Evolution in Electrical and Electronic Engineering Vol. 3 No. 2 (2022) 1030-1038

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

IoT-Based Atmospheric Parameter and Location Detection System Using LoRa

Muhammad Abdul Aziz Ahmad[1], Mariyam Jamilah Homam[1]*

[1]Department of Electronic Engineering, Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2022.03.02.121
Received 04 July 2022; Accepted 13 October 2022; Available online 30 October 2022

Abstract: LoRa is a low-power, long-range wireless technology and can be utilized for IoT-based applications. LoRa is suitable to be used in many applications such as smart cities or smart agriculture. In this project, an atmospheric parameters and location tracking system have been developed using LoRa. In addition to the LoRa modules, ESP32, Arduino UNO, GPS module, and DHT11 sensor are also utilized. Location data dan atmospheric parameters data (temperature and humidity) are then sent to the IoT platform (Favoriot). The system is able to transmit data successfully for a distance of 1 km.

Keywords: LoRa, Atmospheric Parameters, Location Tracking

1. Introduction

In this new era of technology, there are a variety of devices that are developed to make a better life for everyone. Sensing and tracking are becoming more common and would be beneficial for many people and organizations for multiple purposes, for example, monitoring and mitigation. This project is inspired by the balloon tracking system where data from moving high-altitude balloons are sent to the ground and continuously monitored [1]. In this project, atmospheric parameters and a location detection system are developed by utilizing Long Range (LoRa) technology. The sensors are located at a high-rise building and the data from the sensors are continuously sent to a moving receiver via the LoRa module. LoRa has been in the technology industry for 11 years. It was invented in 2009 by two French named Nicolas Sornin and Olivier Seller to develop long-range and low-power products [2].

LoRa is one of the options for wireless technology. The range of LoRa detection is 3 km – 10 km [3]. It also provided high duplex communication and high sensitivity. LoRa provides long-range data communication with a low-cost setup. This is the reason LoRa become the main component of this project. There are many more wireless communications technologies such as commercial detection using cellular tracking, radar tracking system, Automatic Packet Radio System (APRS) tracking system

**Corresponding author: mariyam@uthm.edu.my*

and using ultra-high radio frequency transceivers [1]. In general, these systems are expensive and hard to maintain services.

Furthermore, these systems cannot be customized by the user because it is a commercial product. This project proposes to implement low-cost and long-range detection at a high-rise building. The project uses LoRa modules to connect Arduino UNO, ESP32, DHT11 sensor and GPS module. The GPS module and DHT11 sensor are connected to the LoRa module (transmitter) and it will send the data to LoRa module (receiver). After that data will be uploaded to the Internet of Things (IoT) platform, Favoriot.

1.1 Atmospheric parameters and Location detection

The state of the atmosphere parameter determines the weather condition. Air temperature, atmospheric pressure, humidity, precipitation, solar radiation, and wind are all factors that influence weather. Each of these variables can be measured to identify the quality of local atmospheric conditions and to describe typical weather patterns. Weather monitoring allows for the creation of a database of usual conditions. Weather monitoring functions as an environmental baseline and ensures safe working conditions, marine research, and leisure activities [4].

Location detection refers to technology that physically locates and electronically records and tracks the movement of people or objects. Location detection technology is used every day such as GPS navigation, locations located on digital pictures and searching for businesses nearby using common apps. While location detection is often associated with smartphone use since smartphones have a GPS chip, there are other ways location detection can be done [5].

2. Methodology

The project is developed by integrating two microcontrollers ESP32 and Arduino UNO together with LoRa modules, GPS module and DHT11 sensor and then linked to an IoT platform. There are three major parts developed for this project which are the transmitter, receiver and output. Arduino UNO microcontroller acts as a transmitter that controls the operation of this system. The first part is the transmitter where all the main components (DHT11 sensor, GPS module and LoRa module) are attached to the Arduino UNO. Next, location and atmospheric parameters (temperature and humidity) data are sent to the receiver. The second part of this project is the receiver where all the data obtained from the transmitter are received and uploaded to the IoT platform (Favoriot) to store the data.

2.1 Flowchart of the project operation

Figure 1 shows the flowchart of project implementation. The project operation starts by turning on the LoRa module at the transmitter. After that, the DHT11 sensor and GPS module will turn on. Next, the data from the transmitter are sent to the LoRa module at the receiver. Then, ESP32 is connected to Wi-Fi and sent all the data to the Favoriot platform. However, if the data is not received the operation will start again from the beginning.

