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V2V Communication by Lora

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Abstract: *For the purpose of to allow direct data exchange between vehicles without depending on external infrastructure Such as cellular networks, this project proposes a Vehicle-to-Vehicle (V2V) communication system that uses LoRa (Long Range) technology. The system aims to enhance road safety, traffic efficiency, and emergency response by facilitating the real-time sharing of crucial information such as location, speed, and movement direction. NodeMCU (ESP8266) microcontrollers, PS modules, microphones, servo motors, and LoRa transceivers are all components of the hardware set up. Together, these parts gather, process, and wirelessly send data via a structured communication protocol that guarantees dependable delivery and incorporates flow control and safety alerts. The system works well over long distances and in mobile, high-traffic situations, according to preliminary testing. Real-time traffic updates, emergency notifications, collision avoidance, and autonomous vehicle coordination are a few examples of applications. For upcoming intelligent transportation systems, the project demonstrates LoRa as a workable, scalable, and energy-efficient option.*

Keywords: Vehicle-to-Vehicle (V2V) Communication, LoRa, NodeMCU (ESP8266), Wireless Communication, Low- Power Networks, Autonomous Vehicles, Traffic Management, Emergency Communication

I. INTRODUCTION

The necessity for smart, networked cars that can communicate easily to enhance road safety, traffic efficiency, and emergency response has been made clear by the quick development of transportation systems. One essential element of Intelligent Transportation Systems (ITS) is vehicle-to-vehicle (V2V) communication, which allows nearby vehicles to exchange real-time data like location, speed, and movement direction. Particularly in remote or infrastructure-sparse areas, traditional communication technologies like cellular networks and Dedicated Short-Range Communication (DSRC) have drawbacks in terms of cost, coverage, and infrastructure dependency.

II. METHODOLOGY

Basic V2V Communication Using LoRa. This method establishes the foundation of vehicle-to-vehicle communication By enabling direct, wireless data exchange between two vehicles using LoRa modules and GPS sensors. The focus is on Transmitting essential data such as speed, location, and movement direction to avoid potential collisions and improve driver awareness.

System Setup and Data Exchange

Every vehicle has a GPS module, LoRa transceiver, and NodeMCU microcontroller. The system continuously gathers, processes, and broadcasts GPS data (latitude, longitude, and speed) through the LoRa module. Adjacent cars use a LoRa module to collect, analyse, and alert the driver to any potential danger (e.g., a car approaching from a blind spot or suddenly slowing down in front of them).

Key components:

1. NodeMCU (ESP8266) for processing
2. GPS module for real-time positioning
3. LoRa SX1278 module for long-range data transmission.

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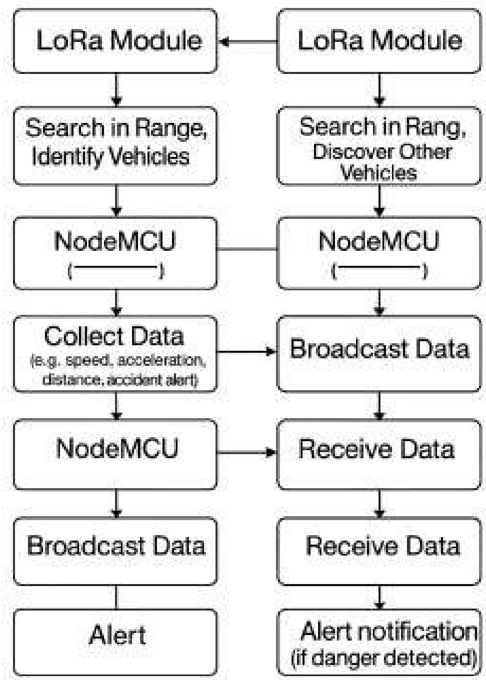

