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Personal Weather Station Monitoring using Arduino and LoRa Technology

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Abstract: Uncertain weather conditions especially in the Malaysian tropical climate have risen the importance of this study. This study developed a prototype of a weather station monitoring using Arduino and LoRa technology. The prototype consists of a DHT11 temperature and humidity sensor, a rain sensor, a transmitter (Arduino Pro Mini and LoRa SX1278 with antenna), a receiver (ESP32 module and LoRa SX12278 with antenna), and a ThingSpeak web application. The prototype will track and monitor rainfall, temperature, and humidity with sensors alerting the user using the ThinkSpeak application. In the ThingSpeak application, a user can keep track of the data obtained from the weather station. As a result, both the transmitter and receiver work well in a 1-kilometre radius. Thus, implementing LoRa technology in the weather station solves the problem of data transmission over a longer distance. The study is preliminary in using the LoRa technology, LoRa network or gateway can be further used to increase the wireless range and have a low power consumption.

Keywords: Weather Station, Internet of Things, Arduino, LoRa Technology, Humidity Sensor, Temperature Sensor, Rainfall Sensor, ThingSpeak

1.0 INTRODUCTION

Mini weather stations using Arduino have gained few interests in recent years. Most of the projects were designed to collect data on temperature and humidity and display the reading using LCD [9-12]. The project also has been updated with the need to keep the data in the database for further research. Usage of SD cards in [11] is a good initiative but is inconvenient due to a safekeeping issue. Usage of new applications to improvise this weather station also has been implemented in [12] by using the Blynk application and ThinkSpeak [6][10] to further employ the IoT technology [8]. In developing a personal weather station monitoring, the key factor is a user-friendly system, easy for the user to understand and operate in the fastest time.

The personal or individual weather stations can help users to prepare for the weather ahead, focus on localized areas and sometimes more accurate reports compare to the official weather station kilometres away [1][4]. This weather station is a collection of sensors that detect or measure atmospheric conditions such as temperature, humidity, and rainfall at a certain location.

This paper presents the results of the prototype development of a personal weather station monitoring using Arduino and LoRa Technology. The objective of this project was to study and develop appropriate hardware and software materials used to develop the weather station monitoring that will also be operated with LoRa technology and ThinkSpeak Application. The remainder of this paper is organized as follows: Section II provides a thorough description of the methodology comprising a block diagram and flowcharts. Section III presents results including the prototype and the monitoring applications. Finally, Section IV summarizes the key findings of this work and provides directions for future work.

2.0 MATERIALS AND METHODS

This project is divided into two phases, software, and hardware development. The first step was to produce a block diagram showing the input, processing element, and output. Figure 2.1 shows the block diagram of the project.

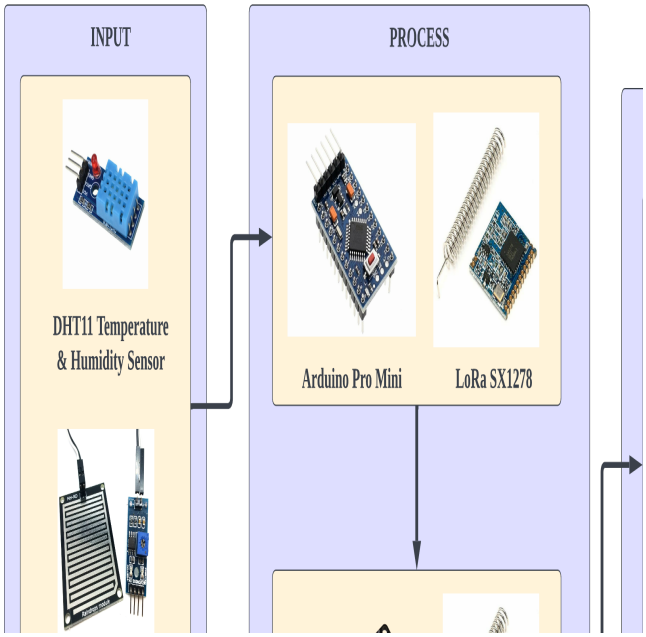

Figure 2.1: Block Diagram

DHT11 and a rain sensor are the project's inputs, as shown in Figure 2.1. The Arduino is the system that controls the project. It will control all sensors and components that are connected to it. [2] The Arduino and LoRa SX1278 act as a transmitter, sending data to the ESP32 and LoRa SX1278 receiver. All data will then be sent to the ESP32, where it will be processed by the microcontroller. After the ESP32 receives the input data from the input sensors, the operation begins. It will send the information to the ThingSpeak application [5]

