ISSN 2277-2685
IJESR/June-2024/ Vol-14/Issue-2s/487—496
R. Vyshnavi *et. al.,* / International Journal of Engineering & Science Research

LORA BASED WIRELESS WEATHER STATION WITH WEB SERVER

R. Vyshnavi[1], P. Jahnavi[2], P.Chaithanya[3]
[1]Assistant Professor, Department of ECE, Bhoj Reddy Engineering College for Women, Hyderabad, India
[2,3]UG scholar students Department of ECE, Bhoj Reddy Engineering College for Women, Hyderabad, India

Abstract: This abstract presents an efficient control system LoRa based wireless weather station using Arduino Nano & ESP32 Wi-Fi module. We can keep the weather station node on the roof of your house or any remote location just a few kilometers away from your home. We can use the sensor like BME280 barometric pressure sensor along with a BH1750 light sensor and also a rain sensor. Basically, this weather station can monitor the environment parameters like temperature, humidity, pressure, altitude, dewpoint, rainfall & light intensity. Using the LoRa module SX1278/RFM95 you can monitor the data from a few kilometers distance. The device operates on a battery and power consumption is low. The gateway can be placed indoors inside the house or can be placed at a certain height to achieve a long distance. The gateway is made using LoRa SX1278/RFM95 and ESP32 Wi-Fi module. The receiver collects the data from the sender or sensor node and uploads it to the server.

Introduction

In recent years, the confluence of wireless technology and meteorological instruments has led to amazing breakthroughs in weather monitoring systems. Out of all these advancements, the wireless weather station based on LoRa (Long-Range) technology is particularly notable for its exceptional efficiency and durability. By using the capabilities of LoRa communication, this advanced station provides exceptional reach and data transmission capacities. It offers up-to-date meteorological information with little energy use, transforming and adapting to atmospheric conditions across many locations, including isolated farming areas and large metropolitan environments.

Conventional approaches to weather monitoring have always depended on collecting data manually and using complex wired instruments. However, these techniques have drawbacks in terms of adaptability, expandability, and extent of coverage. Nevertheless, the introduction of LoRa based wireless weather stations has brought about a significant change in the domain of meteorological equipment.
The authentication procedure is initiated by the system, which scans the driver's license and extracts pertinent information. This information is then cross-referenced with a reliable database to confirm its legitimacy. At the same time, the system acquires the driver's fingerprint and compares it to a pre-registered database in order to improve the process of confirming their identification. By integrating these two technologies, the system offers a strong and dependable authentication procedure.

The LoRa-based wireless weather station incorporates advanced security measures to guarantee the integrity and confidentiality of collected data, in addition to authenticated processes. In addition to its sophisticated communication features, this system places a high emphasis on data security, effectively protecting against illegal access and manipulation. Through sophisticated encryption methods and authentication systems. From the moment of deployment, these stations build a network of linked sensors that continually capture and send real- time meteorological data.

Furthermore, the system features numerous key safety measures to guarantee dependable and secure operation under varied environmental situations. Built upon the sturdy basis of these systems enables for simple connection with current farm management platforms.

Literature Survey

1. P. R. Karn, H. E. Price and R.J. Diersing, published a paper "Packet Radio in the Amateur Service", in Institute of Electronics and Electrical Engineering (IEEE). This paper presents an idea on the packet radio system typically involves a terminal node controller, which interfaces with a radio transceiver to encode and decode digital signals.

2. P. Susmitha, G. Sowmyabala, published a paper "Design and Implementation Weather Monitoring and Controlling System", in International Journal of Applied Engineering Research (IJAER). This paper concludes that the system involves the integration of various sensors to monitor critical weather parameters such as temperature, humidity, air pressure, wind speed and precipitation.

3. Adil Hamid Malik, Aaqib jalal, Bilal Ahmed Par ray, Meena kohli, published a paper "Smart City IoT Based Weather Monitoring System", in International journal of embedded and software computing (IJESC). This paper presents an idea on the sensors which communicate wirelessly with a central hub or server, forming a cohesive network that continuously gathers and processes weather information.

