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LoRa BASED WIRELESS WEATHER MONITROING SYSTEM

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Abstract : This research creates a weather station prototype using LoRa wireless technology. The internet of things (IoT) system is supported by LoRa, a wireless networking technology. This technology is an alternative to existing wireless communication modules such as GSM modules, Wi-Fi modules, and Bluetooth modules (BLE). The LoRa network is used to extend the range of wireless cells, allowing them to reach distances of up to 10 kilometers while consuming very little power. End devices can be connected to hundreds of nodes using a single LoRa network cell. Temperature, humidity, air pressure, rain detection, and wind speed are among the weather data that are monitored. The Arduino microcontroller, DHT11 sensor, BH1750 light sensor, Mems sensor, rain sensor, ESP8266, LoRa module, and web application are all included in the prototype. The number of end device nodes created in one cell is three. As a consequence, the system will be able to work correctly. With several types of sensors attached, this system has the potential to be applied in both urban and rural locations. Data collected from the sensors are then stored into the Firebase real-time database, a cloud-hosted database, and a mobile application ESP8266 wifi controller is used to show the real-time weather conditions of a particular region in an android mobile phone.

IndexTerms - **Internet of Things (IoT), LoRa, Sensors, Weather Parameters and Wireless Station.**

I. Introduction

In recent years, there has been a significant growth in the development and deployment of wireless monitoring systems across various industries such as agriculture, healthcare, smart cities, and environmental monitoring. These systems enable real-time data collection, analysis, and remote monitoring, leading to improved efficiency, cost savings, and better decision-making processes. One of the key technologies driving this revolution is LoRa (Long Range) technology, a low-power wide-area network (LPWAN) protocol that enables long-range communication with low power consumption. Coupled with Microelectromechanical Systems (MEMS) sensors, which are miniature devices capable of sensing and measuring various environmental parameters, LoRa-based wireless monitoring systems offer a robust and scalable solution for monitoring diverse applications. LoRa technology stands out for its long-range communication capabilities, allowing devices to communicate over several kilometres in rural areas and penetrate obstacles such as buildings in urban environments. This makes it ideal for applications requiring wide-area coverage such as precision agriculture, asset tracking, and smart infrastructure monitoring. LoRa operates in unlicensed frequency bands, enabling easy deployment without requiring regulatory approvals in most regions. Its low power consumption extends device battery life, making it suitable for remote and battery-operated applications. MEMS sensors play a crucial role in capturing real-time data from the environment. These sensors are integrated into various devices and systems to measure parameters such as temperature, humidity, pressure, acceleration, and gas concentration. MEMS sensors are compact, lightweight, and offer high sensitivity and accuracy, making them ideal for IoT and monitoring applications. Integrating MEMS sensors with LoRa technology enables the development of cost-effective and scalable monitoring systems. MEMS sensors collect data from the environment, which is then transmitted wirelessly using LoRa technology to a central gateway or cloud platform for processing and analysis. The data can be visualized through dashboards, enabling stakeholders to monitor conditions, detect anomalies, and make informed decisions in real time. In conclusion, the integration of LoRa technology with MEMS sensors offers a powerful solution for developing wireless monitoring systems across various industries. This combination provides long-range communication, low power consumption, high data accuracy, and scalability, making it a preferred choice for modern IoT and monitoring application. An automated weather station is a device that uses sensors to monitor and record meteorological information. This project creates a weather station network prototype using wireless LoRa technology. Temperature, humidity, rainfall, and light intensity are among the weather factors that are measured. To information is shared with the clients through an app. The aim is to develop a robust and scalable wireless monitoring system using LoRa technology integrated with MEMS sensors, enabling real-time data collection, analysis, and remote monitoring across various industries such as agriculture, healthcare, smart cities, and industrial applications.