Figure 2 shows the block diagram of atmospheric parameters and location detection system using LoRa. In general, it starts with two microcontrollers located at different places each connected with a LoRa module. One acts as a transmitter and another one as a receiver. After both the transmitter and the receiver connect to each other, the sensor from the transmitter side turns on to collect the data of the atmospheric parameters (temperature and humidity) and send it to the receiver. The LoRa (at the receiver), receives the data from DHT11 and GPS module. The LCD display turns on when ESP32 power up. Finally, all the data is collected and sent to the IoT platform (Favoriot) and users can access the data from the Favoriot platform.

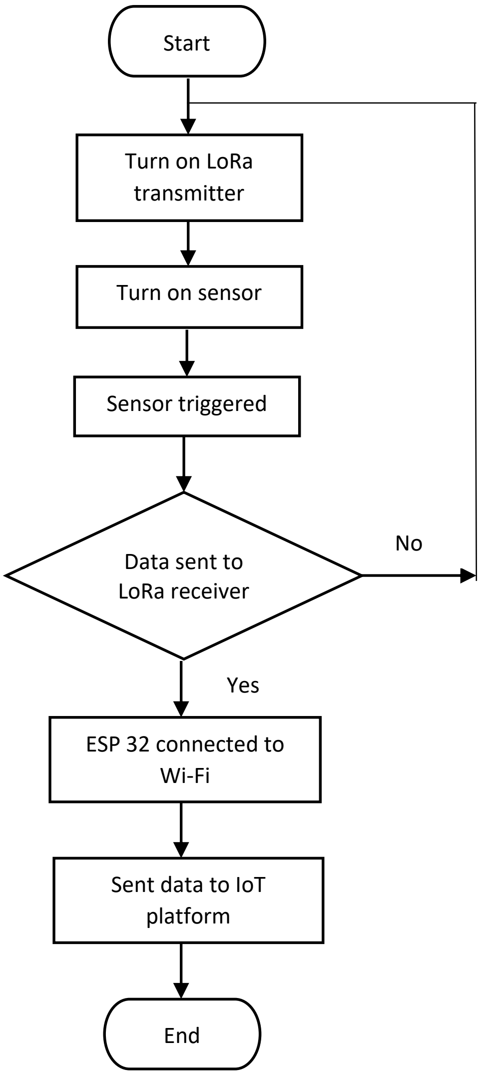

Figure 1: Flowchart of the project operation

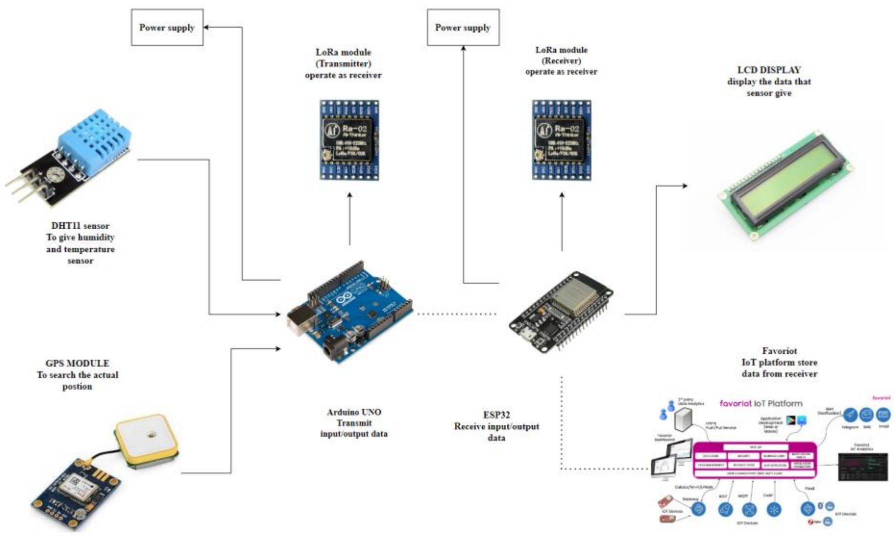

Figure 2: Block diagram of atmospheric parameters and location detection system using LoRa

3. Results and Discussion

The results contain two parts which are the result of atmospheric parameter conditions from the DHT11 sensor and the location detection from the GPS module. The results of all data are sent to the IoT platform (Favoriot). A full prototype of the transmitter and receiver sides of an IoT-based atmospheric parameter and location detection system using LoRa has finally been developed.

