SIGNAL SEEKER: SAFEGUARDING WIRELESS COMMUNICATION WITH LoRa TECH

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Abstract- Wireless communication has become essential to daily living in the connected world of today. There is increasing worry about the unlawful use of radio signals and frequencies for activities like unauthorized broadcasting, and interference as a result of the proliferation of devices and networks. Here, the signal seeker, the heart of our project enters the picture to transform signal security.
It uses LoRa (Long Range) technology to identify and block unauthorized communications. As a powerful tool for security application, it makes dependable communication over long distances possible, regardless of the location-urban or rural- which makes it perfect option for monitoring and safeguarding large assets, vital infrastructure and public places. We provide urgently needed signal security services to the telecom, military, law enforcement, utilities, and other sectors.

1. INTRODUCTION

Our system utilizes LoRa transceivers and a receiver for long-range communication. To detect unauthorized signals, an additional LoRa device is employed with GPS for precise location tracking. This modified LoRa device continuously scans for signals and uses GPS to pinpoint the exact location of the transmitting device. Signal strength measurements help assess the proximity and direction of the source.
When an unauthorized signal is detected, an LED indicator illuminates to visually alert nearby personnel. Signal strength data is displayed on an integrated screen, providing real-time information. Information about the detected signals, including GPS coordinates and signal strength, is logged locally and sent to Firebase. The Firebase platform acts as a intermediary, forwarding data to a dedicated app or website.
The app and website offer a user-friendly interface, allowing users to monitor the system in real time. Users can configure alert preferences and view historical data.

1.1 LoRa

Many applications demand devices with a low data rate but a long range. Cellular, Wi-Fi, and Bluetooth technologies are inadequate for these applications. This is where LoRa (Long Range) technology comes into play. Lora devices have a low power consumption and a long range. They use unlicensed frequency spectrum to send and receive data. A common use is the transmission of low-rate sensor data. A communication protocol called LoRa WAN makes use of the LoRa modulation to send small data packets—such as sensor data—over great distances.
Benefits Of using LoRa:

- Long Range
- Supports 10+ years battery life
- Geolocation
- End-to-end security

2. RF CONGESTION AND INTERFERENCE

Within the Joined together States, radio frequencies are isolated into authorized and unlicensed groups. The Government Communications Commission (FCC) issues licenses that allow commercial substances to have elite utilize of a recurrence band in a given area. Substances incorporate recurrence balance (FM) radio, cellular systems, tv, military and partisan communications. Unlicensed frequencies are free for open utilize but stay a shared medium.
The competition for transmission capacity and channels from web clients has expanded significantly in later a long time, driving to flag issues. In addition, distribution over frequencies isn't impartial. In numerous areas, it is conceivable to discover broadcasters -- radio and TV stations -- with their possess person frequencies, whereas a large number of sources compete for space on the unlicensed frequencies

3. CELLULAR NETWORKS USES RF TECHNOLOGY

A cellular arrange regularly covers a particular geological region separated into cells. Each cell is distributed a set of frequencies that have radio base stations alloted to them. When a communication such as a cellular phone call is started, the gadget looks for the closest base station to set up a radio connect. When accepting the call, the base station radio wire builds up a association with the phone. Phones are planned to intermittently check in with the

arrange, making it simpler for them to get a radio flag of significant quality from a adjacent base station radio wire.
RF innovation permits a set of frequencies to be utilized in other cells, as long as the cells aren't bordering each other. It is conceivable for various callers in one range to utilize the same recurrence since calls can be exchanged to the closest base station with that specific recurrence. This increments the capacity of the cellular arrange. Be that as it may, the recurrence reuse works as it were for disconnected transmissions. Clients can still encounter a few impedances from signals coming from other cells utilizing the same recurrence. Usually why remote systems utilize a framework of frequency-division numerous get to (FDMA), in which there must be at slightest one cell in between cells reusing the same recurrence.