4. Parijit Kedia, published a paper "Localised Weather Monitoring System", in International Journal of Engineering Research and General Science (IJERG). This paper presents an idea on weather conditions within a specific and confined geographical area.

5. Ashish Sharma, T Gaurav, Durvijay Singh, published a paper "Low cost Solution for Temperature and Humidity monitoring and control System using Touch Screen Technology", in International Journal of Latest Research in Engineering and Technology (IJLRET). This paper presents an idea on the system employs sensors measure temperature and humidity levels, and a touch screen interface.

6. Tarun Kumar Das, Yudhajit Das, published a paper "Design of a room temperature and humidity controller using fuzzy logic", in American Journal of Engineering Research (AJER). This paper presents an idea on creating an intelligent and adaptive system for maintaining optimal indoor environmental conditions. Fuzzy Logic is employed to model and control the uncertainty and imprecision associated with human comfort and varying environmental factors.

7. Ravi Kishore Kodali and Snehashish Mandal, published a paper "IoT Based Weather Station", in Institute of Electronics and Electrical Engineering (IEEE). This paper presents an idea on low-power wireless sensor network for soil moisture monitoring using LoRa technology presents a promising solution for agricultural applications, enabling real-time monitoring and decision-making.

8. Ravi Kishore Kodali and Archana Sahu, published a paper "An IoT based Weather Information Prototype Using WeMos", in Institute of Electronics and Electrical Engineering (IEEE). This paper presents an idea on the design and implementation of a LoRa-based soil monitoring system offer a robust solution for agricultural applications, optimizing performance for varying deployment scenarios.

9. M. Prasanna, M. Iyapparaja, M. Vinothkumar, B Ramamurthy, S.S. Manivannan, published a paper, "An Intelligent Weather Monitoring System using Internet of Things", in International Journal of Recent Technology and Engineering (IJRTE). This paper presents an idea on One notable advantage of LoRa technology is its ability to transmit data over several kilometers while consuming minimal power, The gateway acts as a bridge between the LoRa-based sensor nodes and the internet, forwarding the collected data to a centralized server or cloud platform.

10. Mircea Popa and Catalin Iapa, published a paper, "Embedded Weather Station with Remote Wireless Control", in Institute of Electronics and Electrical Engineering (IEEE). This paper presents an idea on Designing a LoRa-based wireless sensor LoRa systems monitor environmental conditions and soil moisture, providing real-time data that helps optimize farming practices and improve crop yields. Smart home applications have also benefited, sensors to measure wireless sensor

Wireless Weather Station

Proposed System

To improve agricultural efficiency and security, the suggested system integrates LoRa soil moisture sensors and PIR sensors. The soil moisture sensor continually monitors soil hydration levels in agricultural settings to optimize crop irrigation, enhancing yield and saving water.

The system monitors and secures the environment using a LoRa-based soil moisture sensor and a PIR sensor. The soil moisture sensor uses LoRa technology, which is low-power and long-range, to detect soil moisture and send it. This permits accurate irrigation control and water saving by monitoring soil conditions in real time. The PIR sensor detects motion, indicating people or animals in the monitored area. The dual-sensor system is beneficial in agriculture since soil moisture is essential for crop health and incursion detection may prevent harm.

The system uses a LoRa-based soil moisture sensor and a PIR sensor for security and environmental monitoring. The soil moisture nsensor uses LoRa technology for long-range, low-power communication to monitor and communicate soil hydration. This keeps agricultural fields and gardens wet, boosting plant health and water efficiency.

The suggested system uses a LoRa-based soil moisture sensor and a PIR sensor for environmental monitoring and resource management in addition to security. LoRa technology, which uses little power and has a great range, transmits soil moisture sensor data across large distances. This allows accurate irrigation control, saving resources and improving plant health by giving crops, gardens, and urban green areas the right quantity of water. The PIR sensor detects motion, indicating people or animals, improving security and providing wildlife activity statistics. Agriculture benefits from this dual sensor setup.

