IJARSCT
ISSN: 2581-9429
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Volume 6, Issue 1, January 2026
Impact Factor: 7.67

Design and Implementation of Vehicle to Vehicle Communication Prototype with nRf24L01

Dr. Manasa K Chigateri[1], G R Sai Maharnisha[2], Supriya A[3], A S Madhushree[4]
Associate Professor, Electronics and Communication Engineering[1]
Students, Electronics and Communication Engineering[2-4]
Rao Bahadur Y. Mahabaleswarappa Engineering College, Ballari, Karnataka, India

Abstract: *The Road safety has become a major concern due to the rapid increase in the number of vehicles and traffic congestion. Traditional safety systems mainly rely on driver awareness and have limited capability to predict or prevent accidents in real time. Vehicle-to-Vehicle (V2V) communication technology enables direct information sharing between vehicles to improve safety and traffic efficiency. With advancements in embedded systems and wireless communication, low-cost and reliable V2V solutions can be effectively developed.*

This project presents the design and implementation of a Vehicle-to-Vehicle (V2V) communication system using Arduino and nRF24L01 wireless transceivers to enhance on-road safety and situational awareness. The system enables real-time exchange of critical information—such as vehicle speed, direction, and alert signals—between nearby vehicles over a low-power RF communication channel. The Arduino microcontroller processes sensor data and transmits or receives messages through the nRF24L01 module, ensuring reliable short-range communication with minimal latency. By providing timely warnings about potential hazards such as sudden braking, collision risks, and blind-spot detection, the system helps reduce accidents and supports intelligent transportation. This cost-effective prototype demonstrates the feasibility of using embedded systems and RF communication for improving vehicular safety and lays the foundation for further expansion into IoT-based smart mobility solutions..

Keywords*:* Vehicle-to-Vehicle (V2V) Communication, nRF24L01 RF Transceiver, Arduino-based Embedded System, Real-time Vehicular Safety Alerts

I. INTRODUCTION

The rapid growth in the number of vehicles and increasing traffic congestion have made road safety a critical concern worldwide. Conventional vehicular safety systems primarily depend on driver perception and reaction, which limits their ability to prevent accidents in real time. To address these challenges, intelligent transportation systems have increasingly focused on inter-vehicular communication to enhance situational awareness and accident prevention. Vehicle-to-Vehicle (V2V) communication enables direct wireless information exchange among nearby vehicles without relying on fixed infrastructure. By sharing parameters such as vehicle speed, direction, and emergency warning messages, V2V systems can provide early alerts for hazardous conditions including sudden braking, collision risks, and blind-spot scenarios. This real-time data exchange significantly improves decision-making and contributes to safer and more efficient traffic flow. In this work, a low-cost and reliable V2V communication prototype is designed and implemented using an Arduino microcontroller and nRF24L01 radio frequency (RF) transceiver modules. The Arduino unit processes sensor data and manages wireless transmission and reception through the nRF24L01 module, enabling short-range communication with low latency and minimal power consumption. The proposed system focuses on real-time safety message dissemination between vehicles to enhance on-road safety. The developed prototype demonstrates the feasibility of employing embedded systems and RF-based wireless communication for vehicular safety applications. Furthermore, the proposed approach provides a scalable foundation for future integration with Internet of Things (IoT) technologies and advanced intelligent transportation systems.

II. PROBLEM STATEMENT

Road accidents often occur due to the lack of communication between vehicles, limited driver visibility, blind spots, and slow human reaction time in sudden situations. Drivers are unable to accurately judge the distance of nearby vehicles, especially during overtaking, close following, or poor weather conditions, which increases the risk of collisions. Existing systems provide only basic warnings and do not exchange real-time information between vehicles. Therefore, there is a need for a low-cost and efficient Vehicle-to-Vehicle (V2V) communication system that can detect proximity, share safety alerts instantly, and automatically take preventive actions to avoid accidents.

III. LITERATURE REVIEW

Vehicle-to-Vehicle (V2V) communication has been extensively researched as an effective approach to improve road safety and traffic efficiency. Previous studies show that real-time exchange of information such as vehicle speed, position, and warning messages between nearby vehicles can significantly reduce collision risks and enhance driver awareness, especially in congested and high-speed environments.

