

LORA-BASED WIRELESS DATA TRANSMISSION SYSTEM

¹Dr K Ramesh Babu,²A Rajesh,³G Seshagiri Rao,⁴Mudda Tejaswini

¹Professor,^{2,3}Associate Professor,⁴Student

Department of ECE

G V R & S College of Engineering & Technology, Guntur, AP

ABSTRACT

The project aims in implementing a data transmission we can implement this technology in defence and military areas and also it can be used in many industrial areas. Here LoRa technology is employed because it provides higher level of security.

The ability to securely store and transfer sensitive information has proved a critical factor in success in war and business. LoRa technology employs higher level of encryption before sending the data.

This project consists of an onboard computer, which consists of number of input and output ports. These onboard computers are commonly termed as micro controllers. The input and output port of the controller are interfaced with different input and output modules depending on the requirements. In other words, micro controller acts as a communication medium for all the modules involved in the project.

In this project, we have two sections. Transmitter and Receiver. In Transmitter section, we will be giving a text to be transmitted to the receiver section through Laptop, that data gets encrypted in transmitter section, gets transmitted through LoRa. In Receiver section, the data is received by LoRa and is given to Microcontroller where the encrypted data gets decrypted and gets the original data displayed on Laptop. LCD and Buzzer gives the visual and audible alerts accordingly.

I. INTRODUCTION

1.1 PROJECT OVERVIEW:

The project aims in implementing a data transmission we can implement this technology in defense and military areas and also it can be used in many industrial areas, such as in industries for monitoring. Here LoRa technology is employed because it provides higher level of security.

The ability to securely store and transfer sensitive information has proved a critical factor in success in war and business. LoRa technology employs higher level of encryption before sending the data.

This project consists of an onboard computer, which consists of number of input and output ports. These onboard computers are commonly termed as micro controllers. The input and output port of the controller are interfaced with different input and output modules depending on the requirements. In other words, micro controller acts as a

communication medium for all the modules involved in the project.

In this project, we have two sections. Transmitter and Receiver. In Transmitter section, we will be giving a text to be transmitted to the receiver section through Laptop, that data gets encrypted in transmitter section, gets transmitted through LoRa. In Receiver section, the data is received by LoRa and is given to PIC Microcontroller where the encrypted data gets decrypted and gets the original data displayed on Laptop. LCD and Buzzer gives the visual and audible alerts accordingly.

1.2 MOTIVATION OF PROJECT

The motivation behind the project of wireless data transmission using LoRa and Arduino is to provide an efficient and low-cost solution for long-range communication in remote areas where traditional cellular or Wi-Fi networks may not be available or reliable.

LoRa (Long Range) technology is a wireless communication protocol that uses a low-power, wide-area network (LPWAN) to transmit data over long distances with low power consumption. It is ideal for applications such as agriculture, environmental monitoring, smart cities, where devices need to be deployed in remote or hard-to-reach areas and require long battery life.

Arduino is an open-source platform that is widely used for building and prototyping electronic projects. It is easy to use and has a large community of developers, making it an ideal choice for building a LoRa-based wireless data transmission system.

By combining LoRa and Arduino, it is possible to create a low-cost, reliable, and easy-to-use wireless communication system that can be used in a variety of applications. The project is motivated by the need to provide an affordable and effective solution for wireless communication in remote and hard-to-reach areas, and to promote the use of IoT (Internet of Things) technologies in various fields.

1.3 OBJECTIVES OF PROJECT

- To design and build a LoRa-based wireless communication system using Arduino platform.
- To optimize the system for low power consumption, long-range communication, and high reliability.
- To develop a user-friendly interface for data acquisition, transmission, and visualization.

- To test and evaluate the system's performance in various scenarios, such as agriculture, environmental monitoring, and smart cities.
- To promote the use of IoT technologies in various fields by demonstrating the potential of LoRa-based wireless communication system.

