Long Range WAN Based Alerting System for Restricted Area

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***Abstract*—The "Long Range WAN Based Alerting System for Restricted Area" is an embedded system designed for enhanced security and access control within restricted areas. This innovative solution utilises two LoRaWAN modules, one for vehicles and the other in the restricted premises, enabling seamless communication and monitoring. The core of the system is an Arduino-based controller, ensuring a compact and efficient design. It incorporates a push button to activate a 5V buzzer through a relay module, providing audible alerts when necessary. Additionally, an L293D motor driver module is used to control four BO motors with wheels, enabling speed limitation of the vehicle within restricted areas based on LoRaWAN signals, thereby serving as an effective prototype for controlled vehicle operation. In a world where access control and security are critical concerns, the paper offers a promising solution. It combines the power of LoRaWAN technology, the flexibility of Arduino-based control, and the practicality of audible alerts and speed regulation. This system promises to enhance security and streamline access management in controlled environments, making it an invaluable tool for various applications.**

***Index Terms*—Embedded Technology, LoRaWAN-based Vehicle Access.**

I. INTRODUCTION

The "Long Range WAN Based Alerting System for Restricted Area" presents a comprehensive solution to address security and access control challenges within controlled environments. In today's world, ensuring the safety and integrity of restricted premises is of paramount importance, whether it's a private property, an industrial site, or a secure facility. This paper aims to provide a robust, adaptable, and efficient system to meet these demands. The foundation of this system lies in its use of LoRaWAN (Long Range Wide Area Network) technology. The system employs three LoRaWAN modules: 2 integrated into vehicles and the other strategically placed within the restricted premises. These modules enable seamless, long-range communication, allowing real-time monitoring and control of vehicular access.

The heart of the system is an Arduino-based controller, chosen for its versatility, reliability, and compact size. This controller serves as the central brain, orchestrating the interactions between vehicles and the restricted premises. It facilitates a range of functionalities, from managing access permissions to ensuring compliance with speed limits, making it a versatile and adaptable solution. To enhance security and convenience, a push button interface is incorporated, activating a 5V buzzer through a relay module. This feature offers an audible signalling mechanism, which can be invaluable for alerting personnel or drivers to specific situations or conditions.

II. LITERATURE REVIEW

1. Abu et al., in this paper, the author developed a home automation system using an android phone and a Raspberry Pi. Communication was established between a server and a relay module which was connected to appliances for monitoring and controlling. However, the Raspberry Pi is expensive compared with other options such as a microprocessor. In addition, a remotely placed system is constrained by power requirement. Therefore, in wireless communication, high power consumption by the associated devices within the system to operate is a great concern. Modular hardware design and integration of renewable energy sources have been suggested to overcome this power constraint.

2. More et al. In this paper, the author developed a system for monitoring home equipment where the authors used a Wireless Sensor Network (WSN) and Message Queuing Telemetry Transport (MQTT) protocol to interact between home appliances and users. For some selective sensors, WSN runs out of energy.

3. Shahjalal et al. In this paper, the author proposed a LoRa based smart home system for remote monitoring. The potential of integrating artificial intelligence (AI) with IoT servers and clouds for serving intelligent tasks in the home environment were also explored.

4. Gambi et al. In this paper, the author proposed an IoT based architecture of a home automation system using LoRa and Message Queuing Telemetry Transport (MQTT) protocol that could cover multistorey large buildings without multiple gateways. The authors tried to figure out how a low-power and low-cost but long-range communication device could be developed for making IoT-based solutions. They used the LoRa module which provided low latency in message delivery for the development of their methodology. The MQTT protocol in their system acted as middleware where interoperability among different devices was obtained through the protocol. However, compared to the proposed system in this study, the major limitation of the system was its inability to provide acceptable quality of services and could not work through multiple nodes.

5. Islam et al. In this paper, the author suggested a home automation system design using LoRaWAN, server based LoRa gateway, and Bluetooth connectivity for covering both short- and long-range communication. An Android application was developed to control the home appliances and to keep smart communications among all the connected devices. The system attained a usability scale score of 93% after calculating transmission delay and coverage area. However, the LoRa gateway used in their system was costly and not quite flexible to manage in comparison to the LoRa modules used in both the sender and receiver sides in this work.

6. Ali et al. In this paper, the author has developed a ZigBee and LoRa based communication system which was tested at Yildiz Technical University campus in Istanbul, Turkey. The system was developed using a central receiver unit with LoRa and ZigBee transceiver modules, a microcontroller, temperature and humidity sensors and a relay unit. ZigBee or LoRa transceiver modules were responsible for sending temperature and humidity data from the sensors to a central receiver unit. The reported results provided the effectiveness of their system as low- power and suitable for long-range smart IoT based applications. The system was only tested for 400 m in comparison to several hundred kilometres in this work.The system was not developed to connect to any mobile application on an android platform for controlling the appliances.