II. LITERATURE SURVEY

This study develops a prototype of a weather station network with wireless LoRa infrastructure. Weather parameters measured include air temperature, air humidity, air pressure, rainfall and wind speed. The number of end-nodes in the prototype developed is two. But in practice later if needed it can be multiplied by dozens of end-nodes. End-nodes consisting of various sensors will be placed in an area within the reach of LoRa to process weather monitoring results in that area. Data obtained from these sensors will then be transmitted wirelessly through a LoRa gateway device connected to the cloud server. There have been many developments of IoT-based weather stations with GSM, Wi-Fi, Bluetooth, Zigbee modules [1][2][3]. But there are still rarely studied in Indonesia that discusses the use of LoRa technology. LoRa is different from other technology modules such as GSM, Wi-Fi, Bluetooth and Zigbee modules. In short, LoRa is a lower power than GSM / LTE modules and LoRa has a long range of up to 10km further than Wi-Fi, Bluetooth and Zigbee [4][5]. In the future, SF could be optimized, and analysis of its difference between those values could be investigated. Thus, improvement in hardware design can be done to improve its performance. One of the ways to do it is by replacing the antenna of the gateway and node. This could improve the characteristics of the signals transmitted, gain of the antenna, and thus improve the results of the findings.

III. EXISTING METHOD

LoRa Shield is a remote transceiver on the Arduino board and has an open-source library that allows users to send data and reach very long ranges on low data. The LoRa shield is shown in Figure 1. LoRa LG01-S is LoRa gateway which is open source. This tool can bridge LoRa wireless networks to WiFi, Ethernet, 3G, or 4G-based IP networks. LG01-S runs on embedded Linux systems that are open source. The LoRa gateway is shown in Figure 2.

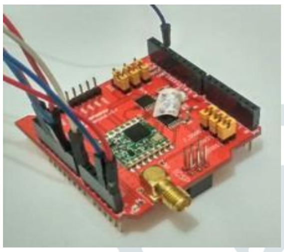

Figure 1. LoRa *Shield*

Figure 2. LoRa *Gateway*

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The study was conducted at the Unsoed Electrical Engineering Laboratory, Jalan Mayjend Sungkono KM. 5 Blater, Kalimanah District, Purbalingga Regency, Central Java. The equipment needed is a laptop, Arduino software (IDE), Proteus software, ThingSpeak web, multimeter, thermometer, hygrometer, barometer and digital anemometer. LoRa gateway LG01 915 MHz, LoRa shield 915 MHz, Arduino UNO Rev3, power bank, anemometer sensor, rain drop, DHT11, BMP180 jumper cables, PCB boards and USB connectors. System architecture shown on Figure 3.

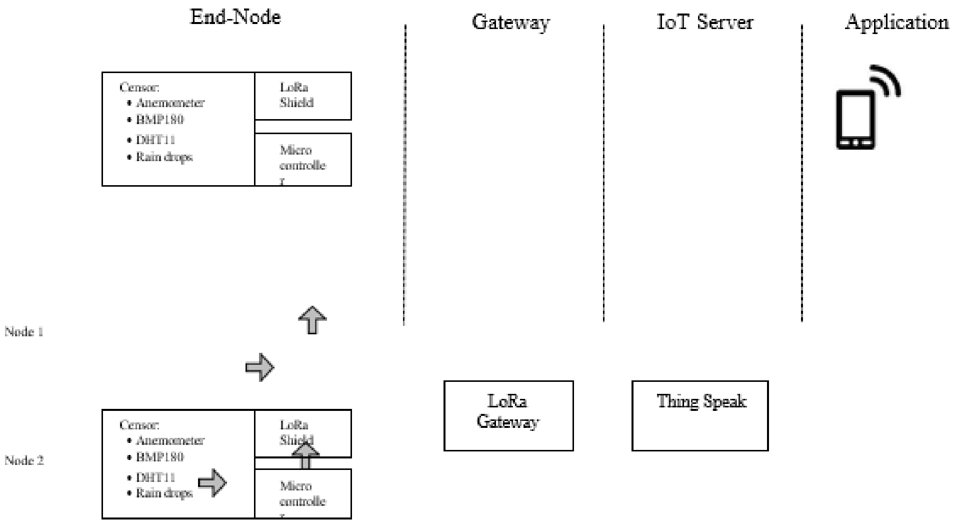

Fig.3 System Architecture.