1.4 BLOCK REPRESENTATION:

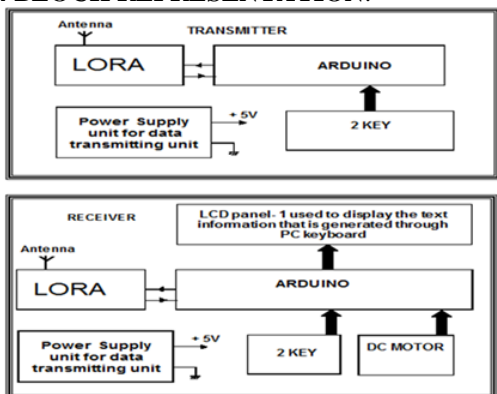


Fig 1. BLOCK REPRESENTATION'

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It is named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board. Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and Analog Input/Output pins (I/O), shields, and other circuits. Rectifier circuit is the most used circuit because almost every electronic appliance operates on DC (Direct Current) but the availability of the DC Sources are limited such as electrical outlets in our homes provide AC (Alternating current). The rectifier is the perfect candidate for this job in industries & Home to convert AC into DC. Even our cell phone chargers use rectifiers to convert the AC from our home outlets to DC. Different types of Rectifiers are used for specific applications.

A step-down transformer is an electrical device that reduces the voltage of an alternating current (AC) power supply. It consists of a primary winding, a secondary winding, and an iron core. When an AC voltage is applied to the primary winding, it creates a fluctuating magnetic field in the iron core. This magnetic field then induces a voltage in the secondary winding, but at a lower voltage level than the primary winding. A fan for ventilating an

Interior by drawing air from the interior and expelling it outside.

Ra-02 is a wireless transmission module based on SEMTECH's SX1278 wireless transceiver. It adopts advanced LoRa spread spectrum technology, with a communication distance of 10,000 meters. It has a strong ability of anti-jamming and has the function of air wake-up Consumption. 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. It can be covering thousands of people in the district environment, particularly suitable for meter reading, smart home, burglar alarm equipment.

A Light Emitting Diode (LED) is a semiconductor device, which can emit light when an electric current passes through it. To do this, holes from p-type semiconductors recombine with electrons from n-type semiconductors to produce light. The wavelength of the light emitted depends on the bandgap of the semiconductor material. Harder materials with stronger molecular bonds generally have wider bandgaps. Aluminium Nitride semiconductors are known as ultra-wide bandgap semiconductors.

A voltage regulator is a system designed to automatically maintain a constant voltage. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use electro-mechanism, electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Communication and Motor Activation: To activate the motor, you would need another LoRa device or module configured to send packets. When sending a LoRa packet, you include the specific code word in the data payload. Once the LoRa packet containing the code word is received by the Arduino, it triggers the motor action as programmed in the code. Overall, the LoRa module receives data packets wirelessly, the Arduino code processes the received data, and if the specific code word is detected, the motor is activated accordingly.

II. LITERATURE SURVEY

A literature survey is a proof essay of sorts. It is a study of relevant literature materials in relation to a topic we have been given. The problem with the fixed position antennas is the broadcasting signal strength may vary due to the climatic changes. Now- a-days due to the increased construction of skyscrapers, the strength of the broadcast signals received by the antenna are becoming weak. If an individual wants to adjust the position manually it becomes complex to adjust the whole system using man power. Our project will focus on reducing the man effort for positioning the antenna using microcontroller and remote. It works with Arduino. It replaces the manual work with a simple switching to position the antenna for maximum gain of the broadcasting signal.

This project idea was introduced in the early 90's by P. K. Saha, S. S. Ahsan, M. H. Bhuyan, K. Islam and AHM Z. Alam in an International Conference on Computing and Information Technology, held at Dhaka, Bangladesh in the year 1998.

2.2 LITERATURE REVIEW

Wireless data transmission has become an essential aspect of many Internet of Things (IoT) applications. LoRa technology, with its low power consumption and long-range capabilities, has emerged as a popular solution for wireless data transmission. In this literature review, we will examine some of the research that has been done on using LoRa and Arduino for wireless data transmission.

1. "Design and Implementation of a Wireless Sensor Network for Environmental Monitoring Using LoRa and Arduino" by Yuguang Li et al. (2020)

This study proposed a wireless sensor network for environmental monitoring using LoRa and Arduino. The system was found to be reliable and effective in transmitting environmental data over long distances.

2. "A Wireless Temperature and Humidity Monitoring System Based on LoRa and Arduino" by Jia-Ying Yang et al. (2018)

This research developed a wireless temperature and humidity monitoring system using LoRa and Arduino. The study found that the system was reliable in transmitting data over long distances, and was effective in monitoring environmental conditions.

3. "Design of a Low Power Consumption Wireless Sensor Network Based on LoRa and Arduino" by Xiaohui Zhang et al. (2021). This study proposed a low power consumption wireless sensor network using LoRa and Arduino for environmental monitoring. The system was found to be effective

in transmitting data over long distances, while consuming minimal power.