4. METHODOLOGY

4.1 Research Objective

The primary goal of this research is to determine the effectiveness and usefulness of the signal seeker system in improving signal security in wireless communication situations. Specifically, we seeks to evaluate the accuracy and reliability of the signal detection technique used with LoRa transceivers and receivers to detect unauthorized signals, such as eavesdropping or unauthorized broadcasting. Assess the precision and efficacy of the GPS integration in the signal seeker system in properly tracking the position of transmitting devices responsible for unauthorized transmissions. We then analyze the signal seeker system's capacity to determine the location and direction of unauthorized signal sources using signal strength data. To Investigate the effectiveness of the LED indicator and real-time signal intensity display in immediately alerting surrounding personnel to the existence of unauthorized signals, hence improving situational awareness and security measures. Examine the reliability and timeliness of data logging and transmission to the Firebase platform, as well as the completeness and integrity of logged information, to allow for real-time monitoring and analytics. Evaluate the user experience and usability of the dedicated app and internet interface for real-time signal seeker system monitoring, including alert configuration and historical data access. Investigate prospective applications and expansions of the signal seeker system beyond signal security, such as environmental monitoring, asset tracking, or emergency response, to uncover additional benefits and uses.

4.2 Hardware Configuration

4.2.1 LoRa Module

The RYLR998 module typically operates in the frequency range of 433MHz, 868MHz, or 915MHz, depending on the version. It uses the LoRa modulation technique, which provides long-range communication with low power consumption, making it suitable for various IoT and M2M applications. The module can be configured using AT commands via the UART interface, allowing users to customize parameters such as frequency, transmit power, spreading factor, and bandwidth. Depending on factors such as antenna design, environment, and regulatory limitations, the RYLR998 module can achieve communication ranges of several kilometers in line-of-sight conditions. It may also comply with regulatory standards such as FC (in the United States), CE (in Europe), and IC (in Canada), depending on the version and intended

4.2.2 GSM Module

GPS is a system of 30+ navigation satellites circling Earth. We know where they are because they constantly send out signals. A GPS receiver in your phone listens for these signals. Once the receiver calculates its distance from four or more GPS satellites, it can figure out where you are.
In this model we have use neo 6m board. The NEO-6M GPS module has five major parts on the board, the first major part is the NEO-6M GPS chip in the heart of the PCB. Next, we have a rechargeable battery and a serial EEPROM module.
An EEPROM together with a battery helps retain the clock data, latest position data (GNSS orbit data), and module configuration but it’s not meant for permanent data storage. Without the battery, the GPS always cold-starts so the initial GPS lock takes more time. The battery is automatically charged when power is applied and maintains data for up to two weeks without power. Next, we have our LDO, because of the onboard LDO, the module can be powered from a 5V supply. Finally, we have our UFL connector where we need to connect an external antenna for the GPS to properly work.

4.2.3 OLED Screen

A flat light emitting device is called an OLED (Organic Light-Emitting Diodes) screen. OLED is a cutting-edge display technology composed of an organic light-emitting thin film. OLED emits bright light when an electrical current is applied. In addition to being efficient and thin, OLED displays offer the best image quality available (when compared to LED and LCD displays). In the future, they may also be made transparent, foldable, flexible, rollable, and stretchable. We have use 0.96inch I2C OLED display

4.2.4 Buzzer

An audio signaling device, also known as a buzzer or beeper, can be mechanical, electromechanical, or piezoelectric (piezo for short). Buzzers and beepers are commonly used in alarm systems, timers, training systems, and as a means of verifying user input, such as mouse clicks and keystrokes. We have use 5volt buzzer.

4.2.5 ESP8266

The ESP8266 is a popular and versatile Wi-Fi module that is widely used in various IoT (Internet of Things) applications. ESP8266 modules are relatively inexpensive, making them accessible for hobbyists, students, and small-scale projects. It provides built-in Wi-Fi connectivity, allowing devices to connect to the internet and communicate with other devices over a wireless network. This feature is essential for IoT applications that require internet connectivity.