The LoRa shield section acts as a node that functions to send data to the LoRa gateway. In this study, the LoRa shield is used with a working frequency of 915 MHz. LoRa gateway will be used by type LG01-S with a working frequency of 915 MHz. The implementation phase is carried out by realizing the design of tools including designing Arduino UNO and LoRa shield as LoRa node, designing LoRa gateway, designing sensors and LoRa nodes, and the process of uploading data to Thing Speak cloud server. This stage adjusts Things peak's source code and configuration so that it can display the data from the sensor correctly. LoRa, an acronym for the long-range, is a wireless connectivity technology module product primarily aimed at IoT systems. There are many claims of LoRa technology's superiority, as a wide area network solution that promises coverage range with very low power consumption and safer securities, with thousands of node devices that can be connected in a network making it very suitable for the Internet of Things.

DRAWBACKS OF EXISTING SYSTEM:

- Limited Scope: The conclusion seems to focus solely on the failure probability of the voter circuit in the context of gate faults, potentially overlooking other types of faults or system-level considerations that could impact overall fault tolerance.

- Sensitivity to Fault Probabilities: The conclusion suggests a critical failure threshold of 0.003% for gate fault probabilities, but it doesn't discuss the sensitivity of this threshold to variations in circuit designs, environmental factors, or manufacturing processes. A slight change in these factors could significantly affect the reliability analysis

