

## Design And Implementation of a Short Message Delivery System Using LoRa Technology

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### ABSTRACT

*This study presents the design and development of a short message communication system capable of operating in areas without internet connectivity by leveraging LoRa (Long Range) technology. LoRa was selected due to its extended coverage and energy efficiency, making it well-suited for deployment in remote regions. The proposed system integrates ESP32-based transmitter and receiver nodes with the LoRa RA-01 module as the communication medium. A mobile application is developed to provide a user-friendly interface for composing and displaying messages, while an SQLite database is utilized for storing communication records locally. System development follows the Waterfall model, covering requirement analysis, design, implementation, and testing. Experimental results demonstrate that the system successfully transmits and receives messages up to a distance of 100 meters without internet connectivity. The solution offers a practical and efficient alternative for wireless communication, particularly for delivering critical information in areas underserved by conventional telecommunication infrastructure.*

**Keywords:** LoRa; ESP32; Short Message Communication; SQLite Database.

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### INTRODUCTION

The rapid development of information and communication technology has become an essential aspect of modern society. Internet connectivity, in particular, plays a significant role not only as a medium of communication but also as a platform for information access, online transactions, and various daily activities (Apriyanti et al., 2022). However, the dependency on internet-based systems poses challenges for regions with limited infrastructure, where access to reliable connectivity and electricity remains a major obstacle.

In recent years, the Internet of Things (IoT) has emerged as a transformative technology, enabling devices and systems to exchange data through interconnected networks (Selay et al., 2022). While IoT provides numerous advantages, most implementations still rely on stable internet connectivity, which limits its application in remote and rural areas. Wireless networks, despite offering mobility, often consume high energy and provide limited coverage. To address these issues, alternative low-power and long-range communication technologies are required.

Long Range (LoRa) has gained significant attention as a solution for such scenarios. LoRa enables long-distance communication with minimal power consumption, making it ideal for IoT applications in remote environments (Hadikusuma & Nurpulaela, 2022). Several studies have utilized LoRa in various contexts, such as landslide early-warning systems (Pangaribuan, 2022), environmental monitoring (Effendi & Oktiwati, 2022), and smart home applications (Saragih et al., 2020). However, these implementations generally focus on monitoring or sensor data transmission and often rely on additional gateways or internet connectivity for data distribution (Elisawati et al., 2019). This highlights a research gap in developing a stand-alone communication system that can operate without internet access while maintaining reliability (Maulana et al., 2021).

This study proposes the design and development of a short message communication system using LoRa technology, supported by ESP32 microcontrollers and an SQLite database for local data storage (Samsugi et al., 2021). Unlike previous works, the system emphasizes two-way short message delivery in areas without internet access. The research aims not only to provide a practical alternative for wireless communication but also to contribute to the innovation of low-cost, energy-efficient solutions for

emergency information sharing in rural and isolated areas(Nugroho & Djaksana, 2022).

## **METHOD**

This research employed an experimental development approach using the Waterfall model, which was selected for its structured and sequential process that ensures systematic system design. The study focused on the development of a short message communication system based on LoRa technology(Badrul et al., 2021).

The hardware components consisted of ESP32 microcontrollers as processing units, LoRa RA-01 modules as the communication medium, and microSD cards for local data storage(Simangunsong et al., 2022). The system was divided into two entities: a transmitter for sending data and a receiver for receiving and storing messages. A mobile application was also developed as the user interface for composing and displaying short messages.

The research procedure followed five main stages: (1) requirement analysis to identify user and system needs, (2) system design including architecture modeling, database design, and communication flow diagrams, (3) implementation through coding and hardware integration, (4) testing to evaluate message delivery, communication stability, and system reliability at various distances, and (5) maintenance to ensure the system remains functional and adaptable to future requirements(Badrul et al., 2021).

Data collection was conducted through direct observation and system testing in both controlled and field environments. The performance analysis was carried out by measuring transmission range, delivery success rate, and stability of the LoRa communication(Ardha Maliki et al., 2023). The results were documented and evaluated to determine the effectiveness of the proposed system(Silaban et al., 2021).

