International Journal of Computing and Artificial Intelligence

E-ISSN: 2707-658X
P-ISSN: 2707-6571
IJCAI 2023; 4(1): 45-50
Received: 21-01-2023
Accepted: 02-03-2023

Balakrishna K
Department of ECE, Maharaja Institute of Technology Mysore, Uttar Pradesh, India

Rakshith N
Department of ECE, Maharaja Institute of Technology Mysore, Uttar Pradesh, India

Shashank R
Department of ECE, Maharaja Institute of Technology Mysore, Uttar Pradesh, India

Nithish Y
Department of ECE, Maharaja Institute of Technology Mysore, Uttar Pradesh, India

Praveen K M
Department of ECE, Maharaja Institute of Technology Mysore, Uttar Pradesh, India

Corresponding Author:
Balakrishna K
Department of ECE, Maharaja Institute of Technology Mysore, Uttar Pradesh, India

Implementation of LoRa and Bluetooth technology in farming application with performance analysis

Balakrishna K, Rakshith N, Shashank R, Nithish Y and Praveen KM

DOI: https://doi.org/10.33545/27076571.2023.v4.i1a.63

Abstract
In the Farming field, IoT plays an important role by collecting datasets from remotely placed farm fields through a communication protocol, where the things are connected in closed-loop network form which is called precision farming. The Internet of Things (IoT) has created ample opportunity for researchers to exchange information for wide range and short range communication such as Wi-Fi (Wireless Fidelity), Bluetooth, ZigBee, LoRa (Long Range), 6LoWPAN, LoRaWAN (Long Range Wide Area Network), NB-IoT (Narrow Band IoT) etc, Bluetooth Low Energy (BLE) addresses low-power short-range connectivity, while LoRa addresses low-power long-range connectivity. Both technologies employ unlicensed, spread spectrum technology. Bluetooth can send data continuously over a short distance, usually less than 10 meters. LoRa has an urban range of connectivity between 2-5 kilometers, while in a rural setting, it can reach up to 15 kilometers. So here we aim to design and develop LoRa and Bluetooth-enabled IoT applications to collect the datasets from the farm fields such as Temperature, Relative Humidity, Rain percentage, and soil moisture.

Keywords: Bluetooth Low Energy (BLE), farming, IoT (Internet of Things) LoRa (Long Range), Low-power

1. Introduction

The Internet of Things (IoT) has created ample opportunity for researchers to exchange information for wide range and short range communication such as Wi-Fi (Wireless Fidelity), Bluetooth, ZigBee, LoRa (Long Range), 6LoWPAN, LoRaWAN (Long Range Wide Area Network), NB-IoT (NarrowBand IoT) etc, [1]. The selection of long and short-range wireless communication depends on the strength and weaknesses of the device module. Short-range communication devices offer a low risk of interference with radio signal-connected devices, due to their connected range and transmission power requirement. Long-range wireless communication depends on the satellite relay, data link and high frequency, which extends to work behind the line of sight. The various factors affecting the performance of wireless communication applications such as throughput, power, noise, frequency, free space loss, diffraction, multipath, absorption, terrain and antenna range [2]. The challenges and choice of a specific range of communication depend on the applications and their utilization in the area such as the healthcare sector, industry sector, agriculture sector, education sector, household sector etc. Here limiting our view to the agriculture sector, that too for the collaboration of datasets for the specific parameters from the remote farm field [3].

In the Farming field, IoT plays an important role by collecting datasets from remotely placed farm fields through a communication protocol, where the things are connected in closed-loop network form which is called precision farming. Precision farming is the one where physically integrated devices observe, monitor, and measure the inter and intra-farm variability of the surrounding environment. Which finally helps us to get valuable insights. The process of the communication for farming field can be done through wireless communication depending on the range of communication. Here focused our work on analyzing the performance of communication for range communication for the selected devices such as LoRa and Bluetooth technology in farming applications [4]. LoRa technology has revolutionized by enabling long-range data transmission using a little amount of power and having the ability to penetrate deep indoor environments. Bluetooth technology enables short-range data transmission having their personal area networks.