To combine environmental monitoring and security, the system includes a LoRa-based soil moisture sensor and a PIR sensor. The soil moisture sensor uses LoRa technology to assess soil hydration and transfer data over long distances, ensuring minimal power consumption and dependable connectivity even in distant places. Finally, the suggested system optimizes environmental monitoring and security using an improved LoRa-based soil moisture sensor and PIR sensor. The soil moisture sensor uses LoRa technology to assess soil hydration and communicate data over great distances with little power.

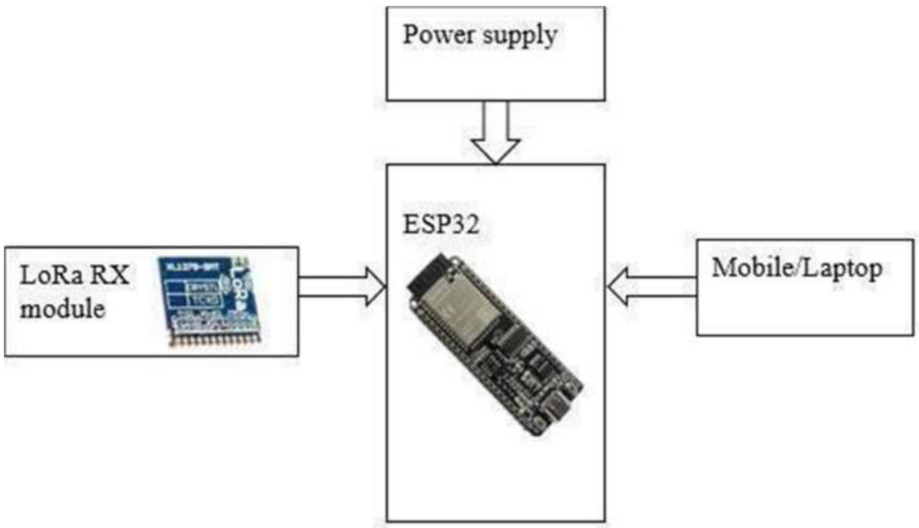

Figure 4.1: Block Diagram

Methodology

The system described consists of several components, including an ESP32 microcontroller, rain sensor, light sensor, BMP180 sensor, LoRa module, green LED, red LED, relay, and a DC motor. The power is supplied to the ESP32 microcontroller from a step-down transformer. The rain sensor, BMP180 sensor, LoRa module, green and red LEDs, relay, and DC motor are all connected to the microcontroller.

To initiate the system, power is supplied to the microcontroller. The first authentication stage involves scanning the RFID tag on the RFID reader. The ESP32 microcontroller then compares the data obtained from the RFID tag with the data stored within the microcontroller. If the data matches, the system proceeds to the next authentication stage.

In the next stage, the user is required to ensure that the ESP microcontroller reads data from all connected sensors, including soil moisture, BMP180, rain, light, and PIR sensors, and then transmits this data via the LoRa network. Once the code is uploaded and the serial monitor confirms that initialization is successful, the ESP microcontroller will start gathering data from the sensors. LoRa (Long Range) is a wireless communication methodology designed to transmit data over long distances with minimal power consumption, making it ideal for Internet of Things (IoT) applications. Operating primarily in the unlicensed ISM (Industrial, Scientific, and Medical) radio bands.

LoRa employs a spread spectrum modulation technique derived from chirp spread spectrum (CSS) technology.

This modulation method allows for robust communication even in the presence of significant noise and interference, and it supports long-range connectivity up to several kilometers in rural areas and several hundred meters in urban environments. One of the key features of LoRa is its ability to achieve long- distance communication with low data rates, which conserves battery life, making it perfect for devices that require infrequent data transmission, such as environmental sensors, asset trackers, and smart meters. The LoRaWAN (Long Range Wide Area Network) protocol adds a networking layer to LoRa, enabling secure bi-directional.

Implementation

Block Diagram

The block diagram of the project provides a high-level overview of the system's components and their interconnections. It illustrates the major functional blocks and their relationships.