3.1 LoRa detecting testing

Detection range testing for the LoRa module is conducted to see how far it can be transmitted. It starts with testing LoRa of approximately 1 km with 433 MHz antenna cable. Figure 3 shows the distance from the transmitter to the receiver. Figure 4 shows the street view on Google Maps. In addition, the testing of the transmitter height above ground is also being tested. The height being tested where the transmitter is put at 25 meters from the ground is shown in Figure 5. Both testings of coverage works fine but to get the best possible coverage it is necessary to have a clear line of sight between the transmitter and the receiver.

Figure 3: Distance 1 km between transmitter and receiver

In radio communication, the radiation area is described using Fresnel zones. A Fresnel zone is an ellipsoid between the transmitter and the receiver. The size of the ellipsoid is determined by the transmission frequency and the distance between the two sites. After 1 km, the data from the prototype cannot be transmitted and received due of a lack of line of sight. This might be due to the obstacles in the surrounding area for example trees and buildings.

Figure 4: Street view on Google Maps

Figure 5: The height of the transmitter at 25 m above ground

3.2 Transmitter and receiver prototypes

The prototype of the system is portable because the system can use a battery to power up. It works with two different power supplies to power up this system. In this system, Arduino UNO used a 9 V battery to power up the DHT11, GPS module and LoRa module. Figure 6 shows the full connection of the transmitter. The Rx and Tx pins of the GPS module are directly connected to digital pins 3 and 4, while the DHT11 sensor is connected to pin analog A0. DHT11 is added to this system to detect the humidity and temperature of the atmosphere. LoRa connection pin connects with 6 digital pins D2, D9, D10, D11, D12 and D13 of the Arduino UNO. The prototype of the system is portable because the system can use a battery to power up. It works with two different power supplies to power up this system.

In this system, Arduino UNO used a 9 V battery to power up the LCD 16x2 and LoRa. Figure 7 shows the full connection of the receiver side. The LCD 16x2 with I2C have SCL and SDA pin which are connected to analog pin 5 and 4 of Arduino UNO. LoRa connection pin connects with 6 digital pins D2, D9, D10, D11, D12 and D13.

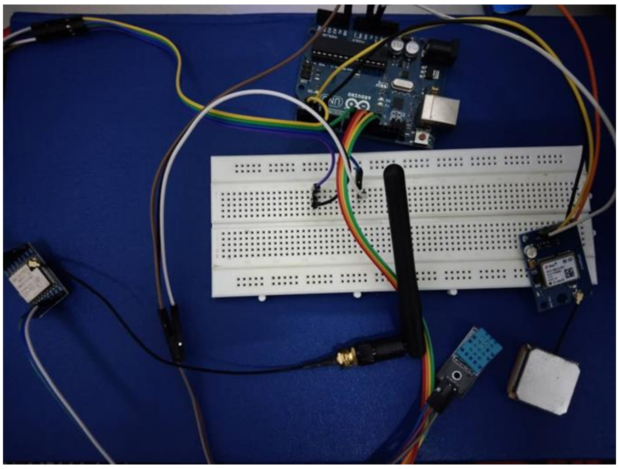

Figure 6: Full connection of the transmitter

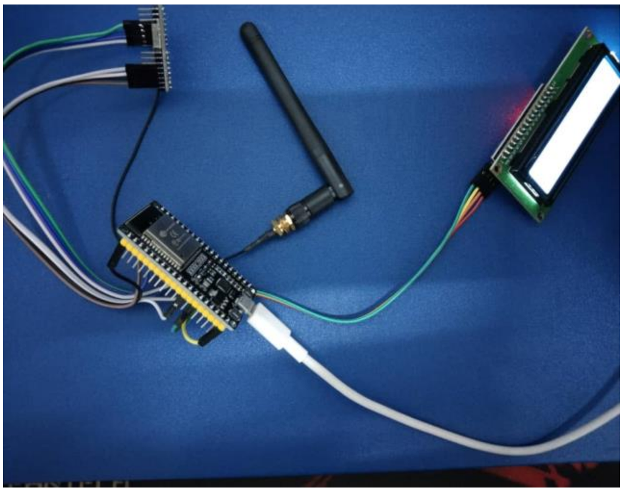

Figure 7: Full connection of the receiver

The GPS module has tiny processors and antennas that receive data directly from satellites through specific RF frequencies in the device. It receives timestamps from each visible satellite, as well as other data. Figure 8 shows the current location which is located around Parit Haji Rais with a reading of latitude 1.852282 and longitude 103.089193 as viewed in Google Maps.