After the project is powered on, the sensors connected to the Arduino will collect weather data, and the LoRa SX1278 will transmit the data to the LoRa SX1278 and ESP32, as shown in Figure 2.2[3]. The ESP32 will then connect to the WiFi network. The data cannot be uploaded to the cloud database if the ESP32 is not connected to WiFi. The data uploaded to the database can be viewed on a smartphone or laptop using ThingSpeak.

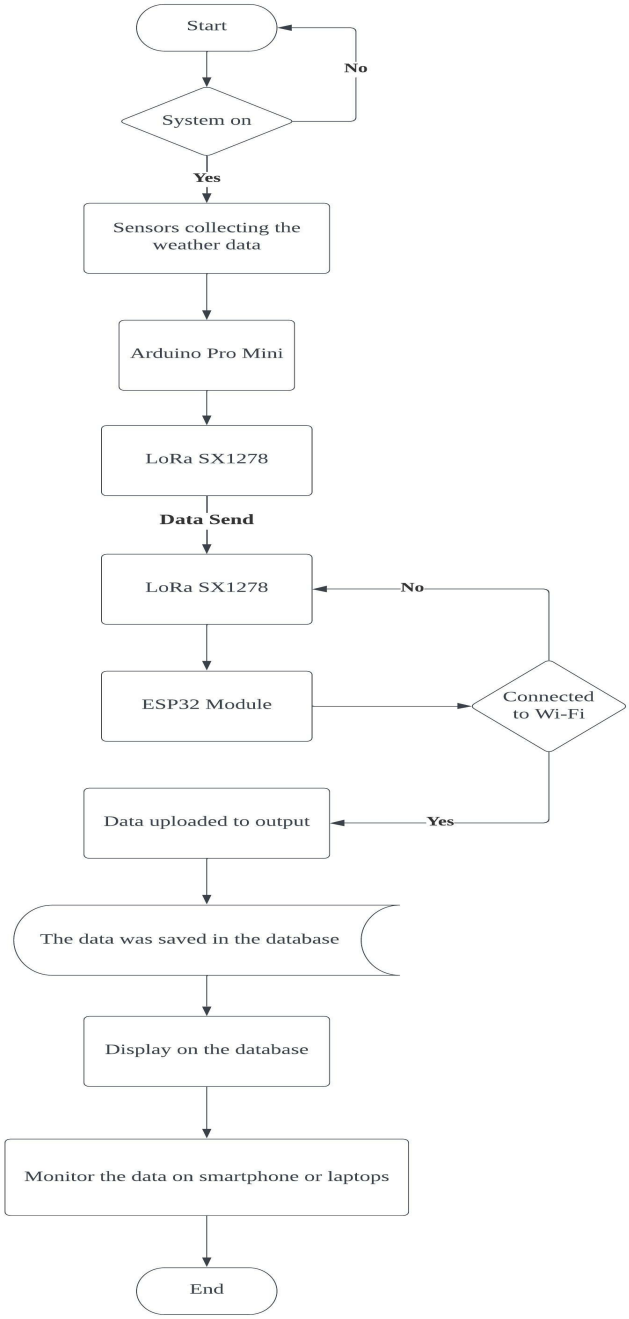

Figure 2.2: Flowchart

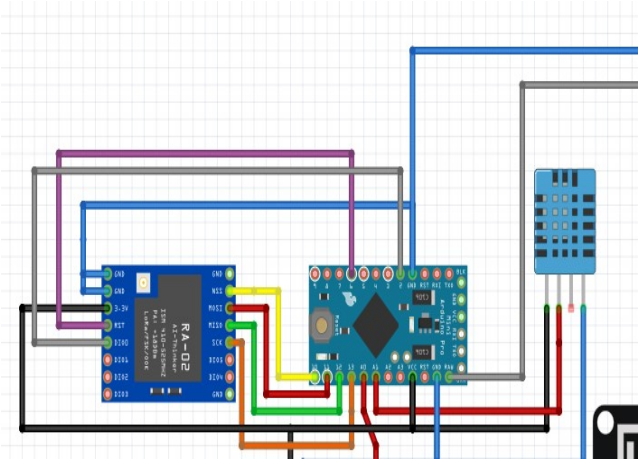

Figure 2.3.1: Schematic Diagram Transmitter

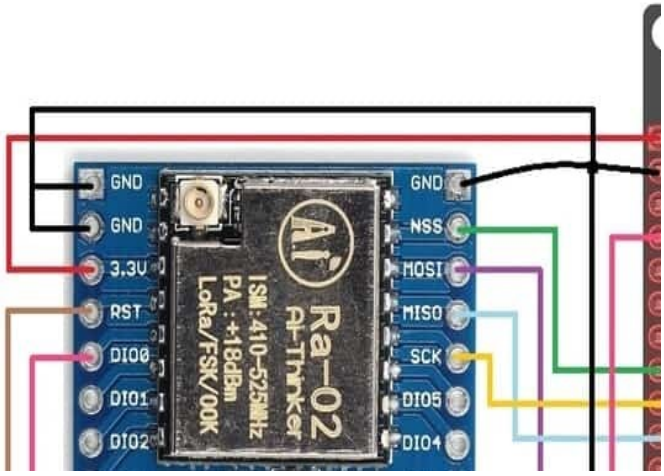

Figure 2.3.2: Schematic Diagram Receiver

The schematic diagram was constructed using Fritzing software, as shown in Figures 2.3.1 and 2.3.2. The circuit diagram illustrates