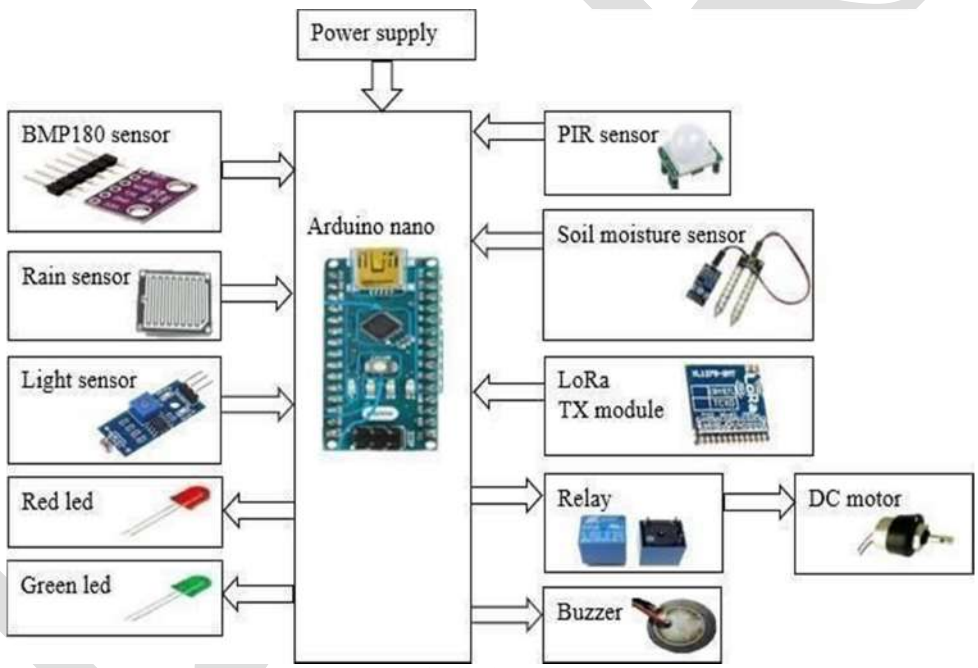

Figure 5.1: Block Diagram

Flowchart

Here is a step-by-step description of the project flowchart:

Step 1: Power is supplied to the system.

Step 2: The ESP32 microcontroller starts running as the power is supplied.

Step 3: Attach the sensors to the ESP32.

Step 4: Verify all sensors are correctly powered and grounded. Step 5: Launch the Arduino Integrated Development Environment.

Step 6: Develop the code to read sensor data and transmit it via LoRa. Step 7: Initialize LoRa module in the code.

Step 8: Implement code to read data from the sensors.

Step 9: Write code to send the sensor data over the LoRa network. Step 10: Connect ESP32 to the computer and upload the code.

Step 11: Use the serial monitor to debug and check connections. Step 12: Ensure the LoRa module initializes correctly.

Step 13: Check that the sensors provide accurate data. Step 14: Ensure the data is being transmitted over LoRa.

Step 15: Verify Wi-Fi SSID and password if connectivity issues occur.

Step 16: After successful setup, copy the IP address from the serial monitor. Step 17: Paste the IP address in a web browser to display real-time data.

Step 18: Confirm the setup is complete and functioning as expected.

This flowchart outlines the sequential steps and decision points of the project, including the initialization and operation of a LoRa-based wireless web server using an ESP microcontroller. The process begins with connecting sensors such as soil moisture, BMP180, rain, light, and PIR to the ESP microcontroller.