5. WORKING OF RX

The ESP node MCU 8266 is used for communication of the RX (Receiving signal) signal, and the GPS module is used for GPS location, connected to the TX , RX pin of the GPS to the GPIO pins 13 and 15 of the ESP 8266, which give the location of our signal seeker device to the web and app, and the OLED is connected to the GPIO pin numbers 5 and 4, which give live signal detection strength as RSSI value (Receiving signal strength indicator) signal from (0 to -120) on the screen. When our equipment detects a signal, the LED and buzzer blink and produces a sound. LED is attached to GPIO pin number 12.868 MHz Lora signal RX receiver with TX, RX pin connected to GPIO pins 1 and 3 of the card,the other pin of the component is connected to ground and 3.3v at the board, our power source is lithium ion cell capacity is 3.7 volts. 1200 MAH and can be charged with an external Type-C charger

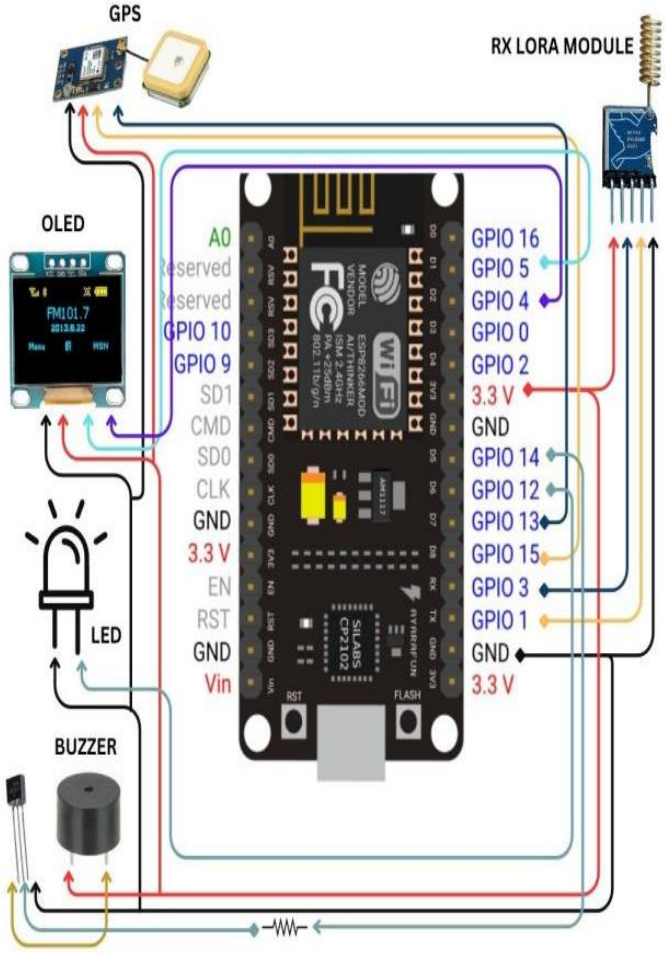

Fig. 5.1 Connection Diagram

6. WORKING OF RX

In this a LoRa transmitter (RYLR 998) is utilized to transmit binary signals (0 or 1). The transmitter is integrated with an Arduino Nano, serving as a compact communication interface. The LoRa transmitter's TX pin connects to the RX input of the Nano, with the RX pin of the Nano connected to the TX connector of the board, and both grounded together. The LoRa transmitter is powered by 3.3 volts. Additionally, a trigger button, generating a signal of 1 when activated, is linked to digital pin 6 of the Nano and the board's ground.

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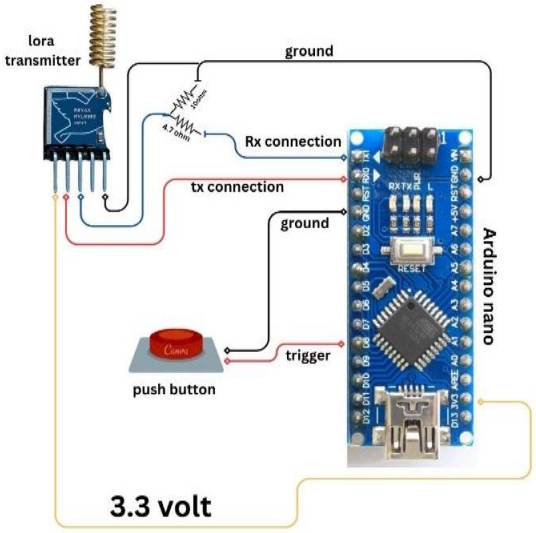

Fig. 6.1 LoRa Transmitter

7. LORA SOFTWARE OVERVIEW

Three Main Parts Make Up the Simplified Software Solution Known as Lora

7.1 Website

Created with JAVASCRIPT, HTML, and CSS to provide a dynamic and aesthetically pleasing user interface. JAVASCRIPT is used in both the frontend and backend.
The application was made with MIT App Inventor, guaranteeing a flexible and easy-to-use mobile experience.