the system's hardware. After you have made the proper connection, you will need to calibrate the circuit to ensure it is working properly. Whether it is not working, double-check the connection to see if it is accurate.

3.0 RESULTS

The outcome of this project is shown below.

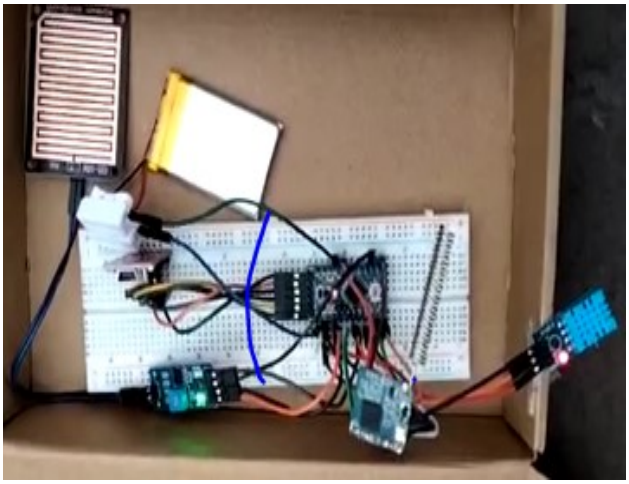

Figure 3.1: Transmitter ON

The transmitter in Figure 3.1 is powered by a LiPo battery. The sensors will collect weather data, which will then be sent to the receiver via LoRa SX1278.

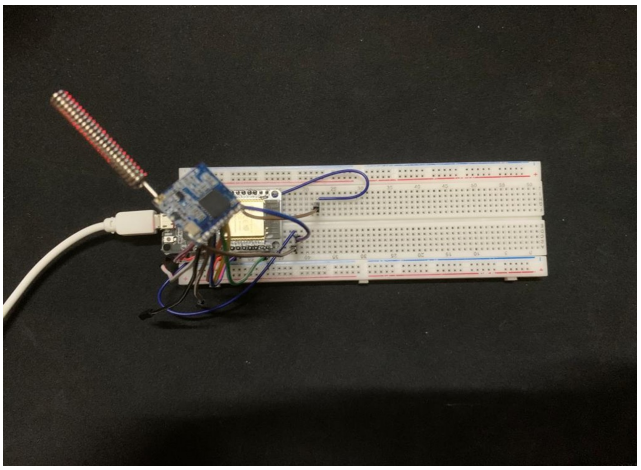

Figure 3.2: Receiver ON

The receiver is powered on in Figure 3.2 by the USB connection connected to the laptop. The data from the transmitter will be received by the receiver, and the ESP32 will connect to WiFi to upload the data to ThingSpeak.

