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Real-Time Hidden Data Transmission Using Lora

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ABSTRACT

Nowadays, it has become a crucial task in transferring confidential data for military departments, many multinational companies, etc. The important requirement is that the data that has been transmitted should not be visible to hackers or third parties from another end. To satisfy this requirement a wireless technology LoRa is used. Long-distance and low-power wireless communication technologies such as LoRa, Sigfox, and Narrowband-Internet of Things (NB-IoT) were developed in recent years. These technologies can contribute to indoor and outdoor smart applications with minimal power consumption. In this study, the LoRa wireless communication technique was used as the primary data communication method, enabling the device to communicate without requiring an Internet connection or a SIM card. This technology can be implemented in military and defense areas.

1. Background

Data transmission is one of the fundamental issues in modern data networks. We can transmit the data through many wireless technologies like Bluetooth, Wi-Fi, Cellular network, etc. But each of them has its own disadvantages.

Wi-Fi, especially public Wi-Fi networks are prone to be hacked due to their wireless nature. You will experience a decrease in Wi-Fi strength as you move away from the access point. The range of Wi-Fi networks is usually between 100 and 150 feet. For a standard home, the amount is sufficient, but for building structures, it can pose a problem.

Bluetooth, wireless technologies have limitations on how fast they can transmit data; usually, faster connections make for more energy use. Because Bluetooth is designed to be energy-efficient, the data it sends is relatively slow. Hence, it is not possible to use Bluetooth for communications over long distances, particularly.

Cellular, we cannot use this for solutions that require high bandwidth. Wireless communication is affected by physical obstructions, weather conditions, and other wireless devices' interference.

2. Introduction

A common requirement in today's world is that, the transfer of data or files from one computer to another. Bluetooth and Wi-Fi are the most popular wireless communication technologies available today for interacting with IoT devices. However, Bluetooth and Wi-Fi technologies consume a lot of power. Various technologies have been developed, but prior to the development of LoRa technology, none of them was suitable for transmitting information over long distances without consuming a lot of power. In LoRa Technology, very long-distance transmissions can be accomplished with minimal power consumption.

LoRa:

Semtech introduced LoRa (Long Range), a wireless technology with long-range, low-power, and secure data transmissions for M2M (Machine-to-Machine) and IoT (Internet of Things) applications. LoRa enables the wireless connection of sensors, gateways, machines, devices, etc. LoRa Technologies operates in different frequency bands in different countries:

1. In the USA, it operates at 915 MHz
2. In Europe, it operates at an 868 MHz
3. In Asia, it operates at 865 to 867 MHz, and 920 to 923 MHz bands.

3. Components Used

3.1 Sx1278 LoRa Ra-02

Based on SEMTECH's SX1278 wireless transceiver, Ra-02 is an advanced wireless transmission module. With a communication range of 10-kilo meters, the system uses advanced LoRa spread spectrum technology. For spread spectrum communications over long distances, the SX1278 RF module is suitable. Low power consumption makes it efficient.

Figure 1. AI Thinker LoRa Series Ra-02

In addition, LoRa modulation technology has noticeable advantages over traditional modulation in terms of anti-blocking and selection, which solves the problem that outdated modulation does not adequately consider distance, hindrance, and energy consumption at the same time.

Module Model	Ra-02
Interface	SPI
Frequency Range	410-525 MHz
Power Supply	3.3V
Weight	0.45g
Max Transmit Power	18±1 dBm

Figure 2. Lora Modulation

3.2 Arduino Nano

Several ports on the Arduino Nano allow it to communicate with a computer, another microcontroller, or any other Arduino. Arduino's software contains a serial monitor that allows for the sending and receiving of simple textual data.

Figure 3. Arduino Nano

The Arduino Nano can be programmed with the help of Arduino software. We can navigate through the Tools → Board menu, and choose "Arduino Duemilanove or Nano w/ ATmega328" (based on your board's microcontroller).

20X4 LCD display

The LCD stands for liquid crystal display, whose light modulation is based on liquid crystals. A liquid crystal display consumes less energy than a light-emitting diode or plasma display.

Figure 4. 20X4 LCD display

In a 20X4 LCD module, there are four rows in a display, a row can contain twenty characters, and a display can contain eighty characters.

