LoRa Based Wireless Weather Station

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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 Atmega 328 microcontroller, DHT11 sensor, BH1750, rain sensor, BMP180 sensor, ESP32, LoRa module, solar panel, 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 is developed using MIT App Inventor to show the real-time weather conditions of a particular region in an android mobile phone.**

Keywords: Internet of Things (IoT), LoRa, MIT App Inventor, Sensors, Weather Parameters and, Wireless Station.

I. INTRODUCTION

Weather refers to the temperature, humidity, and wind in a certain location over a period of time. The weather is always changing. There is sometimes a dry season, with rain, till snowfalls. The sun, water, and wind all have an impact on the weather. The water cycle may be controlled by the energy produced by sunlight. Clouds containing water vapour are carried by the wind to areas with lower air pressure. It rains because the air and clouds contract, becoming heavier and falling to the earth. Because weather conditions have such a large impact on human activities, it is critical to monitor weather conditions in real-time. The meteorological data will be utilized for forecasting and agricultural planning, as well as health and tourism. A collection of equipment must be installed in a specific position to reflect the environmental conditions of the surrounding region in the process of weather monitoring. A weather station is a collection of instruments that are used to monitor and record changes in weather, temperature, and atmosphere in a given region. After being collected, the data is saved in a data acquisition system, where it may later be analyzed by users or researchers. An automated weather station is a device that uses sensors to monitor and record meteorological information. This sensor acts as a weather gauge, allowing you to track any changes in the weather. Following the collection of measurement data from the weather station, the procedure can be carried out locally at the weather station's site or at the acquisition data center unit, where the data is then automatically transferred to the data processing center and processed as needed. Many IoT-based weather stations with GSM, Wi-Fi, Bluetooth, and Zigbee modules have been developed. Other technology modules, including GSM, Wi-Fi, Bluetooth, and Zigbee, are not compatible with LoRa. In concise, LoRa requires less power than GSM/LTE modules and has a range of up to 10 kilometers, much beyond Wi-Fi, Bluetooth, and Zigbee. This research creates a weather station network prototype using wireless LoRa technology. Temperature, humidity, air pressure, rainfall, and wind speed are among the weather factors that are measured. In the prototype produced, there are two end-nodes. In practice, though, it can be increased by dozens of end-nodes if necessary. To process weather monitoring findings in that region, end-nodes made up of various sensors will be installed in an area within LoRa's reach. The data collected by these sensors will then be wirelessly transferred to the cloud server through a LoRa gateway device.

II. LITERATURE REVIEW

“Remote Weather Assistant using LoRa Network, an Enhancement of IoT Design”(2019) [1], Shimona Prabhu M, Dr. Annapurna D, Shamshirun Ibrahim, Kaja Venkata Sai Shravan, Preethu Raj Roy. In the given paper, the authors have focused on the Remote Weather Assistant using LoRa Network, an Enhancement of IoT Design. The sensor data received by the gateway can be measured by using various parameters. In this paper, RSSI (received signal strength indicator which gives an idea of the power of the received signal as well as the sensitivity of the receiver) and SNR (signal to noise ratio which gives an idea of the interference in the channel) values of the signal is used in order to compare it with other existing networks. For measurement purposes, the gateway is kept stationary and the node mobile. This enables the study of the relationship between RSSI and distance as well as that between SNR and distance. By scaling up the number of nodes and the gateways in a star network, a low-cost, long-range, and low-power network can be deployed which connects even the most remote areas. This model can also be made applicable to several areas of application such as industries, hospitals, etc.

"Analysis of Propagation Link for Remote Weather Monitoring System through LoRa Gateway" (2018) [2], N. H. Abd Rahman1, Y. Yamada1, M. H. Husni2, and N. H. Abdul Aziz2. In this paper, the feasibility of Long Range Wide area network (LoRa) implementation in remote locations for weather data transmission is discussed. In this project, its spread factor (SF) was set by default, where LoRa would decide what type of SF from 7 – 12 would be ideal to use in that situation. 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.