Bluetooth Low Energy (BLE) addresses low-power short-range connectivity, while LoRa addresses low-power long-range connectivity [5]. Both technologies employ unlicensed, spread spectrum technology. Bluetooth can send data continuously over a short distance, usually less than 10 meters. LoRa has an urban range of connectivity between 2-5 kilometers, while in a rural setting, it can reach up to 15 kilometers. So here we aim to design and develop LoRa and Bluetooth-enabled IoT applications to collect the datasets from the farm fields such as Temperature, Relative Humidity, Rain percentage, and soil moisture. Finally, analyzing the performance of the technology considering the various parameters to help the market of agriculture field.

2. Related Works

Zarnescu *et al.*, [6] worked on implementing a large LoRa network for an agriculture application using IoT technology in an area of South West of Romania. Datasets from the farm field such as soil parameters and air parameters are collected from the field and made available at the distance using IoT technology. The farm field monitoring involved designing a network in a two-tired star topology having unique placement node number of the stations with selection of gateways between the local area network and a cloud analyzed. Here the poor propagation conditions lead to the adoption of transmission parameters more favourable to the signal quality than to the energy efficiency, but still maintaining the energy independence of the stations.

Ahmed, Mohamed A., *et al.*, [7] worked on implementing LoRa based IoT platform for remote monitoring of large-scale agriculture farms in Chile. The datasets are collected continuously from various IoT devices such as sensors, actuators, meteorological mast and drones from remote locations. These form of data available for the end users or the authorized person for decision-making for advanced training and validating the prediction algorithms. Results collected through both simulation and experimental validation show that the platform can be used to obtain valuable analytics of real-time monitoring that enable decisions and actions such as, for example, controlling the irrigation system or generating alarms.

P. K. Reddy Maddikunta *et al.*, [8] described the future challenges and requirements in smart agriculture for the Unmanned Aerial Vehicles (UAV). The cost and ease in controlling the UAV for smart farming plays a important role for motivating farmers to use UAVs in farming, which are remotely controlled using radio waves such as Wi-Fi, ZigBee and Bluetooth technology. Bluetooth has an advantage over other technologies for the short-range data transmission over a wireless channel, where each smart phones has built-in Bluetooth connectivity. Farmers can use any smartphone to operate their respective UAVs along with Bluetooth Smart-enabled agricultural sensors in the future. However, certain requirements and challenges need to be addressed before UAVs can be operated for smart agriculture-related applications. Hence, in this article, an attempt has been made to explore the types of sensors suitable for smart farming, potential requirements and challenges for operating UAVs in smart agriculture.

Nikodem, Maciej [9] developed a Bluetooth low-energy livestock positioning for smart farming applications with agriculture 4.0 technology. This paper presents a localization method that was designed for Smart Farming and applies to a wide range of radio technologies and IoT systems. The method was verified in a real-life IoT system dedicated to monitor cow health and behaviour. In a large multi-path environment, with a large number of obstacles, using only 10 anchors, the system achieves an average localization error equal to 6.3 m. This allows using the proposed approach for animal tracking and activity monitoring which is beneficial for well-being assessment.

Taşkın, *et al.*, [10] developed a Bluetooth low-energy sensor node for green house in precision agriculture as IoT application. In this study, a new sensor node design, which includes ambient light and temperature sensors employing Bluetooth Low Energy (BLE) communication protocol, is used as an IoT application. Subsequent to this, sensor node power consumption and management cost was investigated.

3. Proposed Methodology

The proposed methodology works in two stages as shown in Figure 1 and 2, which consisting of transmitter part and receiver part. The transmitter part consisting of sensors like DHT11, PIR, Rain and Moisture to record from the farm field, where the recorded datasets are collected cumulatively and transmitted through LoRa/Bluetooth Module as show in Figures. The receiver part receives the datasets from the remote place through the receiver antenna and displayed at the remote/user location to take further appropriate action.