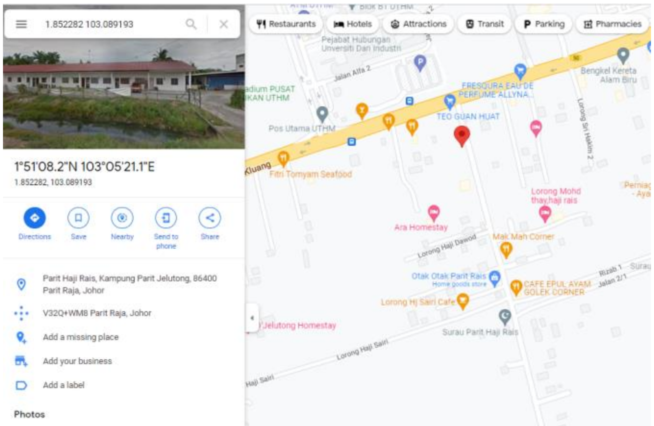

Figure 8: GPS location of the transmitter on Google Maps

The system can store data in the cloud using the IoT platform (Favoriot). This platform can store the location of the GPS module and humidity and temperature data from DHT11. Data of the GPS location and DHT11 are recorded in the Favoriot platform. Figures 9 and 10 are the real-time data of temperature and humidity displayed on the Favoriot dashboard.

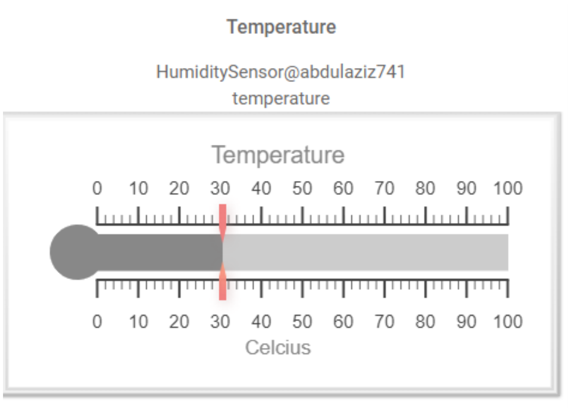

Figure 9: Real-time data of temperature

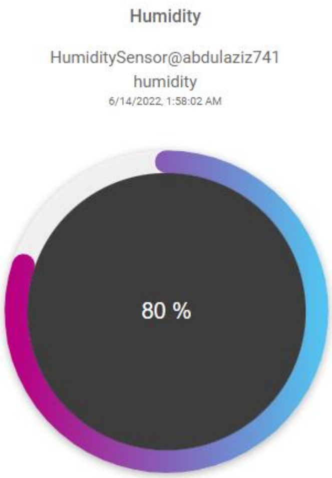

Figure 10: Real-time data of humidity

The result of the data shows that the location, humidity, and temperature update in Favoriot every 5 seconds. The time for location updates in Favoriot can be set to 30 minutes per update. The data were collected for 5 hours to find the average value. All the data from data streams can be displayed on the dashboard to get the graph for monitoring time, temperature, humidity, longitude, and latitude.

The data on location, humidity and temperature stored in the Favoriot platform can be exported in CSV format. Figure 11-14 result of data has been collected for 5 hours. At the beginning of the temperature and humidity graph, it shows the value was zero because the data from the receiver have not been stored in the data stream in the cloud and for the final part of the graph the value slowly becomes zero because the connection between the receiver and IoT platform has been disconnected

