WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Indoor Location (GPS) Detection Using Lora

Miss.M.V.Patil[1],Shivanand Desai[2],Varsharani Patil[3],Rupali Jadhav[4],Diwyani Patil[5],Vaishnavi swami[6]

[1]Professor,[2-6]Student

Department of Electronics and Telecommunication Engineering, Jaywant College of Engineering and Polytechnic, K.M. Gad, Maharashtra, India

Email: mvpatil.etc@jcep.edu.in,shivanand3715@gmail.com, varshapatil7249@gmail.com,rupalijadhav328@gmail.com, patildiwya991@gmail.com, vaishnaviswami75@gmail.com.

ABSTRACT:

Local Area Network (LAN) technologies such as Bluetooth, Wi-Fi, and ZigBee are widely adopted for short-range wireless communication. However, these technologies often face limitations related to high power consumption and limited communication range. In contrast, LoRa (Long Range) technology offers a promising alternative. It is a low-power, long-range, spread spectrum modulation technique that operates in unlicensed frequency bands and does not incur any access fees. This study focuses on evaluating the performance of a commercially available LoRa transceiver for location monitoring applications. A prototype system integrating a GPS module and LoRa communication was developed to monitor the location data and assess system parameters such as transmission range, battery efficiency, and Received Signal Strength Indicator (RSSI). Field tests indicated successful data transmission up to a range of 290 meters. Furthermore, the system demonstrated continuous operation for more than 24 hours using a 6V AA battery pack. The results validate the suitability of LoRa-based systems for low-power, long-range location tracking applications.

Keywords: LoRa, LPWAN, GPS Module, Location Tracking, Arduino Mega, Dragino LoRa Shield, RSSI, Battery Lifetime, Wireless Communication, IoT, Signal Transmission Range, Low Power Consumption, Real-Time Monitoring, LoRa Transceiver, Arduino IDE.

INTRODUCTION

LoRa (Long Range) is an emerging wireless communication technology designed for long-range data transmission with extremely low power requirements. Operating in unlicensed frequency bands, LoRa provides a cost-effective and scalable solution without incurring access or licensing fees. Traditional local area network (LAN) technologies such as Bluetooth, Wi-Fi, and ZigBee are well-established for short-range communication. However, these technologies often suffer from significant power consumption and limited range. Similarly, cellular networks like LTE offer high data throughput but are not optimized for energy efficiency and are costly to deploy over wide geographic areas, such as city-wide coverage.

To address these challenges, Low Power Wide Area Network (LPWAN) technologies—specifically LoRa—have been introduced. LoRa is particularly well-suited for applications in the Internet of Things (IoT), where extended battery life and long-distance connectivity are critical requirements. Its low deployment cost and license-free operation make it an attractive option for numerous monitoring applications.

LoRa technology has been successfully employed in a variety of domains, particularly in healthcare and environmental monitoring. For instance, humidity control systems in buildings have been enhanced using LoRa to reduce air conditioning costs . Similarly, LoRa has been utilized to track temperature levels in blood storage systems for transfusion services . Air quality monitoring systems integrating gas sensors with LoRa communication have also been explored . Furthermore, innovative approaches to location tracking using multilateration techniques—without relying on GPS—have been proposed, using timestamps from LoRa gateways .

Several studies have used Dragino LoRa modules for experimentation, though most of these works do not delve into detailed range performance analysis of the transceivers. Other researchers have focused on enhancing the underlying LoRa protocol, while efforts in have proposed mobile applications and prototype smart home systems powered by LoRa.

Building upon these earlier works, the present study aims to design, implement, and analyze a location tracking system using a LoRa module integrated with a GPS shield. The objective is to evaluate the system's performance in terms of range, signal strength, and power efficiency.
The structure of this paper is as follows: Section 2 describes the research methodology employed in this study. Section 3 presents the results and discusses the key findings. Finally, Section 4 concludes the paper with remarks on future work and potential improvements.

RESEARCH METHOD

The block diagram of the proposed diagram is shown in Figure 1. The system consists of two parts which are LoRa transmitter and receiver. LoRa/GPS shield was stacked onto Arduino at transmitter part before location data being transmitted on the LoRa network. At receiver part, LoRa shield was stacked onto Yun shield for data collection and then onto Arduino.

Hardware and software component

In this project, a LoRa module integrated with a GPS shield based on the SX1276/SX1278 chipset was utilized for long-range communication and location tracking. The Arduino Mega microcontroller was selected due to its extended number of input/output pins, which provided greater flexibility for interfacing multiple components. To address the storage limitations of the Arduino board, a Yun Shield was incorporated into the system. This shield served as an intermediary between the Arduino and the LoRa module, enabling sufficient memory capacity for storing GPS data during operation. The system was programmed and configured using the Arduino Integrated Development Environment (IDE), which facilitated the development and deployment of the codebase for both data transmission and reception.