"A Study of LoRa Low Power and Wide Area Network Technology" (2019) [3], Umber Noreen, Ahc`ene Bounceur, Laurent Clavier. In this work, the authors have analyzed the performance of LoRa, based on its three basic parameters: code rate, spreading factor, and bandwidth. Lora offers five code rates for forwarding error correction which permits the recovery of bits of information due to corruption by interference. Similarly higher spreading factor provides a longer range. Various LPWAN technologies are currently contending to gain an edge over the competition and provide the massive connectivity that will be required by the world in which everyday objects are expected to be connected through the wireless network in order to communicate with each other. This paper focused on one of the most prominent LPWAN technology: LoRa.

"Portable Weather Station Using GUI" (2019) [4], Prof.Vijayalaxmi Kadrolli, Ms.Karuna Melge, Ms.Yogita Kamane, Ms.Pranali Gaikwad, Mr.Rushikesh Sangle. This paper proposes a smart system cloud-based weather station. The system uses Raspberry Pi, for collecting and observing weather data. The storing and processing of the obtained weather data are done in the cloud to predict the effect of this weather change. The system is designed to effectively monitor the ambient weather conditions such as temperature, humidity, wind speed, pressure, rainfall, etc. The objective is to design a system that is low cost, requires less maintenance, and involved minimal manual intervention. The system is built using commodity hardware Raspberry Pi, various sensors, and uses Wi-Fi as a communication medium which makes the system consume very low power and low cost of building. This work has achieved its proposed goal of developing a cost-effective, modular, smart weather station that remotely stores climate data in a database server that can be accessed from anywhere via any device.

III. METHODOLOGY

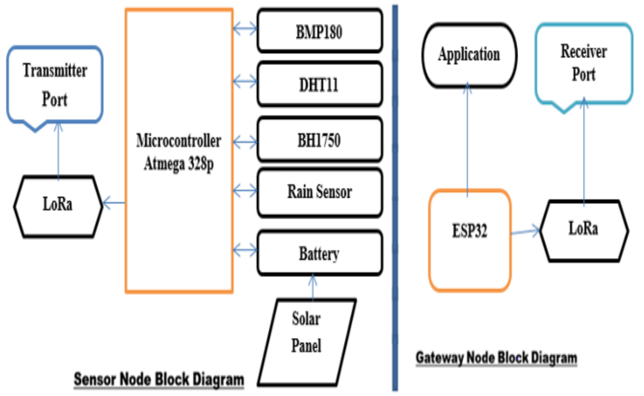

Figure 1. Block diagram of Proposed Weather Station

The above figure.1 shows the block diagram of the given project. The microcontroller Atmega328p 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 ESP32 Wi-Fi module. As the LoRa communication is started the sensors starts collecting the values and transfers to the Atmega. The LoRa shield section acts as a node that functions to send data to the LoRa gateway. This model has LoRa transmitter and receiver which are used for the transfer of data after collecting from Atmega 328 and NodeMCU. The data which is given from the sensors are send to the Atmega 328 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. NodeMCU 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 Web application. The LoRa collects the parameters level and packs them in frame with the physical location.

IV. HARDWARE COMPONENTS

A. *LoRa Module*

LoRa (Long Range) is a proprietary low-power wide-area network modulation technique. It is based on SEMTECH's SX1278 wireless transceiver. It adopts advanced LoRa spread spectrum technology, with a communication distance of 10,000 meters. The SX1278 RF module is mainly used for long-range spread spectrum communication, and it can resist Minimizing current consumption. The SX1278 has a high sensitivity of -148 dBm with a power output of +20 dBm, and a long transmission distance, and high reliability. At the same time, compared with the traditional modulation technology, LoRa modulation technology has obvious advantages in anti-blocking and selection, which solves the problem that the traditional design scheme cannot consider the distance, interference and power consumption at the same time.