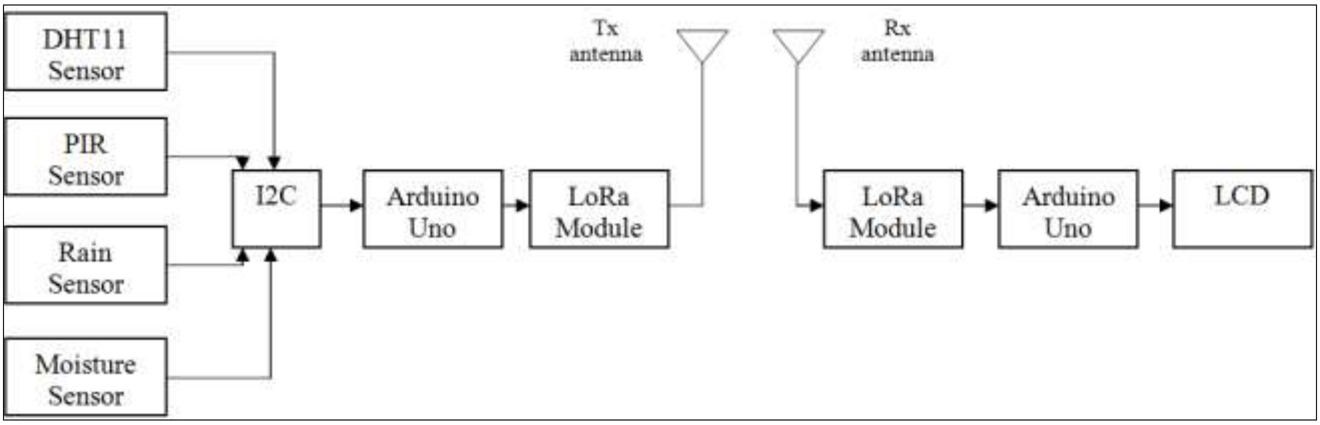

Fig 1: Proposed block diagram containing LoRa Module for the Farming application.

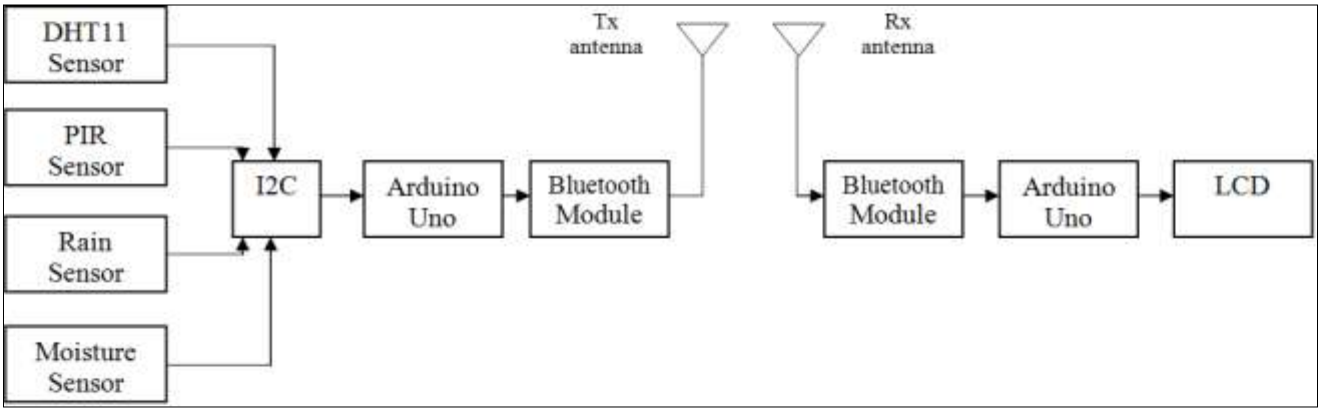

Fig 2: Proposed block diagram containing Bluetooth Module for the Farming application.

4. Experimentation

In this section, an integrated low LoRa/BLE designed to collect temperature, relative humidity, sense motion, rainfall and soil moisture level datasets from the farm field as shown in Figure 3 and 4. The DHT11 sensor measures the temperature and humidity of the field. Temperature is measured from the semiconductive material for small changes in temperature lead to large changes in resistance based on the negative temperature coefficient. Humidity is measured using two electrodes with moisture-holding substrate between them, while the resistance or conductivity changes lead to changes in humidity. A passive infrared sensor (PIR) detects the changes in infrared radiation of the source without emitting radiation. It consists of Fresnel lens and pyroelectric material, Fresnel lens made of high-density polythene concentrate the incoming infrared radiation so that they fall on the pyroelectric material. Pyroelectric material detects the changes in infrared radiation and generates an output signal. The rain sensor contains a sensing pad with series of exposed copper traces that is placed out in the open, possibly over the roof or where it can be affected by rainfall. The sensing pad with series of exposed copper traces, together acts as a variable resistor (just like a potentiometer) whose resistance varies according to the amount of water on its surface. The more water on the surface means better conductivity and will result in a lower resistance. The less water on the surface means poor conductivity and will result in higher resistance. The sensor produces an output voltage according to the resistance, which by measuring we can determine whether it’s raining or not. The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