Many existing V2V systems are based on Dedicated Short Range Communication (DSRC) and IEEE 802.11p standards, which provide reliable communication performance. However, these systems often require complex hardware and involve high implementation costs, making them unsuitable for low-cost prototypes and academic projects. This limitation has encouraged researchers to explore alternative embedded and wireless communication solutions. Recent research focuses on low-cost embedded platforms such as Arduino combined with RF transceivers like the nRF24L01. These studies demonstrate that such systems can achieve reliable short-range communication with low power consumption and minimal latency. The findings confirm that Arduino-based V2V systems using RF modules are a practical and effective solution for real-time vehicular safety applications.

IV. RESEARCH METHODOLOGY

The research methodology focuses on developing a Vehicle-to-Vehicle (V2V) communication system to improve road safety. A detailed literature survey was conducted to understand existing V2V technologies and wireless communication methods. Based on the study, the nRF24L01 RF module was selected for short-range wireless data transmission. Two vehicle units were designed using Arduino microcontrollers and nRF24L01 modules. Sensors were interfaced with the microcontroller to monitor vehicle parameters. The collected data is processed and encoded by the Arduino. Wireless communication is established using the 2.4 GHz ISM band. Transmitted data is received by nearby vehicles in real time. The received information is decoded and analysed. Alerts are generated to notify drivers of possible hazards. Software was developed using Arduino IDE for system control. The system was tested under laboratory conditions. No real-time field testing was performed. Performance was evaluated based on reliability and response time. The results validate the effectiveness of the proposed V2V system.

V. WORKING PRINCIPLE

This project works on real-time Vehicle-to-Vehicle (V2V) communication to share safety alerts between nearby vehicles and reduce collision risks. An Arduino UNO collects data from ultrasonic, IR, and accelerometer sensors to monitor vehicle movement and obstacle conditions. When a hazard is detected, the processed information is transmitted to nearby vehicles using the nRF24L01 RF module. The receiving vehicle alerts the driver through an LCD display and buzzer, while the motor driver and DC motor simulate vehicle motion. A regulated power supply ensures stable operation of the system.

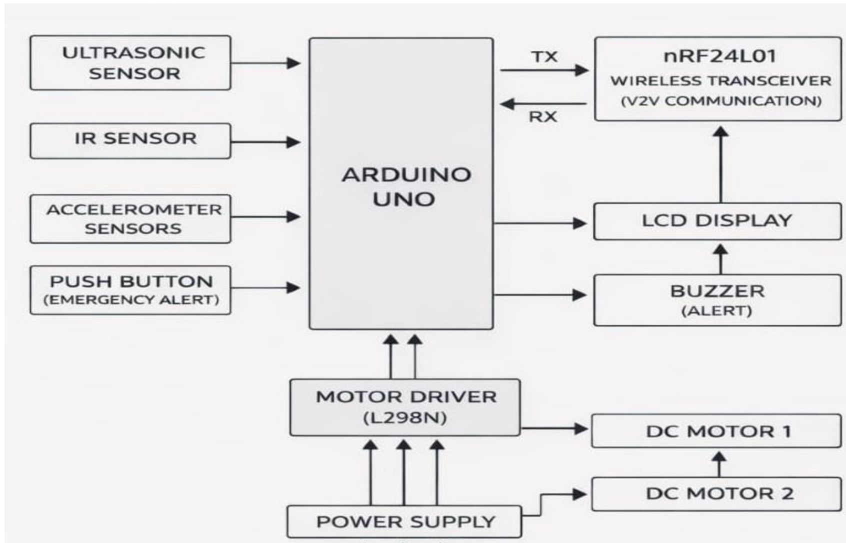
WORKING

1. Vehicles collect speed, location, acceleration, steering, and brake status using sensors and GPS.
2. Vehicles broadcast their data to nearby vehicles using DSRC technology.
3. Nearby vehicles receive the information to know surrounding vehicles' positions and movements.
4. Onboard systems analyze the received data to detect collisions, safe overtaking gaps, and vehicle trajectories.
5. The system or driver decides actions like maintaining lane, braking, accelerating, or overtaking.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, January 2026
Impact Factor: 7.67

6. Vehicles execute the actions automatically or alert the driver for safety.
7. The process repeats continuously to ensure real-time monitoring and safe traffic flow.