III. TECHNICAL DESCRIPTION

3.1 DESCRIPTION

The wireless data transmission using LoRa and Arduino project involves the design and implementation of a wireless communication system that utilizes LoRa (Long Range) technology to transmit data over long distances with low power consumption. The project is built using the Arduino platform, which is an open-source electronics prototyping platform that is easy to use and has a large community of developers.

The system consists of two main components: the transmitter and the receiver. The transmitter includes sensors or devices for data acquisition, such as temperature sensors, humidity sensors, and air quality sensors. These sensors are connected to the Arduino board, which is programmed to collect and process the data. The data is then transmitted using the LoRa module, which is also connected to the Arduino board. The LoRa module is responsible for encoding and transmitting the data over a long-range wireless network.

On the other hand, the receiver includes another Arduino board with a LoRa module, which receives the transmitted data. The received data is then decoded and processed by the Arduino board and displayed on a user-friendly interface, such as a web page or a mobile application. The user can monitor and visualize the data from the sensors in real-time and make informed decisions based on the data collected.

3.2 WORKING

- **Data Acquisition:** The system collects data from various sensors using the Arduino board. The sensors can include temperature sensors, humidity sensors, air quality sensors, and other environmental sensors.
- **Data Processing:** The Arduino board processes the collected data and prepares it for transmission. The data can be displayed on the LCD screen and/or transmitted wirelessly to the receiver using the LoRa module.
- **Wireless Transmission:** The LoRa module is used to transmit the data wirelessly over a long-range network. The LoRa module uses a spread-spectrum technique to encode the data and transmit it at a low data rate with low power consumption. The data transmission can be triggered using the keys on the board.

- **Visual Indication:** The system provides visual indication using the LEDs on the board. The LEDs can be used to indicate the status of the data transmission, power status, and other system parameters.
- **5. Audible Indication:** The system provides audible indication using the buzzer on the board. The buzzer can be used to indicate the completion of data transmission or any other system events.
- **6. Power Supply and Regulation:** The system is powered using a power supply, and the voltage is regulated using a voltage regulator. The voltage regulator ensures that the voltage is maintained at a stable level, which is important for the proper functioning of the system.
- **7. Data Reception:** The receiver receives the transmitted data using the LoRa module and processes it using the Arduino board. The received data can be displayed on the LCD screen, providing real-time information about the sensor readings.

Overall, the system is designed to provide wireless data transmission over a long-range network with low power consumption and high reliability. It includes various components such as sensors, Arduino board, LoRa module, LCD screen, keys, LEDs, buzzer, power supply, and voltage regulator to facilitate the data transmission and provide visual and audible feedback to the user

3.3 CIRCUIT DIAGRAM

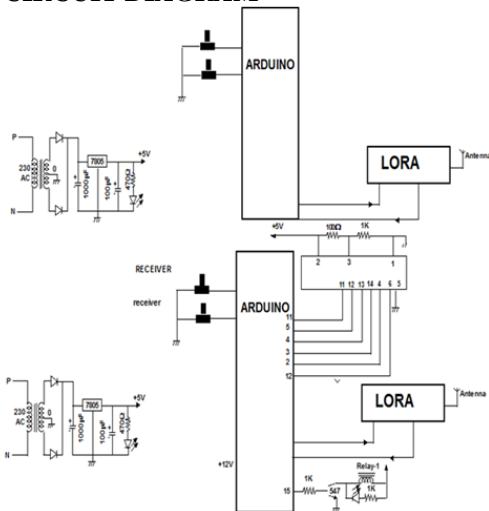


Fig 2 CIRCUIT

IV. HARDWARE DESCRIPTION

4.1 INTRODUCTION TO ARDUINO UNO:

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010. The board is equipped with sets of digital and Analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 Analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.



Fig 3. ARDUINO UNO BOARD

4.2 LoRa Module Ra- 02:

Ra-02 is a wireless transmission module based on SEMTECH’s SX1278 wireless transceiver. It adopts advanced LoRa spread spectrum technology, with a communication distance of 10,000 meters. It has a strong ability of anti-jamming and has the function of air wake-up Consumption. 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.



Fig 4: LoRa MODULE Ra-02.

4.3 INTRODUCTION TO LCD:

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

Command registers stores various commands given to the display. Data register stores data to be displayed. The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register. In your Arduino project Liquid Crystal Library simplifies this for you so you don't need to know the low-level instructions. Contrast of the display can be adjusted by adjusting the potentiometer to be connected across VEE pin.