IV. PROPOSED METHOD

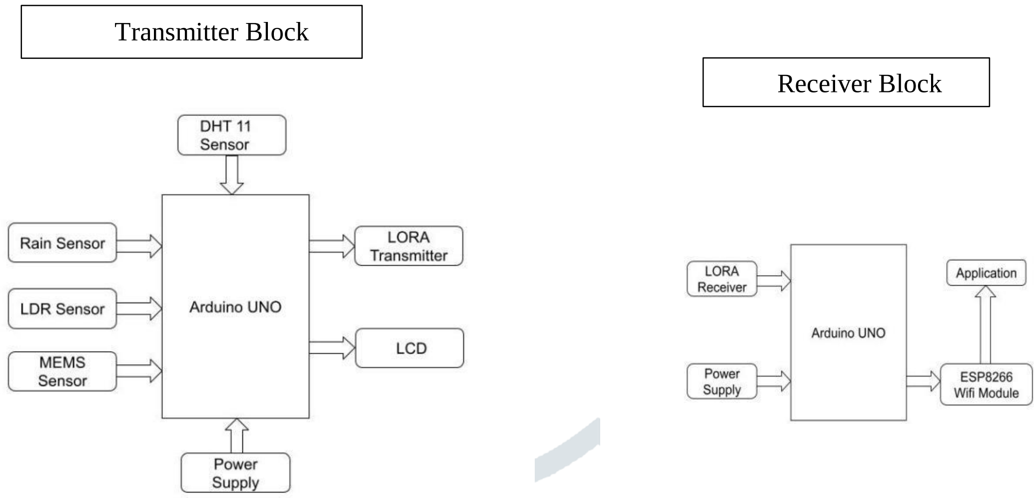

Fig.4 Block diagram of LoRa based wireless weather station

The above flow chart Fig.4 the block diagram of the given project. The microcontroller Arduino UNO will collect the data from the sensors connected and transmit the data with the help of the LoRa module (transmitter port) to the LoRa module (receiver port). The transmitted data will be displayed on the application through the ESP8266 Wi-Fi module. As the LoRa communication is started the sensors start collecting the values and transfer them to the Atmega. The LoRa shield section acts as a node that functions to send data to the LoRa gateway. This model has a LoRa transmitter and receiver which are used for the transfer of data after collecting from Arduino UNO and ESP8266. The data which is given from the sensors are sent to the Arduino UNO and from there LoRa transmitter transfer to the receiver through wireless medium. After the collection of data which is collected will be displayed on the screen, and the data are stored in the Web application storage; the user can take the necessary information for their use. LoRa is a long-range module which can transfer the data in the range of 10 km. The LoRa is a low power device for better lifespan of the device. ESP8266 is used for connecting LoRa to the cloud to store the data. The data collected in different days will be given in the digital way in a Web application. The LoRa collects the parameters level and packs them in frame with the physical location. The sensors are DHT11 Temperature and Humidity Sensor Module, Light Intensity BH1750 Sensor, MEMS Sensor and Rain Sensor module. The sensors will detects the physical quantities and send the information through the microcontroller and LoRa module to the gateway node. While it is processing we can observe the values in the LCD and transmit them through the Sensor Node (LORA transmitter) to the Gateway Node (LORA receiver). At the receiver side the lora receives the information and sends it to the Serial Wi-Fi controller application through ESP Wi-Fi module. We can observe the data from time to time in the application.

V. RESULTS

In the below Fig.5 shows the picture of the sensor node and it consists of different a sensor which is attached to the Arduino Uno microcontroller. The sensors are DHT11 Temperature and Humidity Sensor Module, Light Intensity BH1750 Sensor, MEMS Sensor and Rain Sensor module. The sensors will detects the physical quantities and send the information through the microcontroller and LoRa module to the gateway node. The light intensity sensor measures the intensity of light in the environment. It helps to determine the brightness or darkness of the surroundings. The Raindrop sensor module detects the presence of rain or moisture in the environment. The MEMS sensor detects various physical quantities including orientation. The Sensor node serves as a crucial component in Environmental Monitoring Systems. The below Fig.6 shows the picture of the gateway node which consists of the Lora module, ESP8266 Wi-Fi Module and a transformer. It also called as the receiver in the project. It receives the information from the sensor node and through Wi-Fi module the information is received in the application. It is Responsible for receiving data transmitted from the sensor nodes deployed in the field. It acts as an interface between the sensor nodes and the application system. It enables the transmission of data over significant distances with low power consumption, making it suitable for IOT applications. The transformer is used to convert the voltage levels. Overall the gateway node plays a vital role in transmitting data collected by the sensor nodes, thus enabling efficient monitoring and analysis of environmental conditions for various application. It allows the gateway node to transmit the data received from the sensor nodes to external systems or applications via Wi-Fi.