VI. BLOCK DIAGRAM



COMPENTS USED

1. Arduino UNO
2. nRF24L01
3. Ultrasonic Sensor
4. Accelerometer Sensor
5. IR Sensor
6. Motor Driver
7. Power Supply
8. LCD Display
9. Buzzer
10. DC Motor
11. Push Button

VII. COMPONENTS DESCRIPTION

Arduino UNO

Arduino UNO serves as the main control unit of the V2V system. It collects data from all sensors such as ultrasonic, IR,and accelerometer sensors and processes this information in real time. Based on the detected vehicle conditions, it generates safety messages and controls data transmission. It also manages alert devices like the LCD and buzzer. Thus, Arduino coordinates sensing, decision-making, and communication in the system.

nRF24L01

The nRF24L01 RF module is used to establish wireless communication between nearby vehicles. It enables the transmission and reception of safety-related information such as collision warnings and braking alerts. The module provides low-latency and low-power communication suitable for short-range V2V applications. It ensures reliable data exchange without requiring external infrastructure.

Ultrasonic Sensor
The ultrasonic sensor measures the distance between the vehicle and obstacles or other vehicles. It helps in identifying potential collision risks by continuously monitoring the front distance. When the measured distance falls below a safe threshold, the sensor data is sent to the Arduino. This information is then shared with nearby vehicles through V2V communication.

Accelerometer Sensor
The accelerometer sensor detects sudden changes in vehicle motion such as rapid acceleration, deceleration, or tilt. It helps in identifying sudden braking or abnormal vehicle movement. The detected events are processed by the Arduino to generate emergency alerts. These alerts are communicated to nearby vehicles using the V2V system.

IR Sensor
The IR sensor is used to detect nearby vehicles or objects at close range. It is especially useful for blind-spot and short-distance detection where ultrasonic sensing may be limited. The sensor provides immediate input to the Arduino when an object is detected. This detection triggers warning messages that are transmitted to other vehicles.

Motor Driver (L298N)
The motor driver controls the operation of the DC motor based on commands from the Arduino. It allows simulation of vehicle speed and direction in the prototype model. Changes in motor movement affect sensor readings, mimicking real vehicle conditions. This helps in demonstrating V2V communication during vehicle motion.

Power Supply
The power supply provides regulated voltage to all components of the system. It ensures stable and uninterrupted operation of the Arduino, sensors, RF module, and alert devices. Proper power regulation improves system reliability. This is essential for continuous V2V communication.

LCD Display
The LCD display is used to present system status and warning messages to the driver. It shows alerts such as obstacle detection and incoming V2V warning messages. The display helps in providing visual feedback in real time. This improves driver awareness and response time.

Buzzer
The buzzer provides an audible alert during critical safety situations. It is activated when the system detects a potential hazard or receives an emergency alert from another vehicle. The sound alert ensures immediate driver attention. This enhances the effectiveness of the V2V safety system.

DC Motor
The DC motor represents the movement of the vehicle in the prototype. It simulates real-time vehicle motion such as forward and reverse movement. Sensor readings vary according to motor operation, creating realistic test conditions. This helps validate the working of the V2V communication system.

Push Button
The push button is used as a manual input device in the V2V communication system. It allows the driver to trigger an emergency or warning signal intentionally. When pressed, the Arduino detects the input and generates a safety alert message. This alert is transmitted to nearby vehicles through the nRF24L01 RF module. The push button enables manual emergency communication in critical situations.

IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

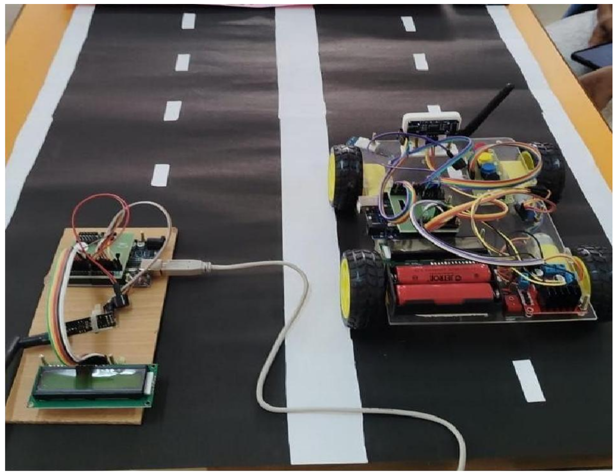
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