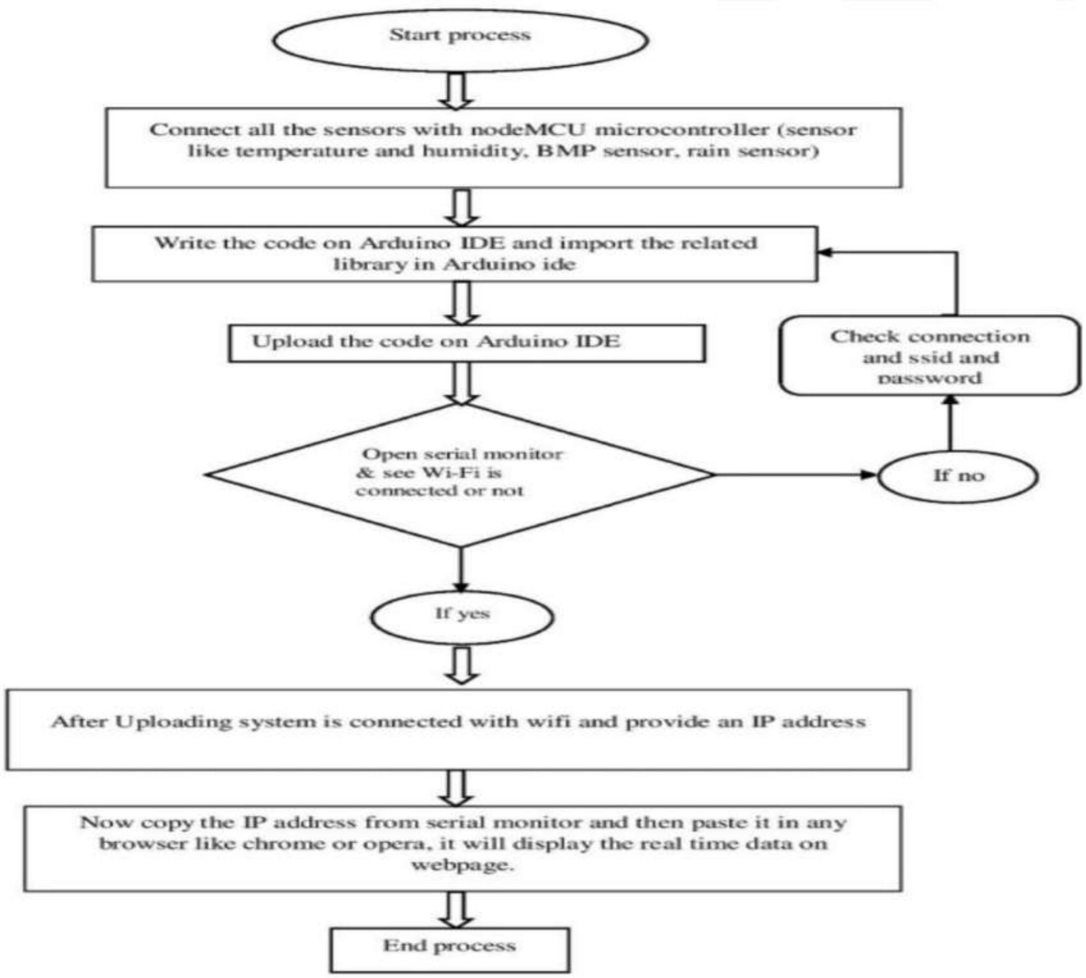

Figure 5.2: Flow chart of complete process

Results and Discussion

Results

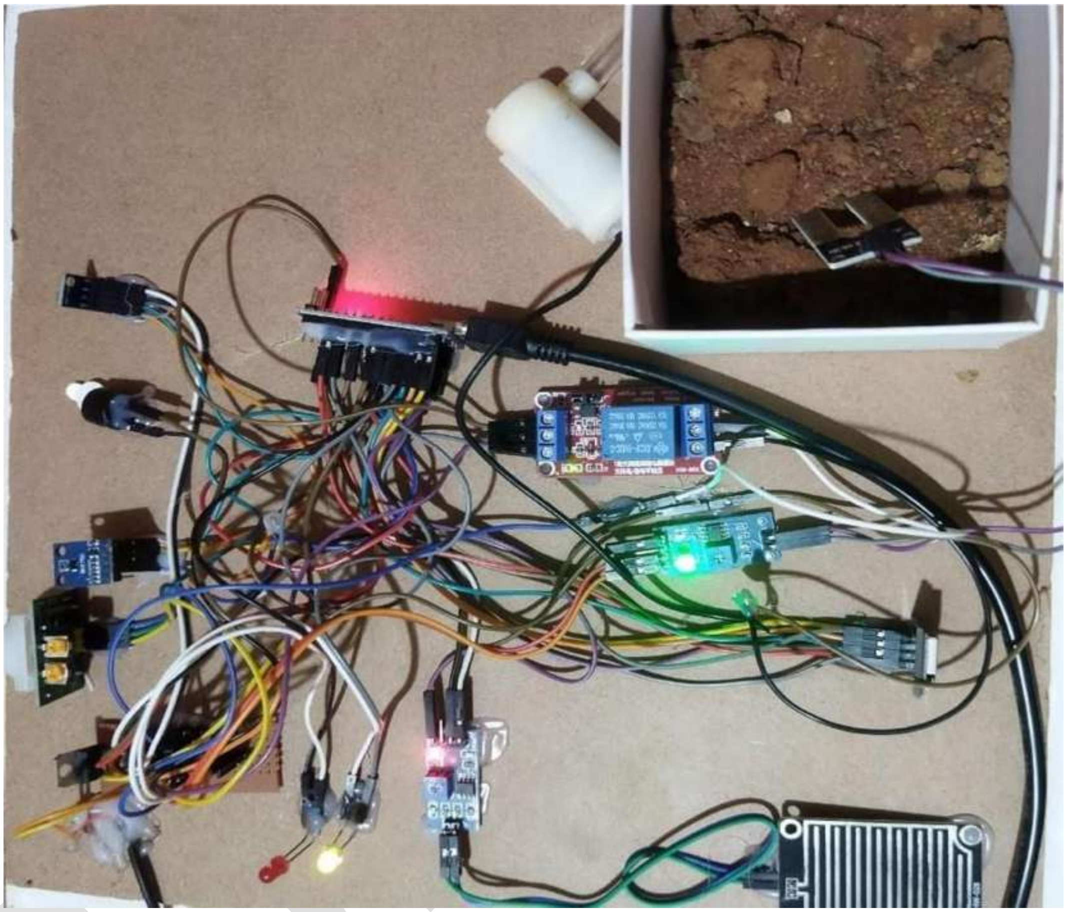

Figure 7.2: LoRa Transmitter

LoRa (Long Range) technology has demonstrated significant results in enhancing IoT (Internet of Things) applications by enabling efficient, long-distance communication with minimal power consumption. Its implementation in smart cities has led to improved resource management through smart metering of utilities such as water and electricity, where data is reliably transmitted over kilometers without the need for frequent battery replacements. In agriculture, LoRa sensors monitor soil moisture, weather conditions, and crop health, allowingfor optimized water usage and better crop management.

Environmental monitoring has also benefited, with LoRa networks providing real-time data on air quality, weather patterns, and natural disaster alerts. Furthermore, asset tracking and logistics have seen increased efficiency as LoRa devices ensure continuous monitoring goods over vast distances, reducing losses and enhancing supply chain management.

The scalability of LoRa networks supports a growing number of connected devices, facilitating expansive IoT deployments without significant infrastructure costs. These advancements underline LoRa's pivotal role in driving innovation across various sectors by delivering reliable, long-range, and low-power communication solutions.