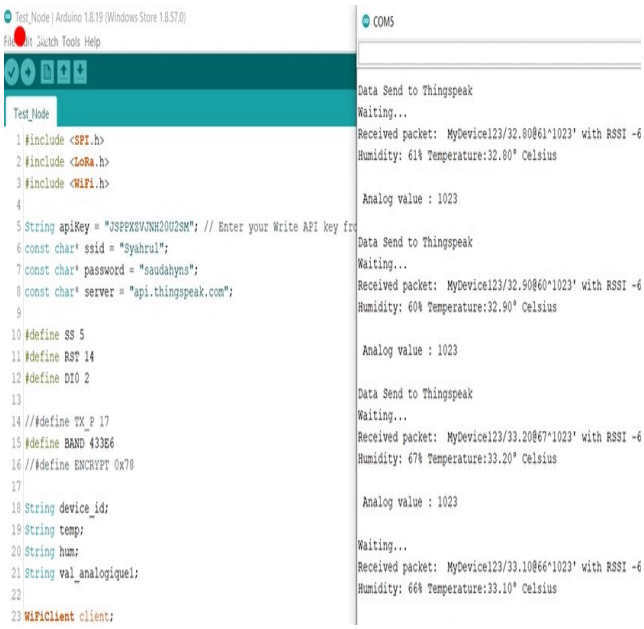

Figure 3.3: Data Collected

The serial monitor in the Arduino IDE software shows the data collected had been received by the receiver and sent to the ThingSpeak application as shown in Figure 3.3.

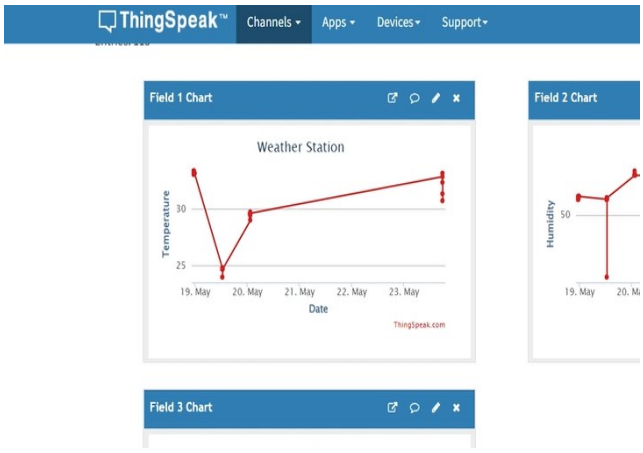

Figure 3.3: Data uploaded to ThingSpeak

The data collected had been successfully monitored on the ThingSpeak application, as shown in Figure 3.4.

4.0 DISCUSSION

The previous weather station, which was developed by others, mostly used an LCD panel to display the weather data. As a result, the weather station lacks the ability to store previously acquired data due to a lack of application to do so. Furthermore, the weather station, which uses Arduino and LoRa technology, could allow customers to use the ThingSpeak application to monitor weather data at their homes. Aside from that, it provides the user with simplicity and ease of use in monitoring their home's weather data at accurate readings. The internet of things (IoT) technology has numerous advantages. This technology will aid in the collection and storage of meteorological data in Malaysia because it is more efficient in many ways and also promotes a system that many people can utilise.

5.0 CONCLUSION

The weather station is designed with Arduino and LoRa technology, and it includes a transmitter and a receiver that can upload sensor data to the ThingSpeak application, which can then be viewed on a laptop or smartphone.

The project would enable users to keep track of data such as temperature, humidity, and rainfall at their residences. For example, if a user wants to know the weather conditions at their home, they can use their smartphone or laptop to watch the data at ThingSpeak as long as they are connected to WiFi. Furthermore, using the LoRa technology, the transmitter and receiver successfully sent the data collected over a longer distance.

With the advancement of sensor technology, the project may be taken to the next level, allowing consumers to get the most out of their investment. Furthermore, adding a pressure sensor, a light sensor, and a dust sensor to the sensor technology would help the project become more efficient and accurate.

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