Figure 2. LoRa Module

B. ESP32 Wi-Fi module

ESP32 Development board is based on the ESP WROOM32 WIFI + BLE Module. It's a low- footprint; minimal system development board powered by the latest ESP-WROOM-32 module and can be easily inserted into a solder less breadboard. It contains the entire basic support circuitry for the ESP-WROOM-32, including the USB-UART Bridge, reset- and boot-mode buttons, LDO regulator and a micro-USB connector. Every important GPIO is available to the developer. ESP32 is capable of functioning reliably in industrial environments, with an operating temperature ranging from –40°C to +125°C.ESP32 adds priceless functionality and versatility to your applications with minimal Printed Circuit Board (PCB) requirements Power: 3.3 V DC and Memory: 320 KiB SRAM.

Figure 3. ESP32 Wi-Fi module

C. BMP 180 Digital Barometric Pressure Sensor Module

This is a BMP-180 based digital barometric pressure sensor module and is functionally compatible with the older BMP-085 digital pressure sensors with less power consumption smaller size and more accuracy. BMP180 combines barometric pressure, temperature, and altitude. The I2C allows easy interface with any microcontroller. On-board 3.3V LDO regulator makes this board fully 5V supply compatible. BMP-180 can measure pressure ranging 300 to 1100hPa (+9000m to -500m relating to sea level) with an accuracy down to 0.02hPa (0.17m) in advance resolution mode.

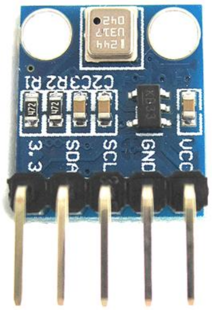

Figure 4. BMP 180 Digital Barometric Pressure Sensor Module

D. DHT11 Temperature and Humidity Sensor Module

DHT11 is a Humidity and Temperature Sensor, which generates calibrated digital output. DHT11 can be interface with any microcontroller like Arduino, Raspberry Pi, etc. and get instantaneous results. DHT11 is a low cost humidity and temperature sensor which provides high reliability and long term stability. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and outputs a digital signal on the data pin (no analog input pins needed). Only three connections are required to be made to use the sensor - Vcc, Gnd and Output.

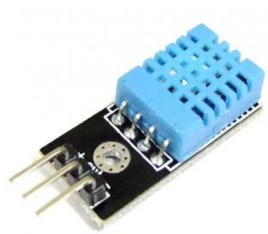

Figure 5. DHT11 Temperature and Humidity Sensor Module

E. Light Intensity BH1750 Sensor

BH1750 module is a digital ambient light sensor, IIC I2C communication. Good for Arduino light detection. It is a light intensity sensor breakout board with a 16 bit AD converter built-in which can directly output a digital signal; there is no need for complicated calculations. This is a more accurate and easier to use version of the simple LDR which only outputs a voltage that needs to be calculated in order to obtain meaningful data.

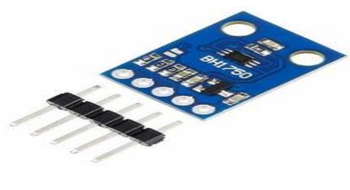

Figure 6. Light Intensity BH1750 Sensor

F. Rain Sensor Module

The rain sensor module/board is shown below. Basically, this board includes nickel-coated lines and it works on the resistance principle. This sensor module permits to gauge moisture through analog output pins & it gives a digital output while moisture threshold surpasses.

Figure 7. Rain Sensor Module

G. Solar Panel

Solar panels get energy from the sun for people to use. Solar panels are those devices that are used to absorb the sun's rays and convert them into electricity or heat.

Figure 8. Solar Panel

V. SOFTWARE COMPONENTS

A. Arduino-IDE

Arduino IDE (Integrated Development Environment) is the software for Arduino. It is a text editor like a notepad with different features. It is used for writing code, compiling the code to check if any errors are there and uploading the code to the Arduino.