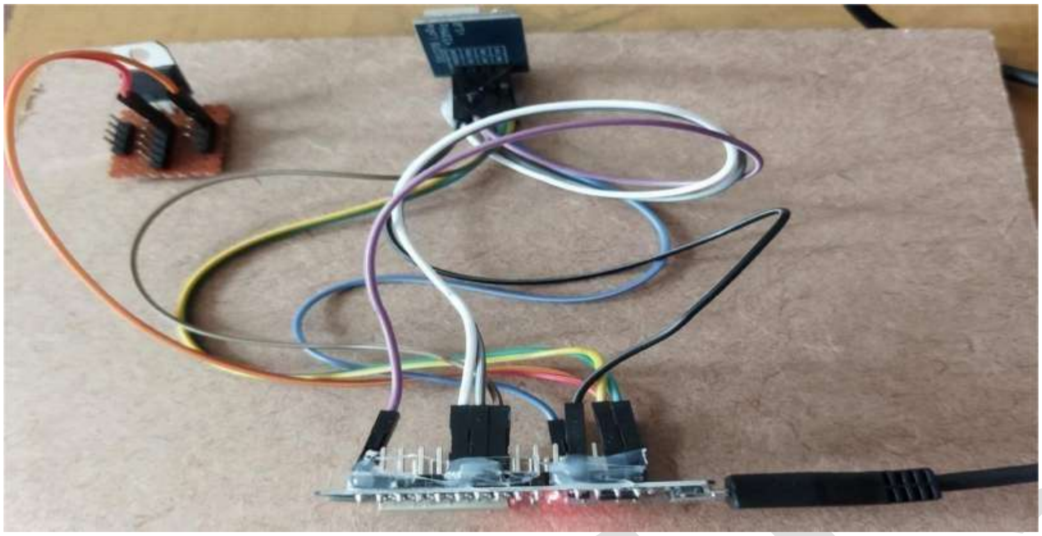

Figure 7.3: LoRa Receiver

LoRa transmitters have yielded impressive results in various IoT applications, shows their capability to provide long-range, low-power communication solutions. In smart agriculture, LoRa transmitters enable continuous monitoring of soil moisture, temperature, and crop health over vast fields, leading to optimized irrigation and increased crop yields. Urban environments benefit from LoRa transmitters in smart city projects, where they facilitate efficient management of resources through smart metering of water, gas, and electricity, and improve public services like waste management and street lighting.

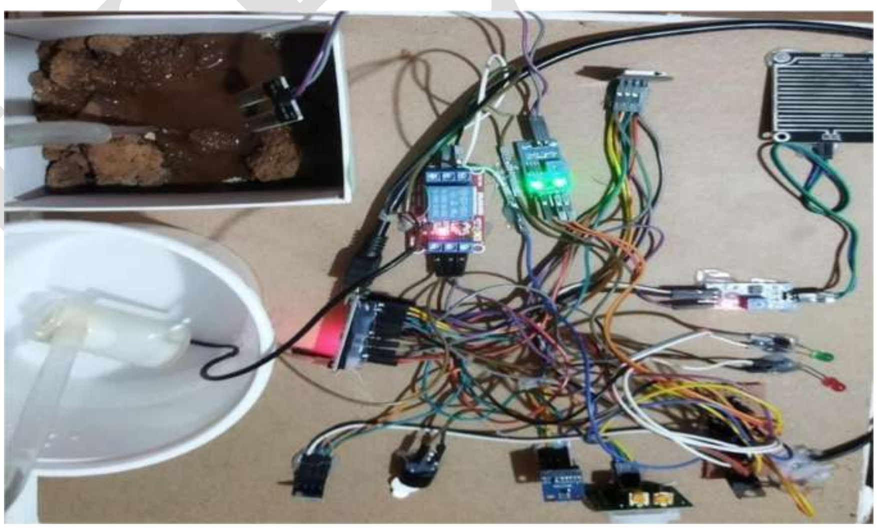

Figure 7.4: Moisture content is less

In agriculture, LoRa sensors monitor soil moisture, weather conditions, and crop health, allowing for optimized water usage and better crop management.

Environmental monitoring has also benefited, with LoRa networks providing real-time data on air quality, weather patterns, and natural disaster alerts.

In smart cities, LoRa receivers are integral to the operation of smart metering systems for utilities, ensuring accurate and timely data collection on water, gas, and electricity usage, which aids in efficient resource management. Environmental monitoring systems leverage LoRa receivers to gather real-time data on air quality, temperature, and humidity, providing valuable insights for public health and safety. Additionally, in logistics and asset tracking.