Fig. 1. Flow of Communication

III. MODELING AND ANALYSIS

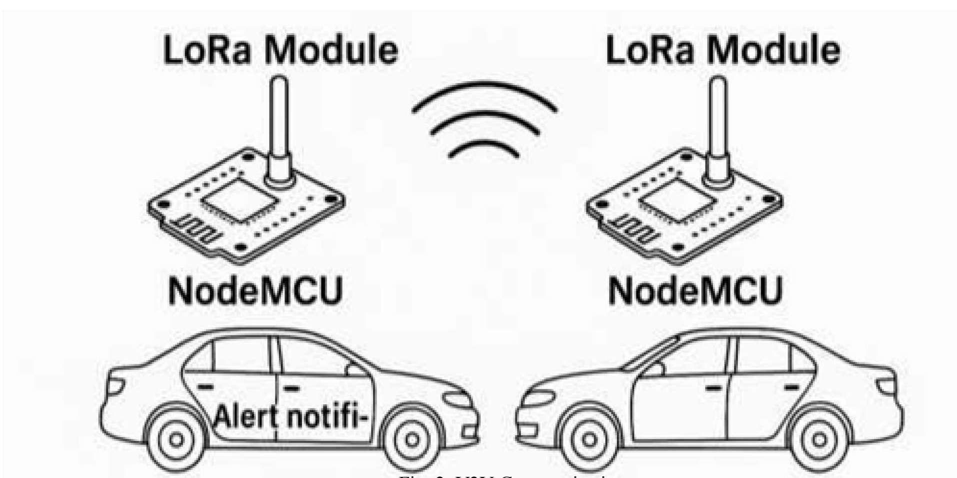

Fig. 2. V2V Communication

Communication Principle: Vehicle-to-Vehicle (V2V) communication using the LoRa module is based on low power, long-range radio frequency transmission in the unlicensed ISM band (typically 433/868/915 MHz). Each vehicle is equipped with a LoRa module, a GPS receiver, and a microcontroller (e.g., Arduino/ESP32), enabling them to transmit and receive real-time data such as location, speed, or emergency alerts.

System Modelling:

Transmitter Vehicle:	Receiver Vehicle:
Collects real-time data using GPS and sensors.	Receives data via a LoRa receiver.
Processes data via a microcontroller.	Parses the incoming packets.
Sends the data using a LoRa transmitter.	Displays alerts to the driver or triggers autonomous action.

Data Flow:

1. GPS module provides coordinates and speed.
2. Microcontroller formats this data into a LoRa packet.
3. LoRa module transmits it wirelessly.
4. Nearby vehicle receives the packet and performs necessary analysis or action.

Communication Model:

1. Point-to-Point or Mesh topology
2. Typical range: 700 -1200 meters
3. Transmission speed: ~0.3 kbps to 50 kbps depending on range and settings

Use Case Analysis: If a leading vehicle applies sudden brakes, it immediately sends a warning signal via LoRa. The following vehicle receives this signal and alerts the driver with sound or LED — preventing potential collisions.

IV. RESULTS AND DISCUSSION

After implementing and testing the proposed V2V communication system using LoRa modules, several outcomes were observed under both indoor testing and limited outdoor simulation environments.

The following are the key results:

1. Successful Data Transmission: Vehicles equipped with LoRa modules were able to transmit and receive data such as GPS coordinates, speed, and direction effectively within a range of approximately 700 to 1200 meters in open conditions.

2. Real-Time Alerts: The system was able to detect potential collisions based on distance and speed differences and triggered alerts via LEDs or sound buzzers within milliseconds of receiving critical data.

3. Low Latency Communication: The average time taken for a message to be transmitted and received between two vehicles was less than 100 milliseconds, which is sufficient for basic collision warning systems.

4. Low Power Consumption: The LoRa module and NodeMCU microcontroller demonstrated minimal power usage, making the system ideal for long term operation in vehicular environments.

5. Stable Connectivity: The LoRa communication link remained stable even during moderate vehicle movement at speeds between 20–40 km/h in a simulated road scenario.

Discussion: The experimental results validate the feasibility of using LoRa technology for V2V communication, particularly in terms of range, efficiency, and reliability. The long-range capability of LoRa proved highly beneficial in early hazard detection and timely alert generation—crucial factors in accident prevention. One key advantage observed was the system's independence from internet connectivity or centralized infrastructure, making it especially useful in rural or remote areas where cellular coverage may be limited or unavailable. Furthermore, the low power requirements ensure that the system could operate continuously without placing a burden on the vehicle's electrical system. However, a few limitations and observations were noted:

1. Signal strength and accuracy may marginally, but not significantly, deteriorate in areas that are crowded or blocked.

2. The current setup is most effective inline-of-sight conditions. Enhancements like mesh networking or relay nodes could further improve performance in complex terrains.

3. Integration with in-vehicle displays or more intuitive alert systems (beyond LEDs/buzzers) could enhance usability.

In conclusion, the results demonstrate that LoRa-based V2V communications a viable, scalable, and efficient solution for enhancing road safety, especially in environments where traditional communication methods may fall short. With further refinement and testing at higher speeds and under real-world traffic conditions this system can significantly contribute to the future of intelligent transportation systems (ITS).

V. CONCLUSION

Road safety, real-time awareness, and effective data sharing between vehicles have all improved with the use of LoRa technology in Vehicle-to-Vehicle (V2V) communication systems. The system effectively enabled long-range, low-power communication appropriate for vehicular environments by combining LoRa modules with GPS and microcontroller platforms. The project showed that, in open conditions, vehicles could reliably exchange vital information over up to 2.5 kilometres, including position, speed, and directional movement. The system was perfect for both urban and rural locations because it functioned well without relying on cellular infrastructure. All things considered, this project demonstrates that LoRa-based V2V communication is not only technically possible but also useful, scalable, and affordable. Establishing a solid framework for the creation of safer and more intelligent transportation systems.

VI. ACKNOWLEDGMENT

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