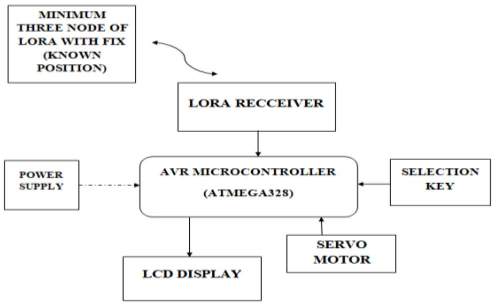

Figure 1. Block diagram of the proposed diagram

Experiment setup

The experimental setup was designed to facilitate data collection and analysis of the location tracking system. A laptop was connected to both the transmitter and receiver units to monitor the data exchange in real time. The serial monitors of the laptops were used to display the received GPS coordinates, including longitude and latitude values. This configuration enabled continuous observation and logging of location data throughout the testing phase.

RESULTS AND ANALYSIS

During operation, the Arduino microcontroller receives serial data from the LoRa GPS module, which includes key parameters such as latitude (LAT), longitude (LON), satellite count (SAT), and horizontal position precision (PREC). The precision value indicates the relative accuracy of the reported location, while the satellite count reflects the number of available GPS satellites contributing to the fix.

In the receiver unit, the incoming serial data includes geographic coordinates and the Received Signal Strength Indicator (RSSI). The RSSI value provides a measurement of the signal power received and is useful for evaluating the quality of the wireless link.

To assess system performance, data was collected at intervals of 50 meters. It was observed that the system successfully transmitted and received data over a distance of up to 290 meters. Although the LoRa datasheet specifies a maximum range of up to 1500 meters under ideal conditions, environmental factors such as buildings and vehicles can interfere with the signal, thereby limiting its effective range. Despite these challenges, LoRa demonstrated superior range capabilities when compared to other wireless technologies such as ZigBee, traditional RF modules, and Wireless Sensor Networks (WSNs), which typically operate reliably within a 100-meter range .

It was also noted that RSSI values decreased as the distance between the transmitter and receiver increased, indicating a degradation in signal quality with increased range.

In terms of power efficiency, each LoRa unit was powered by AA alkaline batteries providing a total of 6 volts. The system remained operational and continued transmitting data for more than 24 hours without requiring a battery replacement. This demonstrates LoRa's suitability for long-duration, low-power applications, reinforcing its advantages in scenarios demanding extended operational lifetimes.

CONCLUSION

The findings of this study indicate that the Dragino LoRa module is capable of providing reliable network coverage up to a distance of 290 meters in a suburban environment characterized by dense residential structures. This demonstrates LoRa's effectiveness for medium-range communication even in areas with potential signal obstructions.

Future improvements to the system could involve the integration of a gateway, enabling device connectivity to a network server and allowing real-time data access through a user application. Additionally, to enhance signal quality and extend the effective range, it is recommended to install the LoRa modules on elevated platforms such as poles. Establishing a clear Line of Sight (LoS) between transmitting and receiving units can significantly improve reception and overall communication performance.

REFERENCES:

[1] M. Centenaro, L. Vangelista, A. Zanella, and M. Zorzi, "Long range communications in unlicensed bands: the rising stars in the IoT and smart city scenarios," IEEE Wireless Communications, vol. 23, no. 5, pp. 60-67, 2016.

[2] J. Petajajarvi, K. Mikhaylov, M. Hamalainen, and J. Iinatti, "Evaluation of LoRa LPWAN technology for remote health and wellbeing monitoring," 2016 10th International Symposium on Medical Information and Communication Technology (ISMICT), Worcester, MA, USA, 2016, pp. 1-5.

[3] S. Liu, C. Xia, and Z. Zhao, "A Low-power Real-time Air Quality Monitoring System Using LPWAN based on LoRa," 2016 13th IEEE International Conference on Solid-State and Integrated Circuit Technology (ICSICT), Hangzhou, 2016, pp. 379-381.

[4] B. C. Fargas, and M. N. Petersen, "GPS-free geolocation using LoRa in low-power WANs," 2017 Global Internet of Things Summit (GIoTS), Geneva, Switzerland, 2017, pp. 1-6.

[5] D. Eridani, E. D. Widianto, R. D. O. Augustinus, and A. Faizal, "Monitoring system in LoRa network architecture using smart gateway in simple LoRa protocol," 2019 International Seminar on Research of Information Technology and Intelligent Systems (ISRITI), Yogyakarta, Indonesia, 2019, pp. 200-204.

[6] P. Edward, A. Muhammad, S. Elzeiny, M. Ashour, T. Elshabrawy, and J. Robert, "Enhancing the Capture Capabilities of LoRa Receivers," 2019 International Conference on Smart Applications, Communications and Networking (SmartNets), Sharm El Sheikh, Egypt, 2019, pp. 1-6.

[7] R. V. Rodriquez, S. Sendra, J. Sendra, J. Lloret, P. Romero-Diaz, and J. L. Garcia-Navas, "Low Cost LoRa based Network for Forest Fire Detection," 2019 Sixth International Conference on Internet of Things: Systems, Management and Security (IOTSMS), Granada, Spain, 2019, pp. 177-184.