7.2 Real-time Database

Firebase integration provides affordable real-time data, which is especially important for real-time location tracking.
Our website and application are subject to frequent security audits and updates, in addition to the strong security measures put in place at the outset, to guarantee the confidentiality and protection of sensitive data accessed by verified government officials. For authorized users, the Sign In /Log In section is the entry point. Tight authentication procedures are in place to confirm the legitimacy of public servants. By ensuring that only authorized users are able to access the system, this additional security layer helps to maintain the platform's overall integrity. An extensive view of all registered devices is available in the Device List section, giving officials a clear picture of the technological environment they are keeping an eye on. This feature improves our system's overall efficacy by making device management and tracking more efficient. The Device Output and Frequency section explores the real-time data produced by the devices under observation at the same time. Because this information is dynamic, officials can make proactive decisions and react quickly to new situations by staying up to date on trends. Our system gains additional sophistication from the Precise Geolocation feature. Officials are able to locate registered devices precisely in real time by utilizing sophisticated Geolocation APIs. This feature is extremely helpful in situations where timely and precise location data is essential for making wise decisions. We guarantee smooth data storage and retrieval by using Firebase as our primary database. Our platform is more responsive and dependable overall thanks to the Firebase API integration, which makes updating and retrieving real-time data easier.
Let us conclude by saying that our application and website are examples of technological innovation used for national security. Our dedication to offering government officials a potent tool for effective device management and monitoring is reaffirmed by the well-balanced integration of dynamic features, strict security protocols, and real-time data processing.

8. USE CASES OF LoRa

The taking after are three of the beat utilize cases for LoRa:

8.1 Savvy Cities

A keen city is an application of IoT that employments innovation to progress the quality of life of its citizens. It can be utilized to decrease contamination, increment open security, and progress productivity. A shrewd city too makes strides maintainability by utilizing renewable vitality sources and lessening squander. Keen cities utilize IoT gadgets such as sensors to gather information approximately activity designs or air quality in arrange to create choices on how they can make strides their framework frameworks. By collecting this data from each sensor, cities are able to form maps appearing where there are issues in particular ranges so that they can send out laborers who will settle those issues rapidly some time recently they ended up genuine issues afterward on down the line.

This permits cities' authorities more control over what happens inside their borders whereas moreover making a difference them keep track of where cash goes since everything has been followed electronically from start-up costs until completion date or the conclusion of the gadget lifecycle.

8.2 Savvy Cultivating

Savvy cultivating leverages IoT innovation in a have of ways to underpins maintainability, increment trim abdicate, and screen animals wellbeing. Sensors can be coordinates particularly ,to : Observing trim wellbeing Observing soil wellbeing Checking water levels within the soil, or indeed underground water supplies , Wind speed, Temperature and mugginess are moreover vital components when it comes to plant growth, so you'll be able utilize sensors to screen these as well. The more information inferred through condition checking the more educated choices agriculturists can make with respect to their crops and animals.

8.3 Associated Domestic

LoRa is an perfect innovation for the associated domestic. It can be utilized to screen and control gadgets, such as keen lights and locks, from anyplace within the world. For example: You'll be able turn on your coffee creator from work some time recently you arrive domestic You'll set up movement sensors all through your house that will send cautions when somebody enters or clears out a room.