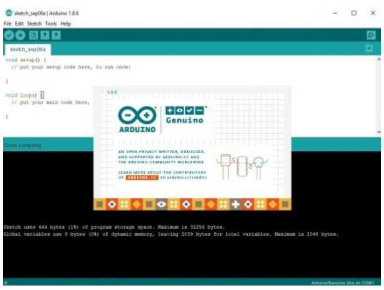

Figure 9. Arduino-IDE

B. MIT app inventor

MIT App Inventor lets you develop applications for Android phones using a web browser and either a connected phone or emulator. The App Inventor servers store your work and help you keep track of your projects.

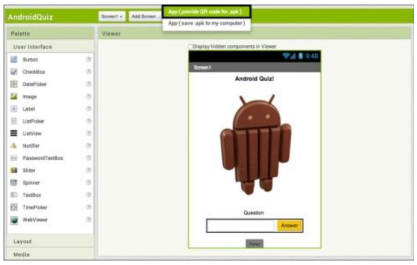

Figure 10. MIT app inventor

Advantages

- This weather station can monitor the weather parameters like Temperature, Humidity, Pressure, Rainfall and Light Intensity.
- Using the LoRa Module we can monitor the data from a few kilometer distances (up to 5Km).
- The prototype of the system can function properly because the value read by the sensor can be displayed on the MIT App Inventor interface precisely and accurately.
- Automated weather stations keep us up to date. Data accessible anywhere.
- Another advantage of a wireless weather station is the option to share data with others.