I2C is a serial communication protocol, so data is transferred bit by bit along a single wire (the SDA line). With I2C, data is transferred in *messages.* Messages are broken up into *frames* of data. Each message has an address frame that contains the binary address of the slave, and one or more data frames that contain the data being transmitted. The message also includes start and stop conditions, read/write bits, and ACK/NACK bits between each data frames:

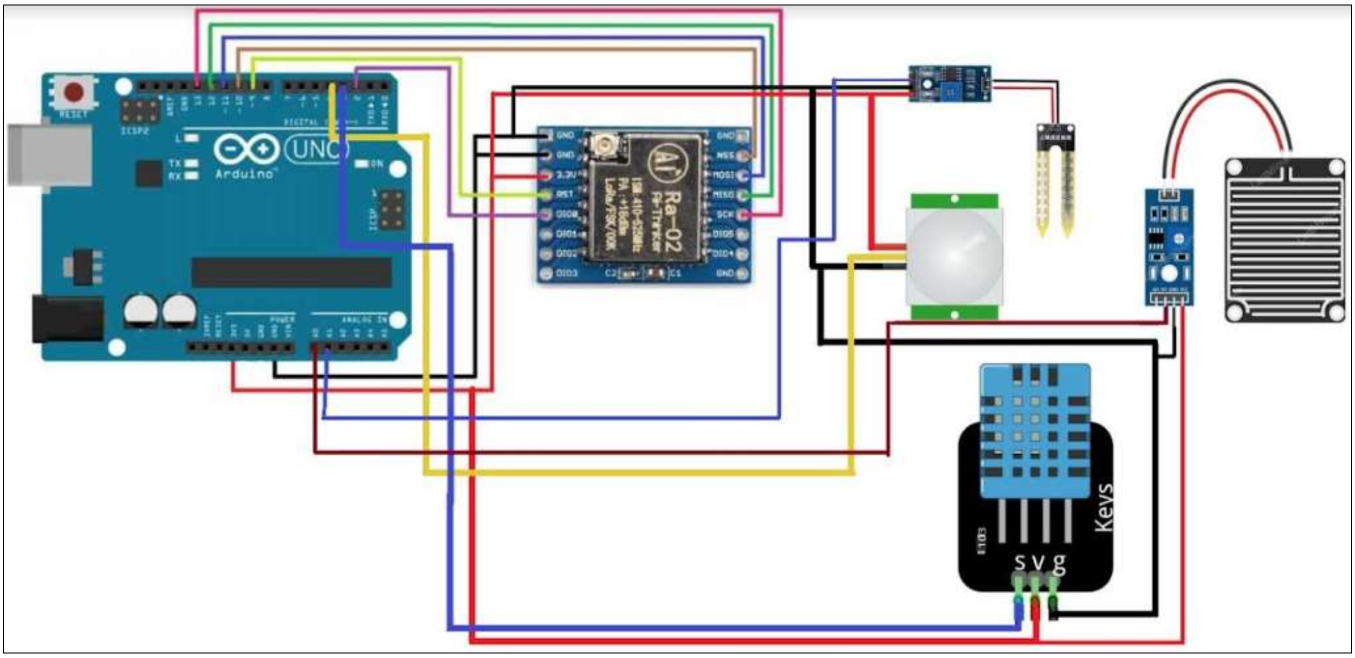

Fig 3: Schematic diagram of the proposed model of Transmitter part.

