

IOT-Location Tracking Using Lora Without Cellular or Internet Connectivity

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Abstract- This paper presents a LoRa-based location tracking system designed to operate without reliance on cellular networks or continuous internet connectivity. The system utilizes GPS-enabled tracking nodes that transmit location data through LoRa communication to a local gateway. The gateway processes the received data and enables visualization through an optional interface. The core communication between devices remains independent of internet infrastructure, making the system suitable for remote and low-connectivity environments. The proposed system ensures low power consumption, extended communication range, and reliable tracking performance. Experimental observations indicate that the system provides effective location monitoring with minimal dependency on external communication networks.

Index Terms- LoRa, GPS Tracking, IoT, LPWAN, Wireless Communication

I. INTRODUCTION

The rapid advancement of the Internet of Things (IoT) has significantly increased the demand for efficient and reliable location tracking systems. These systems are widely used in applications such as logistics, agriculture, disaster management, and asset monitoring. However, most traditional tracking systems depend on cellular networks or internet connectivity, which limits their functionality in remote and infrastructure-less environments.

Conventional GSM-based tracking systems suffer from high power consumption, recurring operational costs, and dependence on third-party network providers. In scenarios such as rural areas, disaster zones, or military operations, reliable network

connectivity may not be available, making such systems ineffective.

To overcome these limitations, Low Power Wide Area Network (LPWAN) technologies have emerged as a promising alternative. Among these, LoRa (Long Range) technology offers long-distance communication with minimal power consumption. The proposed system leverages LoRa communication along with GPS modules to enable efficient location tracking without relying on cellular networks.

Unlike conventional systems, the proposed solution ensures that location data transmission occurs entirely through LoRa communication. The visualization interface is optional and can be deployed locally, ensuring that the system remains operational even without internet connectivity. This makes the system highly suitable for remote and low-network environments.

The key contribution of this work is the development of a low-power, long-range tracking system that eliminates dependency on cellular networks while maintaining reliable communication performance.

1.1 Problem Statement

To design and implement a low-power, long-range location tracking system using LoRa technology that can accurately monitor and transmit the real-time position of assets or users in remote areas without relying on cellular networks or internet connectivity.

1.2 Proposed System

The proposed system introduces a LoRa-based offline IoT tracking solution that overcomes the limitations of traditional methods. It uses a GPS

module to obtain accurate real-time location data and a LoRa transceiver to transmit this data over long distances with minimal power consumption. The transmitted data is received by a LoRa gateway, where it is processed and stored locally for monitoring and visualization. The system is designed to be energy-efficient, scalable, and capable of supporting multiple tracking devices simultaneously. It ensures reliable communication even in challenging environments, making it suitable for applications such as agriculture, logistics, and emergency monitoring.

II. LITERATURE REVIEW

Several studies have explored location tracking systems using technologies such as GSM, GPS, and Wi-Fi. GSM-based systems provide wide-area coverage but suffer from high energy consumption and dependency on cellular networks. Wi-Fi-based systems, although accurate, are limited by short-range communication and reliance on internet connectivity.

Recent advancements in LPWAN technologies have led to the adoption of LoRa for IoT applications. Research indicates that LoRa enables long-range communication over several kilometers with significantly lower power consumption compared to traditional wireless technologies.

Previous works integrating GPS with LoRa demonstrate effective location tracking capabilities. However, challenges such as low data rates, environmental interference, and signal attenuation still exist. This work focuses on addressing these challenges by designing a reliable and energy-efficient tracking system suitable for real-world applications.

III. METHODOLOGY

The proposed system follows a structured approach for designing and implementing the LoRa-based tracking solution. Initially, hardware components such as the GPS module, microcontroller, and LoRa transceiver are integrated to form the tracking node. The GPS module collects real-time location data,

which is processed by the microcontroller and converted into a suitable format for transmission.

The processed data is transmitted using LoRa communication to a nearby LoRa gateway. The gateway receives data from one or multiple tracking nodes and processes and stores it locally. At the gateway system, the data is decoded, stored, and displayed through a user interface for monitoring purposes.

The system is tested in different environments to evaluate parameters such as communication range, accuracy, power consumption, and reliability. This methodology ensures efficient data transmission, low energy usage, and stable performance.

3.1 System Architecture

The system consists of GPS-enabled tracking nodes, a LoRa communication module, and a local gateway system. The tracking node collects real-time location coordinates and transmits them using LoRa technology. The gateway receives the transmitted data, processes it, and stores it locally. An optional visualization interface is connected to the gateway for displaying location data.

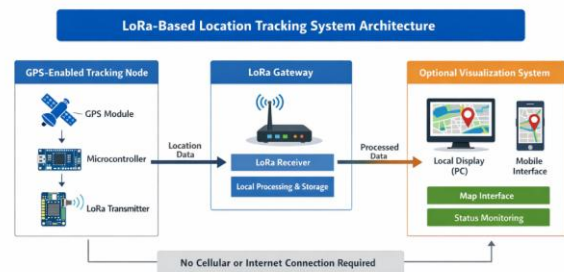


Fig. 1: Architecture of LoRa-Based Location Tracking System without Internet Connectivity

The diagram shows the LoRa-based tracking system architecture. The tracking node uses a GPS module to collect location data, which is processed by a microcontroller and transmitted through a LoRa module. The LoRa gateway receives this data and processes and stores the data locally at the gateway. The gateway processes, stores, and optionally displays the location information on a user interface.