## **RESULT AND DISCUSSION**

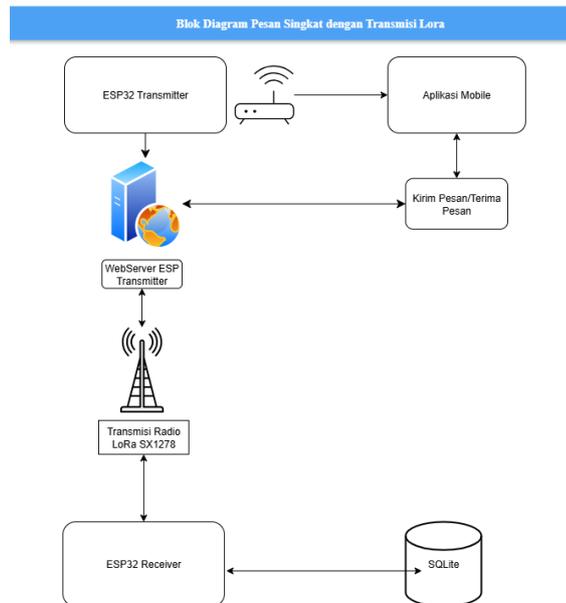
The implementation of the short message communication system was carried out using the ESP32 Dev Board as the main microcontroller, integrated with the LoRa RA-01 (SX1278) module operating at 433 MHz. A local SQLite database stored on an 8GB microSD card was employed to manage both user data and message history, while a mobile application served as the interface for sending and receiving text messages.

### **Result**

The system implementation was carried out to support short message communication in areas with limited internet access. The developed system utilizes the ESP32 Dev Board integrated with the LoRa RA-01 (SX1278) module operating at 433 MHz. The mobile application serves as the user interface for sending and receiving messages, while a microSD card with SQLite is used to store message history locally.

- **System Architecture**

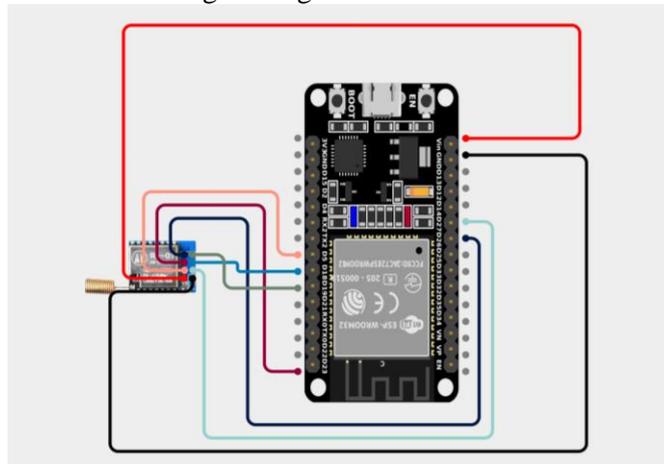
The overall system consists of three main entities: the mobile application, the ESP32-based transmitter, and the ESP32-based receiver. The transmitter receives user input through an access point mode web server, packages the data into JSON format, and sends it to the receiver via LoRa. The receiver stores the received data into an SQLite database on the microSD card.



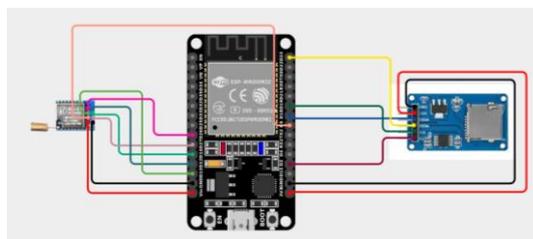
**Figure 1.** System architecture of LoRa-based short message communication

- **Prototype Implementation**

Both transmitter and receiver devices were assembled using ESP32 boards, LoRa RA-01 modules, and lithium batteries supported by solar panels for independent power supply. The transmitter prototype was designed as a mobile access point for message input, while the receiver prototype functioned as a storage unit for incoming messages.



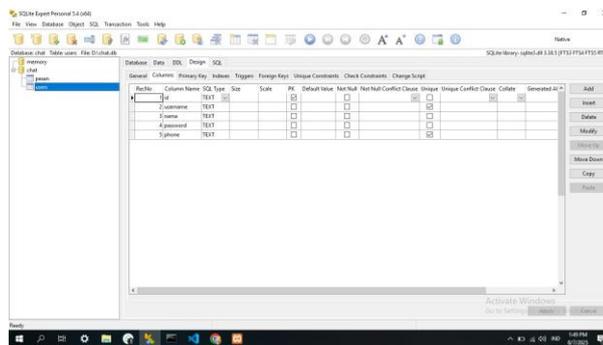
**Figure 2.** Prototype device Transmitter



