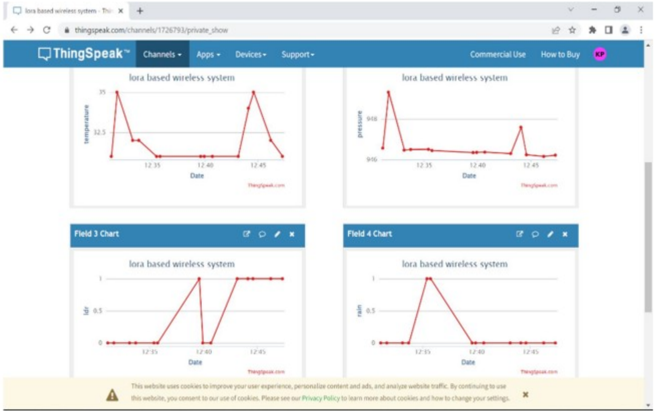

Figure 3. ThingSpeak application Output

IV. Results and Discussion

Figure 1 represents the entire hardware setup of the system.

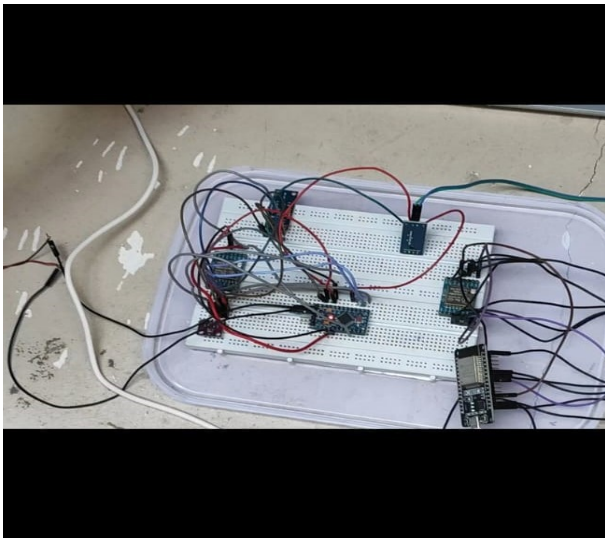

Figure 1. Hardware setup

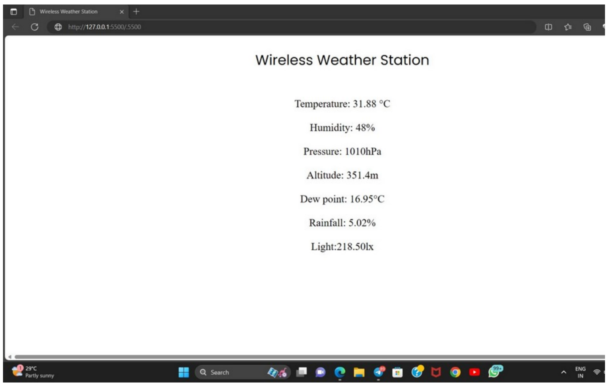

Figure 2. IP address output

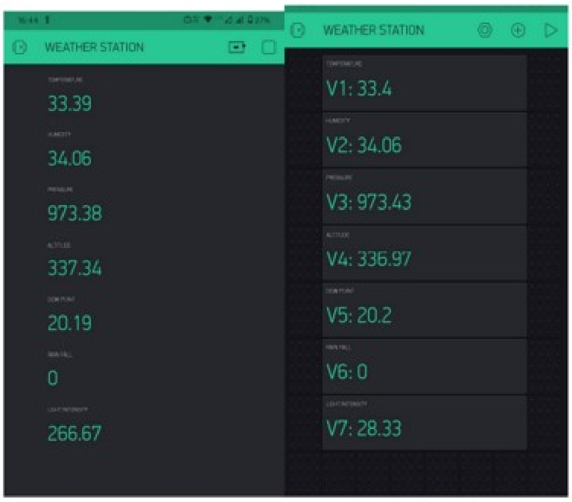

Figure 5. Blynk Mobile Application

V. CONCLUSION

The culmination of this project successfully attains its objective of developing a system capable of remotely monitoring and capturing weather parameters through IoT. The communication between the Sensor Station and Weather Station is facilitated via Wi-Fi, providing an advantage in terms of coverage compared to wired alternatives. Through wireless monitoring devices, individuals can conveniently access real-time weather trends on a dedicated web page, allowing them to take proactive measures and address issues promptly, even in adverse conditions. The sensor-generated results are transmitted and showcased on ThingSpeak for user visibility, streamlining the process of monitoring weather parameters. This seamless integration with Wi-Fi ensures the system's prompt activation, initiating data display on ThingSpeak through graphical representations. Additionally, the collected data is readily available for further analysis on the ThingSpeak platform.

ACKNOWLEDGEMENT

Foremost, we express our gratitude to Karpagam College of Engineering for providing us with the opportunity to undertake this project. We feel fortunate to have collaborated under the guidance of our mentor, Mr. G. Arun Francis. His supervision and insights have been instrumental in the success of this project. Your invaluable insights and encouragement have not only enriched our academic journey but have also ignited a genuine enthusiasm for the subject. Thank you for being a beacon of knowledge and for fostering an environment of curiosity and growth. Your dedication to our success has left an indelible mark, and we are sincerely grateful for the wisdom you have shared.

REFERENCES

[1] https://how2electronics.com/esp32-lora-sx1278-76-transmitter-recipient/
[2] https://ieeexplore.ieee.org/document/8669294
[3] IEEE Xplore: https://ieeexplore.ieee.org/
[4] SpringerLink: https://link.springer.com/
[5] Google Scholar: https://scholar.google.com/
[6] LoRa Alliance: https://lora-alliance.org/
[7] ResearchGate: https://www.researchgate.net/
[8] https://www.researchgate.net/publication/341796626_Systematic_literature_survey_applications_of_LoRa_communication
[9] https://www.researchgate.net/publication/322322331_LoRa_indoor_coverage_and_performance_in_an_industrial_environment_Case_study
[10] https://ijirt.org/master/publishedpaper/IJIRT159472_PAPER.pdf
[11] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9920130/