3.2 Location Tracking Using LoRa Technology

The system uses a GPS module to collect real-time location data such as latitude and longitude. This data is processed by a microcontroller and transmitted using LoRa technology, enabling long-range communication with low power consumption. The LoRa gateway receives the data and displays it through a local visualization interface.

3.3 Algorithm for LoRa-Based Location Tracking

A LoRa-based location tracking system works by combining GPS technology with long-range LoRa communication. Initially, the GPS module collects the real-time location coordinates (latitude and longitude) of the device. These coordinates are then formatted into a data packet along with additional information such as device ID and timestamp. The LoRa transmitter sends this packet over a long distance using low power. On the receiving side, a LoRa gateway captures the transmitted data, verifies its accuracy, and decodes it to extract the location details. The processed data is then stored and displayed on a monitoring system or map interface. This process is repeated at regular intervals to enable continuous and real-time tracking, making the system efficient for remote areas where cellular or internet connectivity is not available.

Algorithm -1: LoRa-based Algorithm

Step 1: The GPS module captures real-time latitude and longitude coordinates.

Step 2: The collected data is encoded and prepared for transmission.

Step 3: The LoRa transmitter sends the data over long-range communication.

Step 4: The LoRa receiver at the gateway captures the transmitted data.

Step 5: The gateway processes and stores the received coordinates locally.

Step 6: The processed data is displayed through an optional local interface for visualization.

3.4 Performance

This section evaluates system performance under varying environmental conditions such as buildings,

terrain, and weather. These factors affect signal strength and communication range.

3.5 Work Flow

The workflow begins with the GPS module capturing location data. The microcontroller processes this data and transmits it through the LoRa module. The LoRa gateway receives the data, processes it, and stores it locally. The processed information is then displayed on a local user interface.



Fig. 2: Workflow of LoRa-Based Location Tracking System

The figure illustrates the workflow of the LoRa-based tracking system. Initially, the GPS module captures real-time location data. This data is then processed by the microcontroller, which prepares it for transmission. The processed data is sent through the LoRa gateway, enabling long-range communication. The gateway processes and stores the received data locally. Finally, the location information is displayed on the user interface (local visualization interface), allowing users to monitor the tracked object.

IV. IMPLEMENTATION AND RESULT

The proposed LoRa-based tracking system was implemented by integrating a GPS module, microcontroller, and LoRa transceiver to form the tracking node. The GPS module collects real-time location data, which is processed and transmitted using LoRa communication. A LoRa gateway receives the data and processes and stores the data locally at the gateway and processed, stored, and displayed on a user interface. The results demonstrate that the system achieves reliable long-range communication with low power consumption. It successfully tracks location data in real-time, even in remote areas without network connectivity. The system shows good accuracy, stable performance, and the ability to support multiple devices. However,

slight signal variations were observed in environments with obstacles. Overall, the system proves to be efficient, cost-effective, and suitable for real-world tracking applications.

The system was implemented using GPS modules, microcontrollers, and LoRa transceivers. The GPS module collects location data, which is transmitted via LoRa communication to the gateway. The gateway processes, stores, and displays the data locally.

The system was evaluated based on communication range, delay, power consumption, and reliability.

Table 1: Performance Analysis of Proposed System

Parameter	Results
Communication Range	2–5 km
Transmission Delay	2–4 seconds
Packet Loss	<10%
Power Consumption	Low

The results indicate stable long-distance communication with minimal power usage. Minor signal variations were observed in obstacle-rich environments.

4.1 Dataset Collection

The system uses real-time data collected from GPS modules, including latitude, longitude, timestamp, and device status (battery level and signal strength). This data is continuously generated during operation and used to evaluate system performance.

4.2 Performance Analysis

The system performs efficiently with stable communication over long distances and low power consumption. Minor variations may occur due to environmental obstacles.

4.3 System Outputs

The processed data is displayed through a local visualization interface connected to the gateway. The interface presents real-time location information including coordinates, timestamp, and device identification. A simple map-based visualization may

be used to indicate the position of the tracked object. This functionality operates locally without requiring internet connectivity.

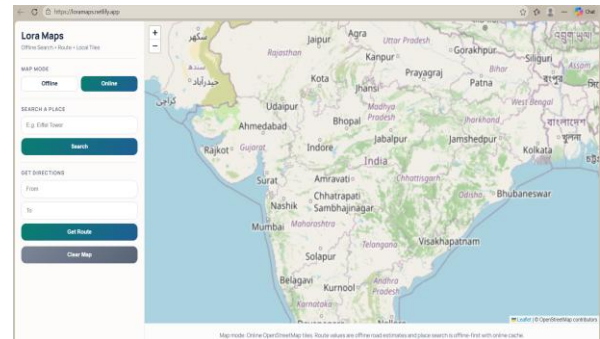


Fig. 3: Visualization Interface Showing Location Output of the Tracking System

V. CONCLUSIONS

This paper presents a LoRa-based location tracking system that operates independently of cellular networks and minimizes reliance on internet connectivity. The system demonstrates efficient long-range communication with low power consumption, making it suitable for remote environments. The integration of GPS and LoRa ensures accurate tracking and reliable data transmission. Overall, the system provides a cost-effective and scalable solution for real-time tracking applications.

VI. FUTURE SCOPE

Future enhancements to the system may include:

- Integration with mobile applications for user-friendly monitoring
- Improvement in location accuracy using advanced sensors
- Implementation of security mechanisms for data protection
- Real-time alert systems for emergency situations

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