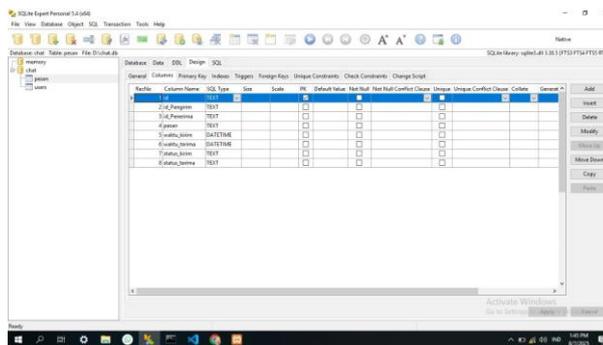
**Figure 3.** Prototype device Receiver

- **Database Implementation**

SQLite was implemented to manage message and user data in the receiver device. The *pesan* table records sender, receiver, message content, and timestamps, while the *users* table stores registered user information.



**Figure 4.** Structure of the SQLite database table users



**Figure 5.** Structure of the SQLite database table pesan

- Performance Testing

System testing was conducted in Klitih Hamlet, Plandaan Sub-district, with a maximum distance of 100 meters in line-of-sight (LOS) conditions. The results showed that the system successfully transmitted and received messages with an average delivery time of 1.0 seconds at 20 meters and 3.3 seconds at 120 meters. No message loss was detected during continuous sending. However, at distance above 130 meters, message is lost.

**Table 1.** Message transmission test results

Distance (m)	Condition	Avg. Delivery Time (s)	Message status	RSSI (dBm)
20	LOS	1.0	Deliver	-80
50	LOS	1.5	Deliver	-84
75	LOS	1.8	Deliver	-89
100	LOS	2.0	Deliver	-90
110	LOS	2.0	Deliver	-95
120	LOS	3.3	Deliver	-110
130	LOS	Request Timeout	Lost Connected	-125
150	LOS	Request Timeout	Lost Connected	-135

### Discussion

The implementation results demonstrate that the LoRa-based short message communication system operates effectively for text message exchange at distances up to 100 meters under line-of-sight (LOS) conditions. The measured RSSI values, ranging from -80 dBm to -110 dBm, remain within the acceptable threshold for LoRa communication, confirming the suitability of the RA-01 (SX1278) module operating at 433 MHz for medium-range communication without internet infrastructure.

In terms of delivery time, the system successfully transmitted messages with an average of 1.0 seconds at 20 meters and 3.3 seconds at 120 meters. This latency is considered efficient for simple text-based communication, although a slight increase in transmission time was observed as the distance increased. The additional delay can be attributed to signal degradation over longer distances.

The use of SQLite on an SD card for message storage further enhances the system's reliability, as it allows users to access communication history locally without depending on external servers. This approach aligns with the communication needs of remote areas, where internet access and conventional telecommunication infrastructure are often unavailable.

Compared with previous studies, which primarily focused on LoRa-based sensor monitoring, the strength of this system lies in the integration of a local database that enables structured message management. Moreover, the combination with a mobile application through the ESP32 access point mode provides users with straightforward access without requiring additional network configuration.

Nevertheless, the system still has limitations, particularly regarding communication range, since testing was limited to LOS conditions. Environmental factors such as buildings or dense vegetation may negatively affect signal quality. Future development can therefore focus on extending testing to longer ranges and non-LOS scenarios, as well as incorporating encryption mechanisms to enhance message security.

## CONCLUSIONS

This research successfully designed and implemented a LoRa-based short message communication system utilizing the RA-01 (SX1278) module operating at 433 MHz and controlled by an ESP32 microcontroller. The test results indicate that the system can reliably send and receive text messages at distances of up to 100 meters under line-of-sight (LOS) conditions. The recorded RSSI values, ranging from -80 dBm to -110 dBm, confirm the stability of the communication link within the tested range.

Message delivery time was relatively fast, with an average of 1.0 seconds at 20 meters and 3.3 seconds at 120 meters. Although transmission latency increased slightly with distance, the overall performance remained stable and effective for text-based communication. The integration of SQLite on an SD card further enhanced system reliability by providing local storage of communication history, eliminating the need for internet connectivity.

In summary, the system demonstrates potential as a practical and low-power alternative for wireless communication in remote areas where conventional telecommunication infrastructure is unavailable. For future development, extended testing in non-line-of-sight environments and the addition of message encryption mechanisms are recommended to improve robustness and data security.

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