VI. RESULTS

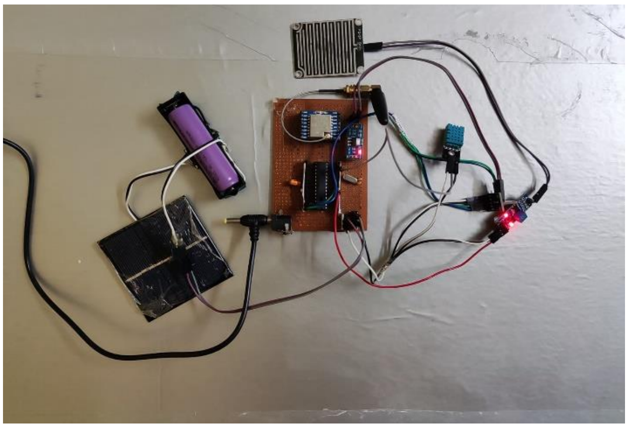

Figure 11. Sensor Node

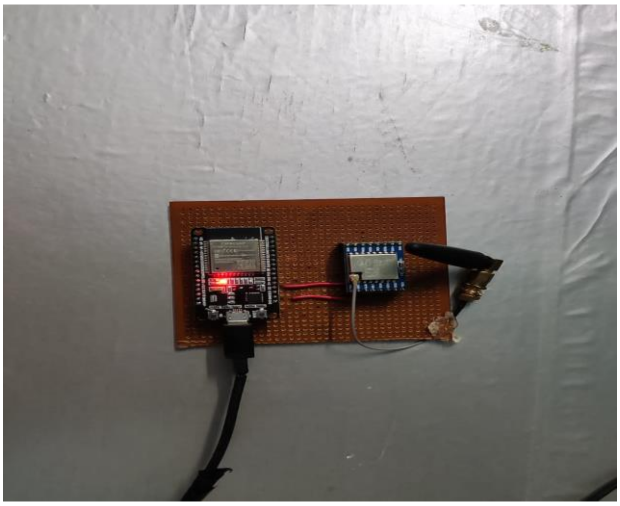

Figure 12. Gateway Node

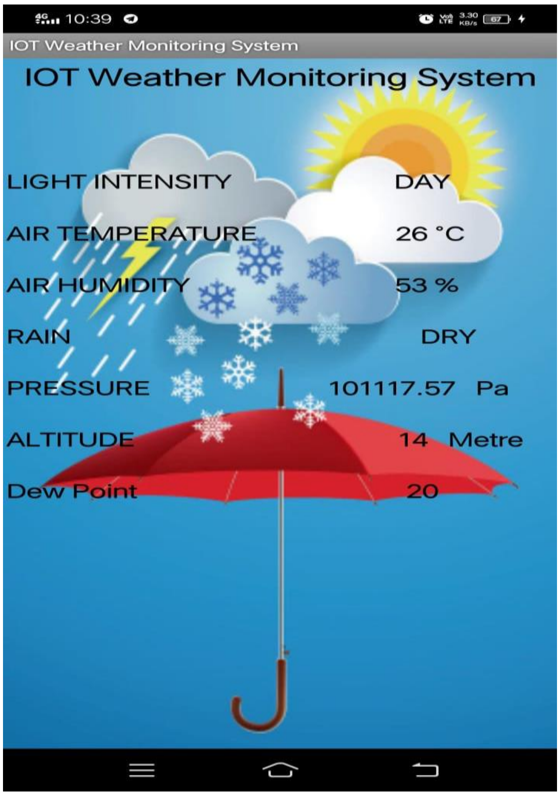

Figure 13. Weather Application

In this project, Pressure Sensor, Light Intensity Sensor, Rain Sensor Module, Temperature and Humidity Sensor are tested. The next step is sending measurement sensors data to the firebase real-time database. All the output results are sent to the Firebase database of weather project. The input weather data to all the sensors are sent to the database. The data from the real time database can be checked using the mobile application and result will be shown in the android apk for weather station that showed seven parameters.

VII. 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.

VIII. REFERENCES

[1] Eko Murdyantoro1,2 , Ridlo Setiawan1 , Imron Rosyadi1 , Azis WW Nugraha1 , Hesti Susilawati1 , Yogi Ramadhani1, “Prototype weather station uses LoRa wireless connectivity infrastructure”, Issue 2019.

[2] N. Sabharwal, R. Kumar, A. Thakur, J. Sharma "A Low Cost Zigbee Based Automatic Wireless Weather Station With Gui And Web Hosting Facility" ICRTEDC, Vol. 1, Spl. Issue 2, May, 2014.

[3] D. V. Sose, A. D. Sayyad, “Weather Monitoring Station: A Review” Int. Journal of Engineering Research and Application, ISSN: 2248-9622, Vol. 6, Issue 6, (Part -1) June 2016, pp.55-60.

[4] Hakkı Soy1*, Yusuf Dilay2, “A Conceptual Design of LoRa based Weather Monitoring System for Smart Farming”, DOI: 10.31590/ejosat.1011947.

[5] Microchip Technology Inc. (2021) RN2483 Low-Power Long Range LoRa® Technology Transceiver Module Datasheet. http://ww1.microchip.com/downloads/en/DeviceDoc/RN24 83-Low-Power-Long-Range-LoRa-Technology-TransceiverModule-Data-Sheet-DS50002346D.pdf.

[6] Chen Jianyun1,* Sun Yunfan1 and Lin Chunyan1, “Research on Application of Automatic Weather Station Based on Internet of Things”, doi:10.1088/1755-1315/104/1/012015.

[7] T.Amulya¹, B.Vyshnavi², B.Shravani³, Dr.S Ibrahim sadhar4, “IOT WEATHER STATION USING ARDUINO UNO”, © 2021 JETIR June 2021, Volume 8, Issue 6.

[8] KarthikKrishnamurthi, SurajThapa, LokeshKothari, Arun Prakash, March 2015, “Arduino Based Weather Monitoring System”, International Journal of Engineering Research and General Science Volume 3, Issue 2.

[9] Zaw Lin Oo *1, Theint Win Lai #2, Su Mon Ko #3, Aung Moe*4, “IoT based Weather Monitoring System Using Firebase Real Time Database with Mobile Application”,DEC 2019.

[10] Ravi Kishore Kodali and Archana Sahu,”An IoT based Weather Information Prototype Using WeMos” 2016 2nd 5090-5256-1/16/$31.00 c 2016