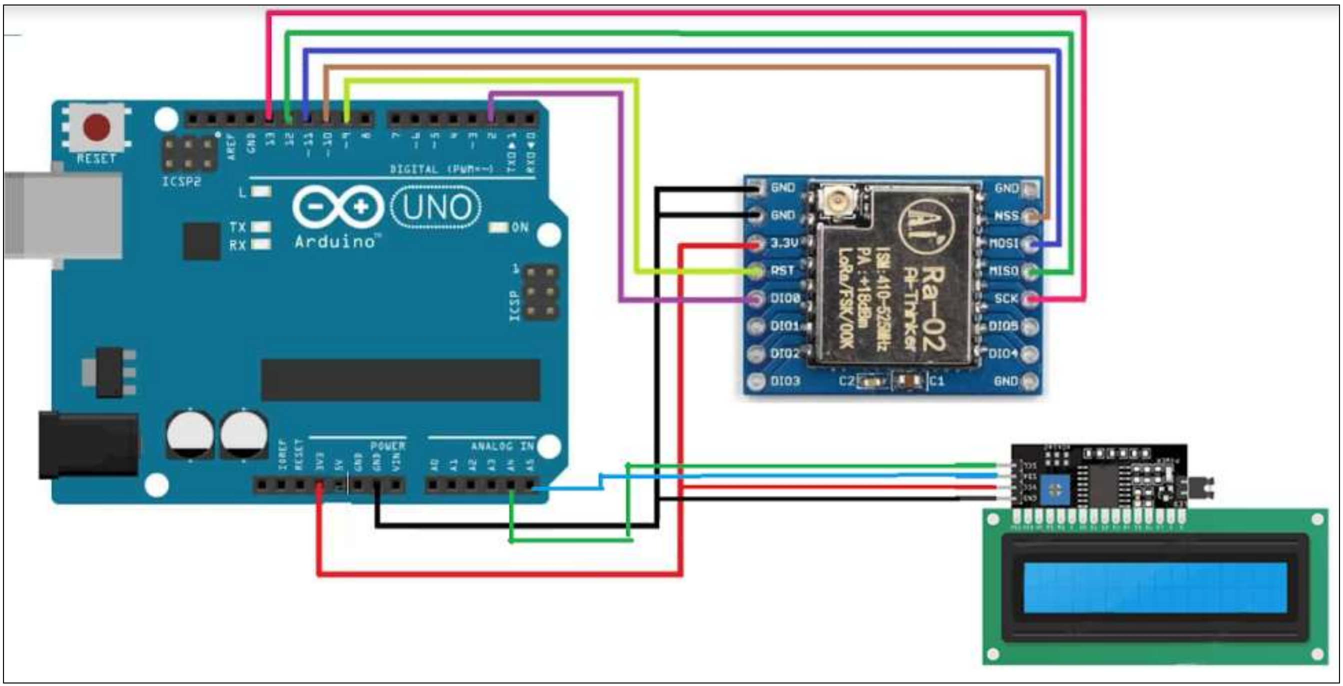

Fig 4: Schematic diagram of the proposed model of Transmitter part.

Start Condition: The SDA line switches from a high voltage level to a low voltage level *before* the SCL line switches from high to low.

Stop Condition: The SDA line switches from a low voltage level to a high voltage level *after* the SCL line switches from low to high.

Address Frame: A 7 or 10 bit sequence unique to each slave that identifies the slave when the master wants to talk to it.

Read/Write Bit: A single bit specifying whether the master is sending data to the slave (low voltage level) or requesting data from it (high voltage level).

ACK/NACK Bit: Each frame in a message is followed by an acknowledge/no-acknowledge bit. If an address frame or data frame was successfully received, an ACK bit is returned to the sender from the receiving device.
LoRa (Long Range) is a wireless technology that offers long-range, low-power, and secure data transmission for M2M (Machine to Machine) and IoT applications. LoRa is a spread spectrum modulation technology that is derived from chirp spread spectrum (CSS) technology. In this project, we are going to send temperature and humidity values from one Arduino to another using LoRa SX1278 module. The DHT11 sensor is connected to transmitting side, Arduino. So this Arduino will get temperature and humidity values from DHT11 and then send it to another Arduino via LoRa SX1278 module. These humidity and temperature values will be printed on LCD connected to a second Arduino. On the transmitting side, we will use an Arduino UNO with LoRa module and DHT11 sensor. For the Receiving side, we will use an Arduino Uno with LoRa module and 16×2 LCD Display module.
MT76813DBI ESP8266 Serial WIFI wireless Gain Antenna works like a standalone wireless transceiver that can be used for end-to-end point connectivity. In data management mode, the module reads data from analog or digital sensors and manages what to do with it, ranging from delivering data based on data type to processing it as per the program. Further, it can easily transfer data with the router using integrated WiFi technology and built-in stack.