[8] J. Jaffar, A. F. A. Malik, M. F. A. Zuhairi, A. A. B. Sajak, M. T. Ismail, "Development of the LoRaWAN-based Movement Tracking System," 2020 14th International Conference on Ubiquitous Information Management and Communication (IMCOM), Taichung, Taiwan, 2020, pp. 1-6.

[9] M. A. I. M. Ariff, Y. L. Then, and F. S. Tay, "Establish Connection Between Remote Areas and City to Improve Healthcare Services," 2019 International Conference on Green and Human Information Technology (ICGHIT), Kuala Lumpur, Malaysia, 2019, pp. 18-23.

[10] S. Sadowski, and P. Petros, "RSSI-Based Indoor Localization with the Internet of Things," IEEE Access, vol. 6, pp. 30149-30161, 2018.

[11] Y. Hou, Z. Liu, and D. Sun, "A novel MAC protocol exploiting concurrent transmissions for massive LoRa connectivity," Journal of Communications and Networks, vol. 22, no. 2, pp. 108-117, 2020.

[12] P. Edward, S. Elzeiny, M. Ashour, and T. Elshabrawy, "On the Coexistence of LoRa- and Interleaved Chirp Spreading LoRa-Based Modulations," 2019 International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob), Barcelona, Spain, 2019, pp. 1-6.

[13] R. Y. Azhari, E. Firmansyah, and A. Bejo, "Simple Protocol Design of Multi-Hop Network in LoRa," 2019 International Seminar on Research of Information Technology and Intelligent Systems (ISRITI), Yogyakarta, Indonesia, 2019, pp. 177-181.

[14] X. Wang, L. Kong, L. He, and G. Chen, "mLoRa: A Multi-Packet Reception Protocol in LoRa networks," 2019 IEEE 27th International Conference on Network Protocols (ICNP), Chicago, IL, USA, 2019, pp. 1-11.

[15] L. Leonardi, F. Battaglia, and L. Lo Bello, "RT-LoRa: A Medium Access Strategy to Support Real-Time Flows Over LoRa-Based Networks for Industrial IoT Applications," IEEE Internet of Things Journal, vol. 6, no. 6, pp. 10812-10823, 2019.

[16] M. H. Dwijaksara, W. S. Jeon, and D. G. Jeong, "Multihop Gateway-to-Gateway Communication Protocol for LoRa Networks," 2019 IEEE International Conference on Industrial Technology (ICIT), Melbourne, VIC, Australia, 2019, pp. 949-954.

[17] W. Wu, Y. Li, Y. Zhang, B. Wang, and W. Wang, "Distributed Queueing-Based Random Access Protocol for LoRa Networks," IEEE Internet of Things Journal, vol. 7, no. 1, pp. 763-772, 2020.

[18] S. Opipah, H. Qodim, D. Miharja, E. A. Zaki, and T. Juhana, "Prototype Design of Smart Home Base on LoRa," 6th International Conference on Wireless and Telematics (ICWT), Yogyakarta, Indonesia, 2020.

[19] F. A. R. M. Wildan, E. A. Z. Hamidi, T. Juhana, "The Design of Application for Smart Home Base on LoRa," 6^{th} International Conference on Wireless and Telematics (ICWT), Yogyakarta, Indonesia, 2020.

[20] A. B. Bababe, K. J. Ashish, K. Rajiv, "LoRa Based Intelligent Home Automation System," International Journal of Engineering and Advanced Technology (IJEAT), vol. 6, no. 3, pp. 88-92, 2017.

[21] N. Hashim, M. A. H. A. Razak, and F. Idris, "Home Security System Using ZigBee," Jurnal Teknologi (Sciences & Engineering), vol. 74, no. 10, pp. 29-34, 2015.

[22] F. Idris, N. Hashim, A.F. Kadmin, and L. B. Yee, "Intelligent Fire Detection and Alert System using LabVIEW," International Journal of Electrical and Computer Engineering (IJECE), vol. 9, no. 3, pp 1842-1849, 2019.

[23] N. Hashim, S. H. S. Ariffin, F. Yunus, F. Idris, and N. Fisal, "Deployment of Optimized Algorithm for MPEG-4 over Wireless Sensor Network," ARPN Journal of Engineering and Applied Sciences, vol. 9, no. 7, pp. 1035-1041, 2014.

[24] N. Hashim, N. F. A. M. Azmi, F. Idirs, and N. Rahim, "Smartphone activated door lock using WiFi," ARPN Journal of Engineering and Applied Sciences, vol. 11, no. 5, pp. 3309-3312, 2016.

[25] N. Hashim, N. Noordin, F. Idris, S. N. I. M. Yusoff, and M. Zahari, "IoT blood pressure monitoring system," Indonesian Journal of Electrical Engineering and Computer Science (IJEECS), vol. 19, no. 3, pp. 1384-1390, 2020.