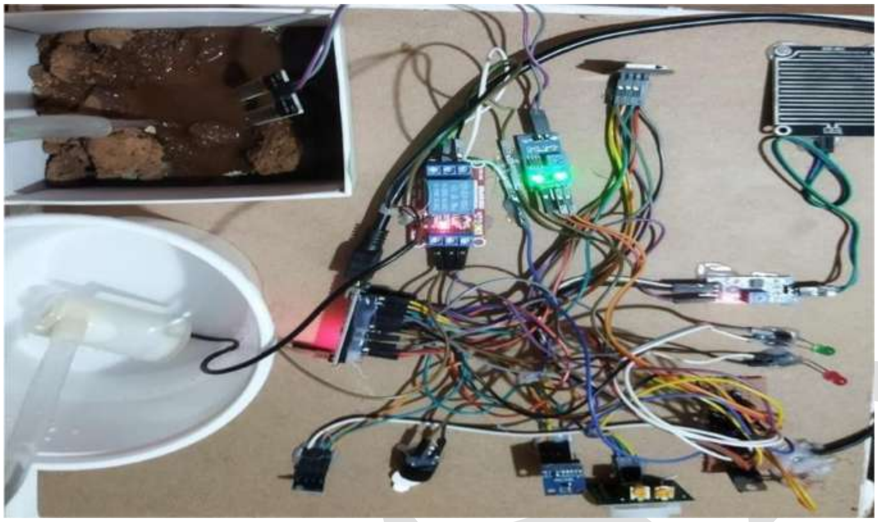

Figure 7.5: Moisture content is more

In agriculture, LoRa sensors monitor soil moisture, weather conditions, and crop health, allowing for optimized water usage and better crop management.

Environmental monitoring has also benefited, with LoRa networks providing real-time data on air quality, weather patterns, and natural disaster alerts.

Conclusion

We covered the block diagram, flowchart, and methodology for Phase 2 of the project. The block diagram provided an overview of the system components and their interconnections, giving a clear understanding of the project's structure. The flowchart illustrated the step-by-step process of the system, guiding the implementation and logic flow. Finally, the methodology outlined the systematic approach to setting up the hardware, configuring the development environment, and implementing various features such as access control, safety measures, and real-time notifications. These tools and methodologies provide a solid foundation for successfully executing Phase 2 of the project, ensuring an efficient and secure vehicle control system.

References

[1] M. A. Mohammed and G. W. Roberts, "Packet Radio in the Amateur Service", 2021 IEEE International Symposium on Circuits and Systems (ISCAS), 2021.

[2] M. Anand, Anushree and J. Dhanoa, "Design and Implementation Weather Monitoring and Controlling System", 2022 IEEE Delhi Section Conference (DELCON), New Delhi, India, 2022 .

[3] S. Pourashraf, J. Ramirez-Angulo, A. Roman-Loera and M. Gangineni, "Smart City IoT Based Weather Monitoring System", 2019 IEEE 62nd International Midwest Symposium on Circuits and Systems (MWSCAS), Dallas, TX, USA, 2019.

[4] S. Rambabu, A. Majumder and A. J. Mondai, "Localised Weather Monitoring System", 2017 2nd

International Conference on Communication and Electronics Systems (ICCES), Coimbatore, India, 2017.

[5] Panigrahi and A. Parhi, "Low cost Solution for Temperature and Humidity monitoring and control System using Touch Screen Technology", 2016 International Conference on VLSI Systems, Architectures, Technology and Applications (VLSI- SATA), Bengaluru, India, 2016.

[6] L. Artola, M. Gaillardin, G. Hubert, M. Raine, P. Paillet, "IoT Based Weather Station", IEEE Trans. Nucl. Sci., vol. 62, no. 4, pp. 1528-1539, Aug. 2015

[7] S. Kiamehr, T. Osiecki, M. Tahoori, and S. Nassif, “An IoT based Weather Information Prototype Using WeMos”, Proc. DAC 51th, San Francisco,CA, USA, 2014, pp. 1–6.

[8] T. Calin, M. Nicolaidis, R. Velazco, “An Intelligent Weather Monitoring System using Internet of Things”, IEEE Trans. Nucl. Sci. vol. 43, no. 6, pp. 2874-2878, Dec. 1996.

[9] Shah M. Jahinuzzaman, David J. Rennie, and Manoj Sachdev, “Embedded Weather Station withRemote Wireless Control”, IEEE Trans. Nucl. Sci. vol. 56,no. 6, pp. 3768– 3773. Dec. 2009.

[10] Q. Wu et al., “Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network”, IEEE Trans. Nucl. Sci., vol. 62, no. 4, pp. 1898– 1904, Aug. 2015.