5. Results and Discussion

Start off by including the ESP8266_AT.h library. This will make it easy to send the AT commands. Next, if you want to see the demonstration for TCP receive. We will specify the WiFi SSID, WiFi password, Thing Speak write API key and channel ID. You have to replace these parameters with your own values in order to successfully connect to the local WiFi and send data to the server or receive data from the server. Specify the host and port of the Thing Speak server. Inside the setup function, we will open the serial communication at a baud rate of 115200. Then we will initialize the ESP8266 Wi-Fi module. First, we will set the Wi-Fi mode as both station and AP. Next, we will check the wi-fi connection and connect to the wi-fi using the SSID and PASSWORD provided. Moreover, we will connect to the TCP port at the specified host and port using ESP8266_Start(0, HOST, PORT). We will save the connection status of ESP8266 in the variable 'Connect_Status.' Then we will make sure that the ESP8266 Wi-Fi module is connected to Wi-Fi and connected to the TCP port. Make sure you choose the correct board and COM port before uploading your code to the board. Go to Tools > Board and select Arduino UNO. Next, go to Tools > Port and select the appropriate port through which your board is connected. After you have uploaded your code to the development board, open the serial monitor and set the baud rate to 115200. In a few moments, the Wi-Fi will get connected. The results of our proposed work is shown in the below Figure 5.

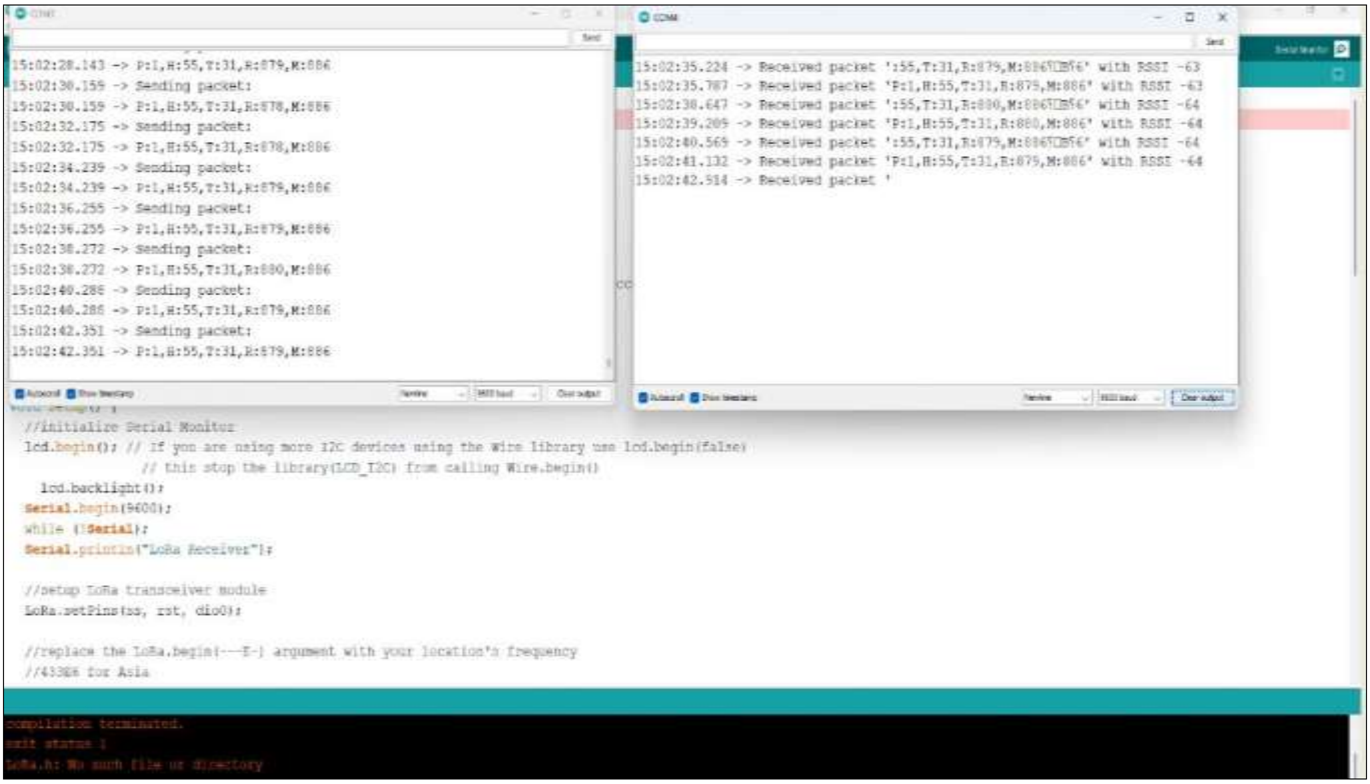

Fig 5: Sending and Receiving packets through communication model.