7. Bravo-Arrabal et al. In this paper, the author developed a LoRa-based low power consumption static and mobile wireless sensors network to attain a wide coverage in an urban environment. The technology was deployed in a mid-size city (Malaga, Spain) where a mobile node was developed by a gateway and sensors. Activation by Personalization (ABP) mode was used for multicasting in urban areas for managing the coverage through communicating data between the end devices and the gateways. The data collected from the city was synchronised in an external database. Web mapping services used in the system can monitor data in real time by geolocating data frames. The experiments showed that it can cover 12 km distance during exchanging information with vehicles, objects etc. on the road of Malaga.

8. Zhang et al. In this paper, the author proposed an emergency light-based smart building solution to reduce system deployment and maintenance cost using a LoRa mesh network with one gateway. The system deployed nine types of building including residential and commercial as a case study. The results showed that the proposed system achieved over 97% average packet delivery rate. The system also performed well during the changing environment. However, the system could be further improved by a user interface to facilitate remote monitoring of appliances in the building.

9. Xu et al. In this paper, the author has proposed a LoRa system where large-scale and temporal fading characteristic, coverage, and energy consumption were analysed in four individual buildings for measuring its performance. Different measurement parameters in their study were varied for up to 145

times enabling the LoRa adaptive data rate feature in energy limited applications. However, the proposed system was tested only for indoor application. From the smart home point of view, indoor localization is very important in order to identify locations of people or devices within a multi-floor building.The author conducted an experiment for assessing feasibility of LoRa for the application of indoor localisation in an apartment. The results showed that the LoRa based system achieved better localisation accuracy of a robot integrated with sensors compared to in line-of-sight scenario (1.6 m) and in extreme non-line-of-sight scenario (3.2 m) condition with a precision better than 25 cm. However, the authors did not explore the opportunity of integrating a mobile application with the system.

10. Yasmin et al. In this paper, the author deployed indoor sensor network devices connected over low power wide area network (LPWAN) technology for monitoring a campus indoor environment. Their work was focused on identifying the reasons for the packet loss, which was approximately 8.56% both during the on-air transmission and within the backbone. Nonuniform distribution of the packet transmissions caused by nodes in the networks was identified. Furthermore, the seasonal effects on packet delivery and effects of interferences on network performance were observed.

III. METHODOLOGY

The proposed system, the "Automobile Controlling System for Restricted Premises," is an innovative and comprehensive solution designed to address security and access control challenges within restricted areas. It involves implementing a system comprising three LoRaWAN modules, two functioning as receivers integrated with Arduino Nano boards installed on bikes, and one as a transmitter mounted on a restricted premise. The system includes a push button with a 5V buzzer connected to a relay for horn functionality, controlled through the Arduino Nano on the bike. An L293D motor driver module, with a potentiometer acting as an accelerator, governs the speed limit of a prototype motor set at 1000 rpm. A 9V battery powers the entire circuit. Together, these components form a comprehensive system that enhances security, access control, and vehicular safety in restricted environments.

Block Diagram

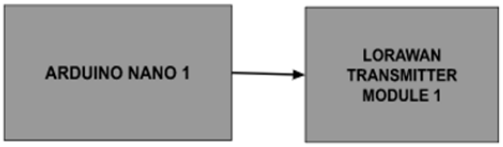

Fig. 1 Shows the Transmitter System

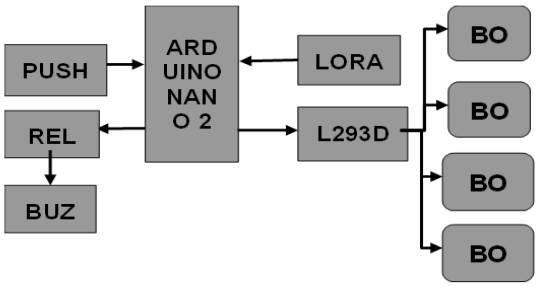

Fig. 2 Shows the Receiver System

Description

Block Diagram 1 - rst Block Diagram shows the Transmitter system which shows that in this paper we used Arduino Nano as a microcontroller, and we used a Lorawan SX1278 Module as an output device.

Block Diagram 2 - Second Block Diagram shows the receiver module which shows that we used Arduino nano as a microcontroller, and we used a lorawan receiver module and a push button as an input device in it. And the L293D Motor Driver, four BO motors and buzzer as an output device.