Figure 11: Result of humidity for 5 hours

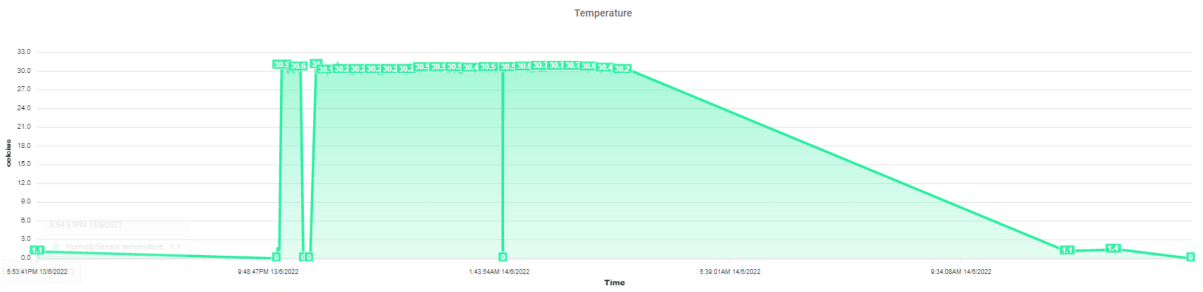

Figure 12: Result of temperature for 5 hours

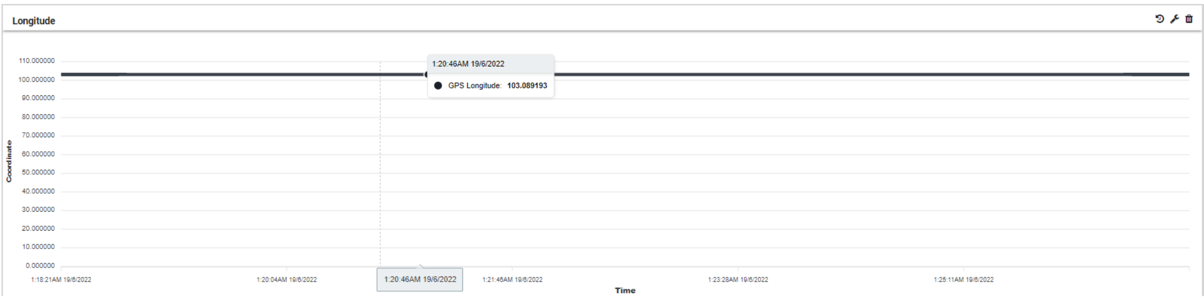

Figure 13: Longitude GPS coordinates for 5 hours

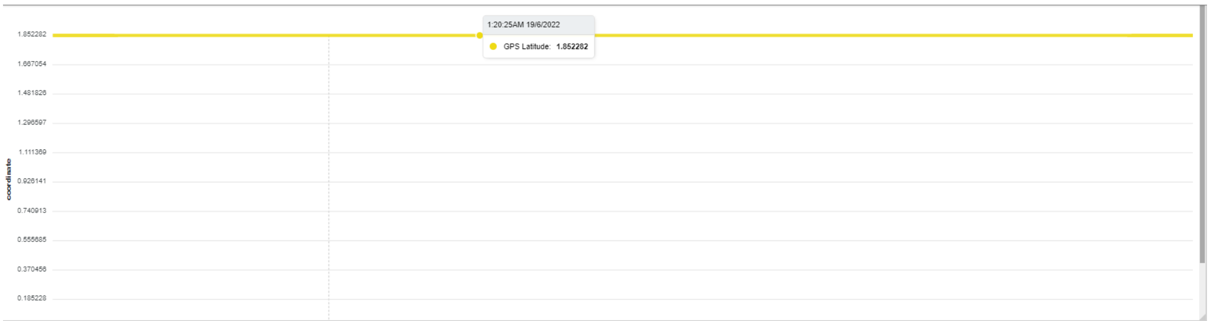

Figure 14: Latitude GPS coordinates for 5 hours

The prototype of the transmitter and receiver of atmospheric parameters and location detection system using IoT has finally been developed. This system works when the transmitter and receiver parts can successfully connect to each other and data can be stored in the IoT platform of Favoriot.

4. Conclusion

In summary, IoT-based atmospheric parameters and location detection system using LoRa modules utilizing the DHT11 sensor and GY-NEO6MV2 GPS module is successful in terms of simulations and experimental for the distance of 1 km between the transmitter and receiver.

However, it needs an improvement in coverage output and real-time monitoring on the IoT platform. The connection quality may be improved if there is a clear line of sight between the transmitter and receiver. At the end of this project, the objectives of this project are achieved, and the results obtained have been analyzed. This effort contributes to a better understanding of IoT. However, this project also has its drawbacks that can be improved in the future.

Acknowledgement

The authors would like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] Mohammed M., Yasser A., & Teddy S ‘’Low Altitude Balloon IoT Tracker: Proc. of the 4th IEEE International Conference on Smart Instrumentation, Measurement and Applications’’ (ICSIMA), 2017s)

[2] Laurens Slats “A Brief History of LoRa”: https://blog.semtech.com/a-brief-history-of-lora-three-inventors-share-their-personal-story-atthe-things-conference., 2020

[3] Bob Cohen "What is location tracking?" https://www.bobology.com/public/What-is-Location-Tracking.cfm, 2020)

[4] Wetzel, R. G. “Limnology: Lake and River Ecosystems” (3rd ed.). San Diego, CA: Academic Press, 2001

[5] E. J. J. Gonzalez et al. "Location detection for navigation using IMUs with a map through coarse-grained machine learning," Design, Automation & Test in Europe Conference & Exhibition (DATE), 2017