Fig 5: LCD DISPLAY

4.4 LIGHTEMITTING DIODE(LED):

A light-emitting diode (LED) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The Colour of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to

cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.



Fig 6: LED

4.5 BUZZER:

A buzzer or beeper is an audio signalling device, may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke.



Fig 7:BUZZER

4.6 RELAY:

Relays are electrical devices that are used to control the flow of electricity in a circuit. They consist of an electromagnet and a set of contacts. When an electrical current is applied to the electromagnet, it creates a magnetic field that attracts or releases the contacts, thereby opening or closing the circuit.

Relays are commonly used in various applications where electrical isolation, switching, or control is required. They can be found in numerous devices and systems, such as industrial machinery, automotive systems, household appliances, and electronic equipment.

Relays serve several purposes, including:

1. Switching: Relays act as electrically controlled switches, allowing a low-power circuit to control a higher-power circuit. This is useful when a low-power signal, such as from a microcontroller or sensor, needs to control a larger load, like a motor or a lighting circuit.

2. Electrical isolation: Relays provide electrical isolation between the control circuit and the load circuit. This isolation can protect sensitive control components from voltage spikes or other electrical disturbances present in the load circuit.
3. Signal amplification: Relays can amplify weak signals. For example, a small signal from a sensor can be used to control a relay, which in turn switches a larger load or activates an alarm.
4. Timing functions: Relays can be used to introduce timing delays or sequences in a circuit. This is commonly seen in applications like motor control or sequential operations.

Relays come in different types, such as electromechanical relays, solid-state relays (SSRs), and reed relays. Each type has its own advantages and is suitable for specific applications.



Fig 8: RELAY

4.7 DC MOTOR:

A DC (direct current) motor is an electromechanical device that converts electrical energy into mechanical motion. It operates based on the interaction between a magnetic field and an electric current. DC motors are widely used in numerous applications that require precise speed control, high torque, and smooth operation. A typical DC motor consists of a stationary part called the stator and a rotating part called the rotor. The stator contains permanent magnets or electromagnets that establish a fixed magnetic field, while the rotor carries a coil winding known as the armature. The armature is connected to a commutator, which facilitates the flow of current in the armature windings. When an electric current flows through the armature windings, a magnetic field is created around the windings. This magnetic field interacts with the fixed magnetic field of the stator, resulting in a force known as the Lorentz force. The Lorentz force causes the rotor to rotate, producing mechanical motion.



Fig 9 DC MOTOR

V. CIRCUIT CONNECTIONS AND RESULTS

5.1 CIRCUIT DIAGRAM:

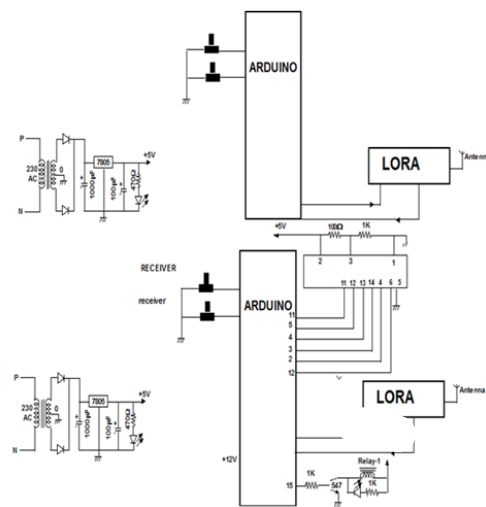


Fig 10 CIRCUIT WITHOUT POWER SUPPLY

5.2 RESULT: This is an Ideal circuit without the power supply. The circuit connections are made according to the circuit diagram. Were the project is divided into 2 major parts transmitter and receiver.

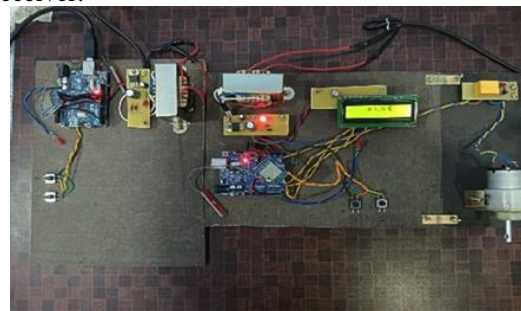


Fig 11: CIRCUIT WITH POWER SUPPLY

The project on wireless data transmission using LoRa and Arduino is expected to deliver significant results, showcasing the successful implementation and functionality of the system.