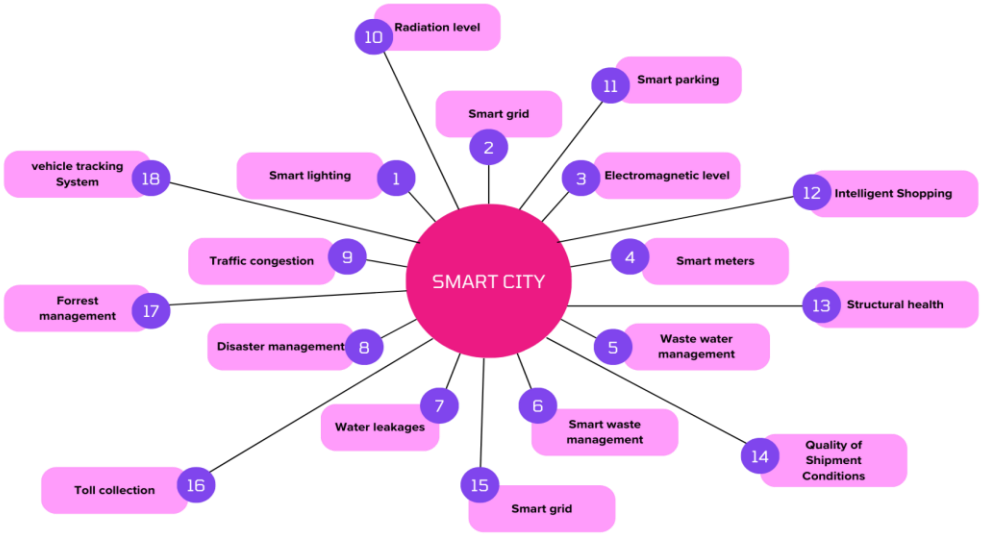

Fig. 8.1 Smart City

9. CAD CHANNEL ACTIVITY DETECTION

Using spread spectrum modulation technology, it is difficult to determine if a channel is already in use before a frame is sent. Since a LoRa receiver can demodulate signals below its noise level, using RSSI is impossible. Instead, a Channel Activity Detector (CAD) is used to detect other LoRa signals. The Channel Activity Detection feature, available across the entire LoRa radio band, introduces a possible CSMA mechanism for LoRa-based networks. CAD is a power-efficient way to detect an incoming frame without using the powerful continuous receive mode. Before running the CAD, the LoRa radio is tuned to the desired frequency, SF and BW. The radio then enters CAD mode and performs a [T symbol + (32/BW)] millisecond CAD operation during which the radio performs receive function correlation on the received samples. The symbol is the duration, which is the transmission time of one LoRa match depending on the SF value. The CAD mode available in all LoRa radios [1] is mainly designed to identify the energy-efficient initializer. Although starter detection is not a full-fledged carrier sensor, CAD can reliably and effectively detect the payload beeps of an ongoing transmission.

Table-9.1 Different Between Different Technologies

ATTRIBUTE	LoRa WAN	WIFI	BLUETOOTH	LTE-M	ZIGBEE
RANGE	2KM-20KM	30M-50M	15M-100M	1KM-10KM	2KM LOS
THROUGHPUT	10 KBPS	54MBPS	125KBPS	UPTO 1MBPS	250KBPS
POWER CONSUMPTION	LOW	MEDIUM	LOW	MEDIUM	MEDIUM
TOPOLOGY	STAR	STAR, MESH	P2P, STAR, MESH	STAR	STAR

CONCLUSION

In summary, the Signal Seeker system leverages advanced technology and robust communication protocols to address growing concerns about the unauthorized use of wireless signals. By using LoRa transceivers and receivers for long-range communication, combined with GPS for precise location tracking, the system effectively detects and locates rogue signals. Improved LoRa devices continuously scan for signals and provide real-time data on signal strength and location Screens integrated with visual indicators provide immediate warning and information to nearby personnel, improving situational awareness. Additionally, the system logs detected signals locally and sends the data to Firebase for further analysis and monitoring. An easy-to-use interface with a dedicated app and website allows users to monitor the system in real time, configure alarm settings, and access historical data

This comprehensive approach to signal security not only increases protection against unauthorized activity, but also facilitates proactive management and response capabilities.

In a wireless and increasingly connected world, Signal Seeker systems are critical tools for protecting networks, infrastructure, and sensitive information, ultimately creating a more secure environment for everyone Contribute to.

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