4. Block Diagram

4.1 Transmitter

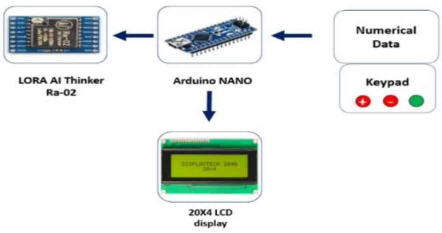

Figure 5. Transmitter

4.2 Receiver

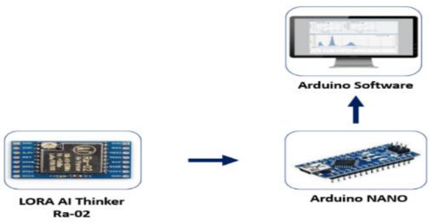

Figure 6. Receiver

5. Working

Every data must be transmitted using a wired or wireless communication method. Thus, in this paper, the data is transmitted via LoRa, the acronym for Long Range, a wireless communication technology at both ends that are used to transmit the data. From the transmitter station, the data can be sent with the help of the joystick which consists of three buttons that performs the operations like increment, decrement, and sending the data. The data that is being sent is displayed on LCD.

Similarly, on the other station, the data received can be displayed on the serial monitor of Arduino. The data that was being sent is in the form of numerical rather than alphabetic. Hence, it is highly confidential and difficult to decode except for the officials who can understand.

6. Hardware Description

6.1 Transmitter Side

We have used an Arduino Nano and LoRa module for the transmitting side. The circuit diagram for connecting an Arduino Nano with LoRa SX1278 module is shown below diagramatically.

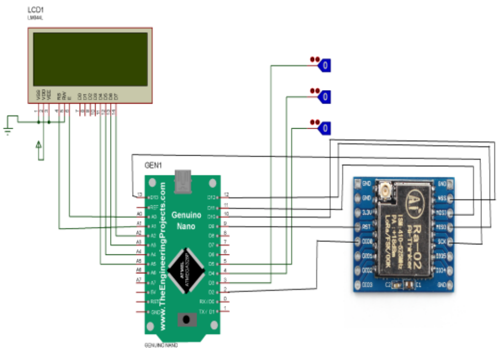

Figure 7. Arduino Nano with LoRa SX1278 module

LoRa SX1278 module totally consists of 16 pins, 8 on each side. Among these, six of them are used by GPIO pins which range from DIO0 to DIO5 while four of them are used as Ground pins. In the next step, we have to establish a connection between the SPI (Serial Peripheral Interface) pins on the LoRa and the SPI pins on the Arduino board as shown above. The following figure shows the connections of the pins.

LoRa SX1278 Module	Arduino Nano Board
3.3V	-
Gnd	Gnd
En/Nss	D10
G0/DIO0	D2
SCK	D13
MISO	D12
MOSI	D11
RST	D9

Figure 8. Connections of the pins

6.2 Receiver Side

While considering the Receiving side, we have used an Arduino Nano with a LoRa SX1278 module. The circuit diagram below shows the connection between Arduino Nano and LoRa SX1278 module.

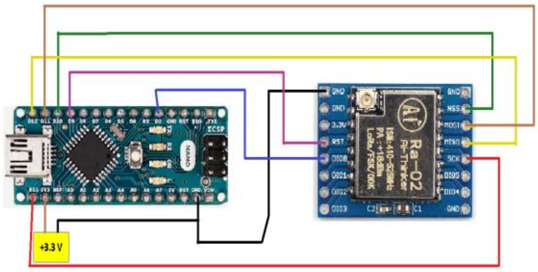

Figure 9. Connection between Arduino Nano and LoRa SX1278 module

As for the transmitting and receiving sides, the connections are almost the same.

7. Software Description

As soon as the hardware is ready, we can proceed with Arduino IDE, which already has an in-built library called LoRa created by Sandeep Mistry. In order to access and add the library, open the Arduino IDE and select Sketch → Include Library → Manage Libraries. By searching for LoRa Radio, we can find the library that was created by Sandeep Mistry and click the Install button to install the library. Write the required code for the transmitter as well as for the receiver. Make sure there are no errors in it. Compile and upload the code.