5.3 APPLICATIONS

- Smart home using LoRa.
- Battlefield surveillance
- Remote control of unmanned systems
- Health monitoring
- LoRa-based Smart Agriculture.
- Livestock Monitoring using Lora Based Wireless Sensor Network.
- Office Temperature monitoring Using Low Power Wide Area Network.
- Building a management system Using LoRa.
- Energy monitoring system Based on LoRa.

5.4 ADVANTAGES:

- **Long range:** LoRa technology can transmit data over a long distance, up to several kilometres in open areas, making it ideal for applications that require long-range connectivity.
- **Low power consumption:** LoRa devices have low power consumption, making them ideal for battery-powered devices that need to operate for long periods without the need for frequent battery replacements.
- **Low cost:** LoRa devices are relatively inexpensive, making them a cost-effective solution for building wireless communication systems.
- **Robustness:** LoRa technology is resistant to interference from other wireless signals and can work in challenging environments with high levels of noise and interference.
- **Scalability:** LoRa networks can be easily scaled up or down to support a wide range of devices and applications.
- **Security:** LoRa technology offers robust security features such as AES encryption, ensuring that data transmitted wirelessly is secure and protected from unauthorized access.
- **Flexibility:** LoRa technology can be used in a wide range of applications, including smart homes, industrial automation, agriculture, and smart cities, making it a versatile wireless communication technology.

5.5 DISADVANTAGES:

- Limited data rate
- Limited bandwidth
- Line-of-sight requirement
- Interference

- Complexity
- **License requirements:** In some regions, LoRa technology may require a license to operate. This can increase the cost and complexity of building a LoRa network.

VI. CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

- LoRa technology provides a promising solution for wireless data transmission in applications that require long-range, low-power, and low-cost communication. Its ability to operate over long distances while consuming minimal power makes it ideal for use in remote or hard-to-reach areas, such as rural or industrial environments.
- LoRa technology is also highly scalable, allowing for the creation of large-scale networks that can support a wide range of devices and sensors. This makes it suitable for applications such as smart cities, agriculture, environmental monitoring, and industrial automation.
- As technology continues to evolve, LoRa technology is likely to play an increasingly important role in wireless communication, enabling the creation of innovative and cost-effective solutions for a wide range of applications.

6.2 FUTURE SCOPE

The increasing demand for IoT devices, there is a need for long-range and low-power communication technology. LoRa, with its long-range capabilities and low power consumption, and Arduino, with its open-source platform, offer a perfect solution for wireless data transmission applications. The combination of these technologies opens up possibilities for applications in precision agriculture, smart city systems, asset tracking, industrial automation, and environmental monitoring. The implementation of wireless sensor networks for these applications would enable real-time monitoring and control, leading to increased efficiency, reduced costs, and improved decision-making. The combination of LoRa and Arduino also holds great potential for wireless data transmission applications in the army. In military operations, it is essential to have reliable and secure communication systems that can transmit data over long distances, even in harsh environments.

LoRa technology with its long-range capabilities, low power consumption, and anti-jamming features can provide such a solution. Using Arduino, the army can build customized devices to collect and transmit data, such as

environmental conditions, troop movements, and enemy positions, to command centres in real-time. With this data, commanders can make informed decisions and plan operations more efficiently.

REFERENCES

- "Building Wireless Sensor Networks Using Arduino and LoRa" by Matthijs Kooijman, published by Packt Publishing
- "Lora WAN with Arduino" tutorial by The Things Network (<https://www.thethingsnetwork.org/docs/devices/arduino/>)
- "Wireless Sensor Network Using LoRa and Arduino" project by Hackster.io (<https://www.hackster.io/aryansh-singh/wireless-sensor-network-using-lora-and-arduino-1fdd51>)
- "LoRa Based Intelligent Monitoring and Control System for Agriculture" by D. Mohapatra, B. Majhi, and S. Pattanaik. 2017 IEEE 3rd International Conference on Computational Intelligence and Computing Research (ICCIC), Coimbatore, India. (DOI: 10.1109/ICCIC.2017.8281927)
- "Wireless Sensor Network-Based Water Quality Monitoring System Using LoRa and Arduino" by K.R. Thirumalaivasan and T. Srinivasan. IEEE Sensors Journal, 2020. (DOI: 10.1109/JSEN.2020.3017026)