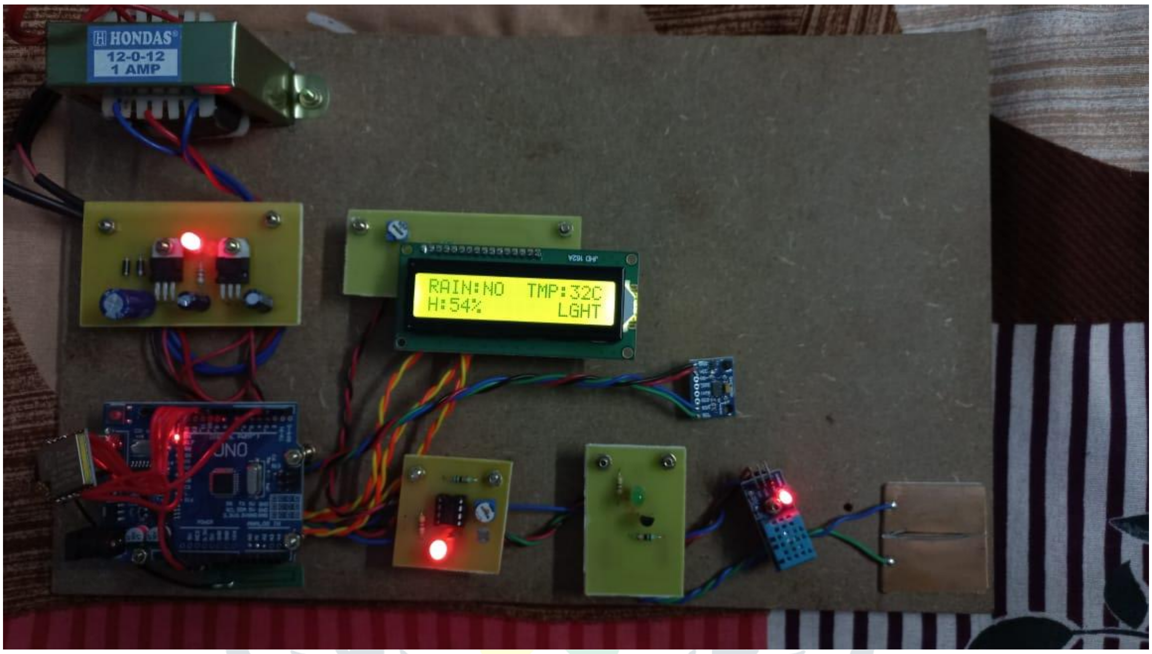

Fig.5 Sensor Node

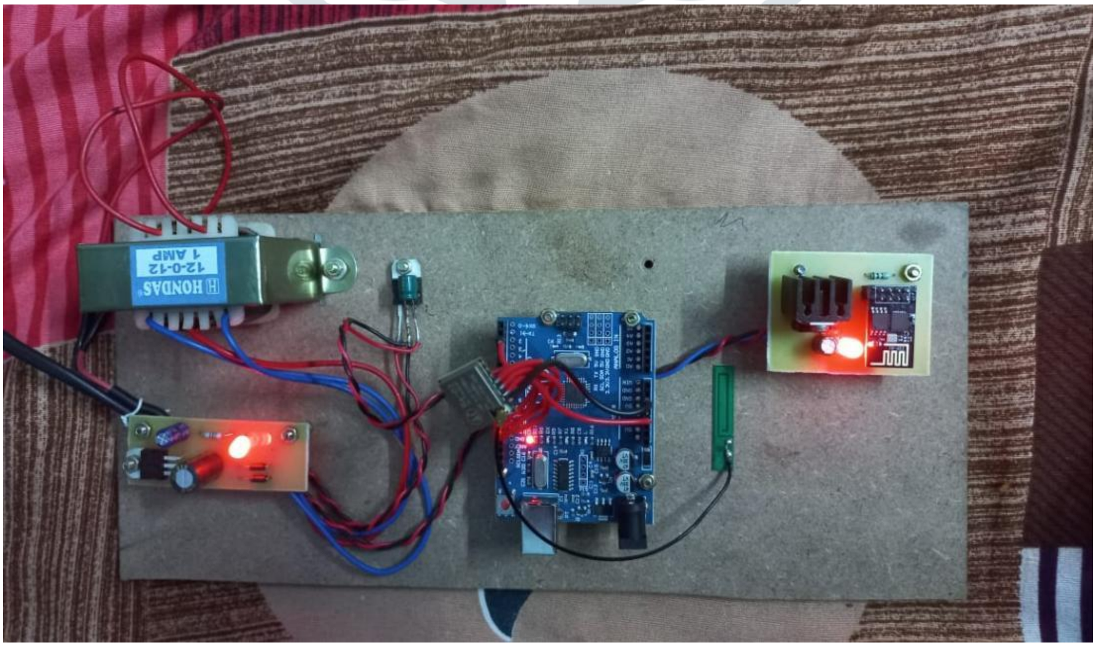

Fig 6. Gateway Node

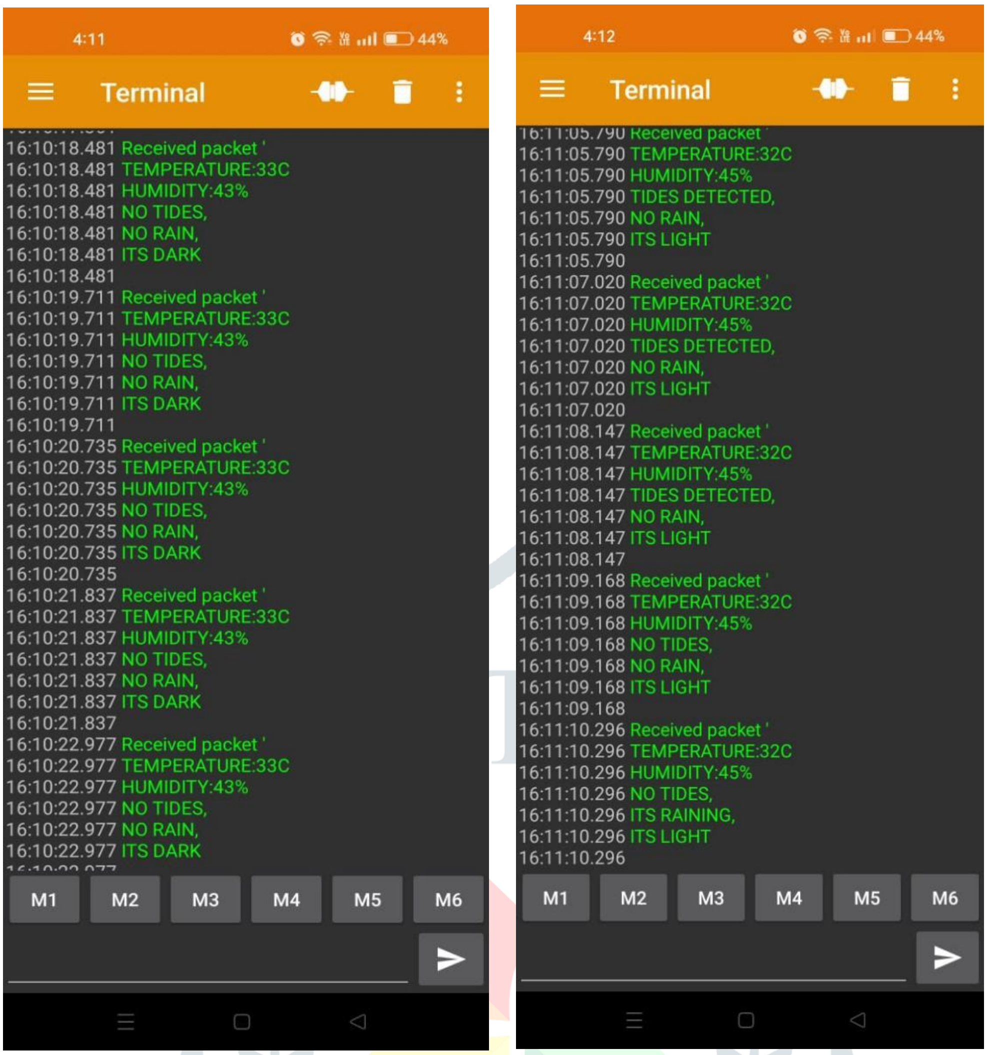

Fig.7 Wi-Fi ESP8266 Application

In the above Fig.7 it shows the conditions of different values of different physical parameters such as Temperature, Humidity, light intensity, land sliding and rainfall. This is the application where the changes in the weather will be shown immediately. This application gets the information through Wi-Fi module in the gateway node.

VI. CONCLUSION

Weather monitoring is a tricky activity as the environmental conditions can easily change from point to point even at small distances. The paper demonstrates simple and low-cost system architecture for accurately measuring climatic parameters. All the weather parameters successfully stored in Firebase real time database and displayed on a mobile application. We conclude that the proposed system can be useful for weather-related projects, such as transportation systems, aviation, and agriculture.

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