6. Conclusion

This paper describes the method to monitor the agricultural factors at long distance using LoRa technology. Factors like power, time, data rate for both Bluetooth and LoRa have been analyses. Comparisons of these factors are presented in Table 1. LoRa is 2.85% is better in terms of power consumption than Bluetooth and 6.96% better in delay when compared with Bluetooth. LoRa covers larger area and on average 23% decrease in data rate as distance increases. Bluetooth flops in covering such a long distance. As the adoption of technology increases, the cost of instalment and maintenance is increasing in agricultural Fields. The world prefers cost-effective methods with efficiency to be used in their system and this method helps them in all aspects of Smart Technologies. An analysis is done with Bluetooth and LoRa on different parameters and came a conclusion to use LoRa methodology for long-range correspondence in the proposed system.

Table 1: Complementary functionalities of two low-power technologies.

Features	Bluetooth	LoRa
User friendly for app based management	Yes	No
Low latency	Yes	No
Able to withstand RF interference	Yes	Yes
Long-Range	No	Yes
Low capital expenses	No	Yes
Low operational expenses	No	Yes

7. Acknowledgement

We would like to show our gratitude to the Maharaja Institute of Technology Mysore and we thank teaching and non-teaching staff of Department of Electronics and communication engineering. Also, thanks to our parents and friends who all are directly or indirectly supported this research.

8. References

1. Coetzee Louis, Johan Eksteen. The Internet of Things-promise for the future? An introduction. 2011 IST-Africa Conference Proceedings. IEEE; c2011.
2. He Danping, *et al*. The design and applications of a high-performance ray-tracing simulation platform for 5G and beyond wireless communications: A tutorial. IEEE Communications surveys & tutorials. 2018;21(1):10-27.
3. Ramakrishnam Raju SVS, *et al*. Design and Implementation of Smart Hydroponics Farming Using IoT-Based AI Controller with Mobile Application System. Journal of Nanomaterials, 2022, 1-12.
4. Siddique Ayesha, *et al*. A review on intelligent agriculture service platform with lora based wireless sensor network. Life. 2019;100:7000.
5. Chen Xing, *et al*. Analysis and design of an ultra-low-power Bluetooth low-energy transmitter with ring oscillator-based ADPLL and 4$\times $ frequency edge combiner. IEEE Journal of Solid-State Circuits. 2019;54(5):1339-1350.
6. Zarnescu A, Ungurelu R, Secere M, Varzaru G, Mihailescu B. Implementing a large LoRa network for an agricultural application, 2020 7th International Conference on Energy Efficiency and Agricultural Engineering (EE&AE), Ruse, Bulgaria, 2020, 1-5, Doi:10.1109/EEAE49144.2020.9279019.
7. Ahmed Mohamed A, *et al*. LoRa based IoT platform for remote monitoring of large-scale agriculture farms in Chile. Sensors. 2022;22(8):2824.
8. Reddy Maddikunta PK, *et al*., Unmanned Aerial Vehicles in Smart Agriculture: Applications, Requirements, and Challenges, in IEEE Sensors Journal. Aug.15, 2021;21(16):17608-17619. DOI:10.1109/JSEN.2021.3049471.
9. Nikodem Maciej. "Bluetooth Low Energy Livestock

Positioning for Smart Farming Applications. "Computational Science–ICCS 2021: 21st International Conference, Krakow, Poland, June 16–18, 2021, Proceedings, Part IV. Cham: Springer International Publishing; c2021.

10. Taşkın Deniz, Cem Taşkin. Developing a Bluetooth low energy sensor node for greenhouse in precision agriculture as internet of things application. Advances in Science and Technology. Research Journal. 2018, 12(4).