Flow Chart

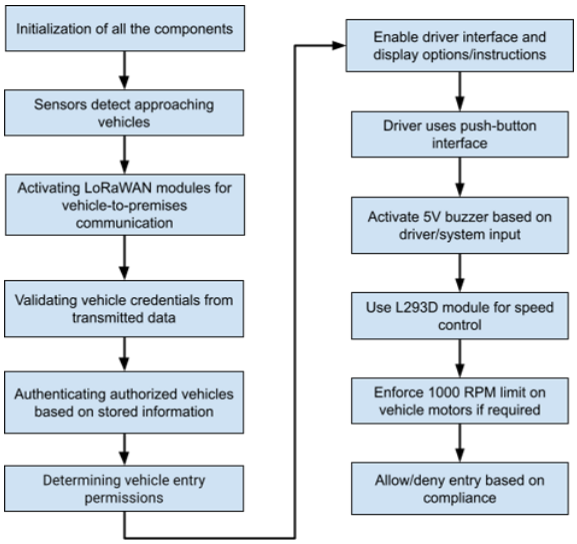

Fig. 3 Shows the Flowchart of the System

Circuit Diagram

Working

The proposed system uses LoRaWAN technology to control access and vehicle movement inside restricted hospital and college zones. A LoRa transmitter installed at the restricted location continuously broadcasts a signal. When a vehicle equipped with a LoRa receiver enters the area, the Arduino Nano detects the signal and activates safety features. The relay triggers a buzzer or horn alert, while the L293D motor driver limits the BO motor speed to ensure slow and safe movement. As long as the vehicle remains inside the signal range, controlled operation is enforced. Once the vehicle exits the restricted zone and signal is lost, the system automatically returns the vehicle to normal mode, ensuring secure, intelligent, and contactless access regulation.

IV. SYSTEM REQUIREMENT

Hardware Requirement

1] Arduino Nano *2
2] Lorawan Sx1278 transmitter and receiver module
3] L293D Motor Driver
4] BO motors *4
5] Buzzer
6] Relay
7] Push button
8] 3.7V battery *2

Software Requirement

1] Arduino IDE
2] Proteus

V. EXPERIMENTAL SETUP & RESULT

Experimental Setup

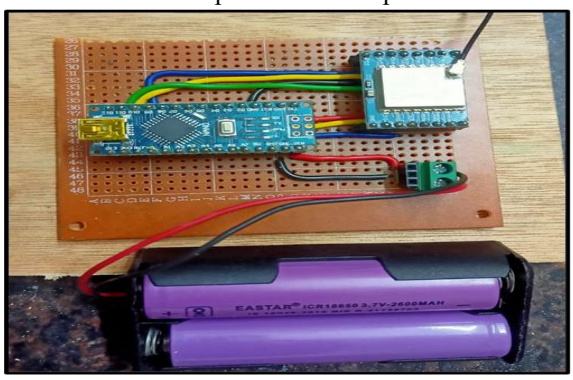

Fig. 5 Shows the Experimental Setup of the Transmitter system

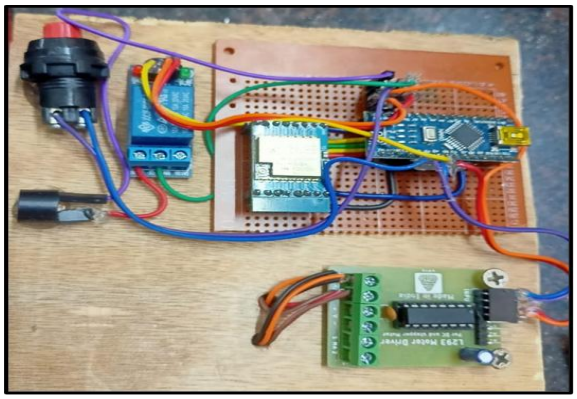

Fig. 6 Shows the Experimental Setup of the Receiver System

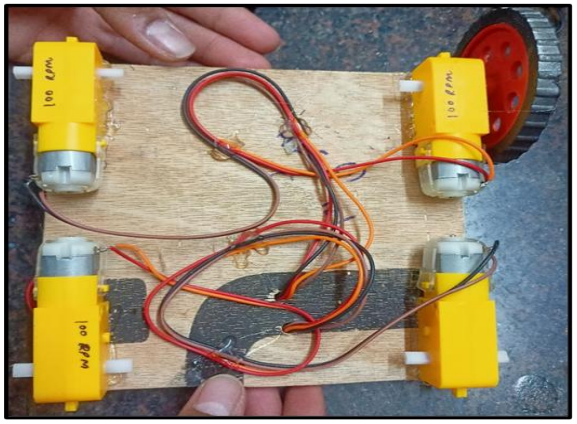

Fig. 7 Shows the Experimental Setup of the Receiver System

Result

The implementation of the system demonstrates a successful integration of LoRaWAN modules and Arduino Nano boards to enforce security measures and access control within restricted areas. By utilizing a transmitter-receiver setup, the system effectively regulates vehicle access, enhancing the overall security of the premises. Additionally, the incorporation of features such as horn functionality and speed limit control contributes to improved vehicular safety within the restricted environment. The successful demonstration of this prototype underscores its potential to be scaled and deployed in various restricted premises, providing a robust solution for addressing security and access control challenges.

VI. CONCLUSION

In conclusion, the system offers a robust and versatile solution to the pressing challenges of security, access control, and vehicular safety in controlled

environments. By leveraging LoRaWAN technology, an Arduino-based controller, and additional components, this system enhances security measures, ensures compliance with speed limits, and optimises access management, ultimately contributing to a safer and more efficiently managed restricted premise. Its potential applications extend to a wide range of scenarios, making it a valuable tool for enhancing security and control in various environments.

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