8. Design

8.1 Transmitter

Figure 10. Transmitter

8.2 Receiver

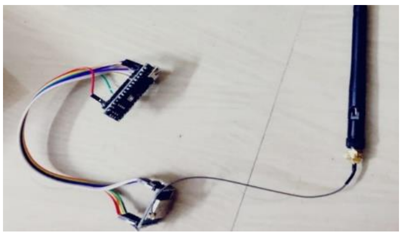

Figure 11. Receiver

9. Final Setup

As soon as the program is uploaded, open the Serial monitor for the Receiver on the Arduino Board. When we choose the data to be sent and press the send button on the transmitting side, the serial monitor of the receiver will display it. Here there will be an RSSI **(Received Signal Strength Indicator)** value for each message that was received by the LoRa module. RSSI's value will always be negative. The value closer to zero signifies a stronger signal. The signal strength decreases as the devices are moved further apart.

10. Explanation of Key Functions

Here in the process of sending the signals, the transmitter has 3 buttons that perform operations such as increment, decrement, and sending the data. Initially, the LCD will display the message "WELCOME TO LORA DATA TRANSMISSION". Here the initial Data is considered to be zero.

Figure 12. LCD Display

10.1 Increment

When we press the 1st button which is connected to the 3rd pin of the Arduino Nano, then the numerical data on the LCD gets increased. For easy identification by the user, we have included an increment sign ">" which will be displayed on the LCD when the increment button is pressed.

Figure 13. LCD display increment

10.2 Decrement

Similarly, when we press the 2nd button which is connected to the 4th pin of the Arduino Nano, then the numerical data on the LCD gets decreased. For easy identification by the user, we have included a decrement sign "<" which will be displayed on the LCD when the decrement button is pressed.

Figure 14. LCD display decrement

10.3 Send:

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When the 3rd button which is connected to the 5th pin of the Arduino Nano is pressed, the data that the user decided to transmit will be sent to the receiver side. While sending the data, we can see the message “SENDING DATA:” on the LCD.

Figure 15. LCD display send

10.4 Serial Monitor:

The function of the serial monitor is to display the message that was sent by the transmitter. Each message that was being sent has an RSSI value which indicates the Signal Strength.

11. Result

11.1 Transmitter Side

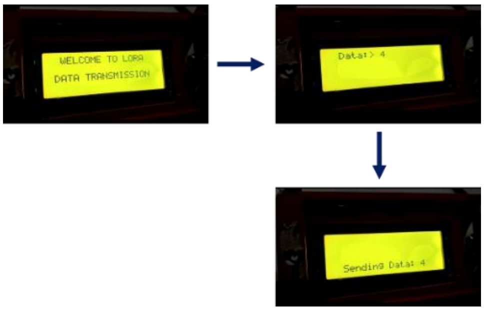

Figure 16. Transmitter Side

11.2 Receiver Side

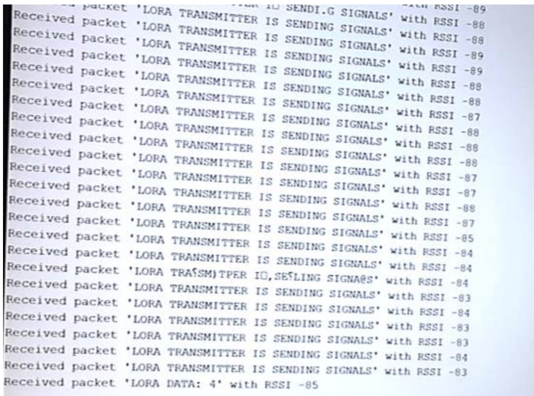

Figure 17. Receiver Side

11.3 Comparison of Key Features of Wireless Technologies

Table 1. Comparison of Key Featuress of Wireless Technologies

Wireless Standars	Bluetooth	Wifi	Zigbee	LoRa
IEEE spec	IEEE 802.15.1	IEEE 802.11b	IEEE 802.12.4	
Power Consumption	Medium	Medium	Low	Low
Transmitting Range	1 to 100m	100m to several km	1 to 100m	3-5km (urban areas), 10-15 (rural areas)
Power Profile	7-40hrs	2-3 years	Atleast 2 years	10 years
Data Rates	1-3 Mbps	10-100+ Mbps	20-250 kbps	300 bps-50 kbps
Frequency Band	2.4 GHz	2.4 GHz	868/915Mhz; 2.4 KHz	169/433/868/915 MHz

12. Conclusion

With the help of LoRa, users can establish long-distance transmission, extended battery life, as well as high capacities while expanding their sensor networks without compromising on transmission distance or power consumption. As of now, LoRa operates mostly in free frequencies, including 433, 868, and 915 MHz. Thus, LoRa technology offers great distances, and lower power consumption (long battery life) at a low cost.

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