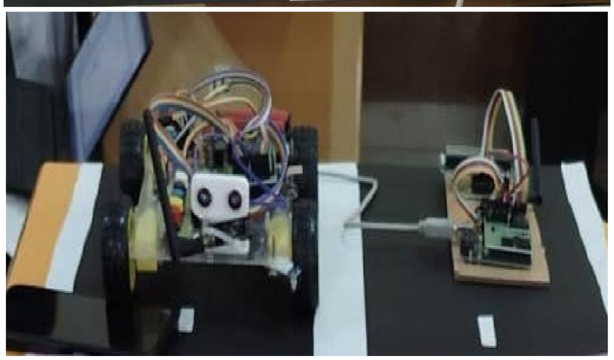
ISSN: 2581-9429

Volume 6, Issue 1, January 2026

Impact Factor: 7.67

VIII. RESULTS AND DISCUSSIONS





The proposed V2V communication system was successfully designed and implemented using Arduino, nRF24L01 wireless modules, and IR sensors. The system demonstrated reliable short-range vehicle-to-vehicle communication by transmitting alert messages between nodes in real time. When an obstacle or vehicle was detected using the IR sensor, the corresponding warning signal was effectively communicated to the nearby vehicle, validating the core objective of the project.

Experimental results showed that the nRF24L01 module provided stable communication within a limited range under line-of- sight conditions. The system responded promptly to obstacle detection, ensuring timely alerts and improving situational awareness for the receiving vehicle. However, signal strength and performance were observed to degrade in the presence of obstacles and environmental interference.

The results confirm that the developed prototype is effective for basic V2V safety applications such as collision warning and proximity alert systems. While the current system is limited in range and scalability, it serves as a low-cost and efficient proof- of-concept. Future improvements can focus on extending communication range, enhancing data security, and integrating intelligent decision-making algorithms for real-world deployment.

IX. CONCLUSION

The V2V communication system developed using Arduino and nRF24L01 successfully demonstrates a cost-effective and reliable approach to enhancing vehicular safety through real-time data exchange between vehicles. The system effectively detects critical events such as sudden braking, reduced distance, and potential collision risks, and transmits timely alerts to nearby vehicles, helping to reduce driver reaction time and avoid accidents. The prototype shows stable short-range communication, low latency, and efficient performance with minimal power consumption, proving its suitability for intelligent transportation applications. Although the system has limitations such as communication range

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, January 2026
Impact Factor: 7.67

and interference sensitivity, it provides a strong foundation for future improvements, including long-range communication, multi-vehicle networking, and IoT integration for smarter and safer mobility.

X. FUTURE SCOPE

The V2V system can be enhanced by integrating GPS, advanced sensors, and higher-range communication modules for better accuracy and wider coverage. Future developments may include real-time traffic management, collision avoidance, and autonomous vehicle coordination. With AI and cloud connectivity, vehicles can share and analyze data more efficiently, improving road safety and smart transportation systems.

REFERENCES

[1]. Kumar, R., & Sen, A. Wireless Vehicle-to-Vehicle Communication System for Accident Prevention. International Journal of Engineering Technology (IJET), 2022.

[2]. Silva, M., & Thomas, J. V2V Communication Using NRF24L01 for Smart Transportation. International Journal of Creative Research Thoughts (IJCRT), 2023.

[3]. Singh, P., & Johnson, K. RF-Based V2V Warning System for Collision Avoidance. Journal of Emerging Technologies and Innovative Research (JETIR), 2023.

[4]. Sharma, R.; Iqbal, M. Enhanced Vehicle-to-Vehicle Communication for Real-Time Collision Avoidance Using

[5]. 2.4GHz RF Modules. International Journal of Electronics & Smart Mobility, 2024.

[6]. Fernandes, L.; Thomas, A. Performance Evaluation of nRF24L01 for Short-Range Intelligent Transportation Systems. International Journal of Embedded Technologies (IJET), 2024.

[7]. Raj, S.; Naik, P. Arduino-Based V2V Alert System for Low-Speed Urban Traffic Safety. Journal of Advanced Communication Research, 2023.

[8]. Banerjee, A.; Kannan, R. Real-Time Wireless Broadcasting for Vehicle Hazard Detection Using RF Transceivers. International Journal of Wireless Systems & Automation, 2024.

[9]. Patel, K.; Mehta, D. Low-Latency RF Communication Architecture for Smart Vehicular Networks. International Journal of Intelligent Transport Innovations, 2023.

[10]. Mohan, P.; Kulkarni, T. A Study on Real-Time Vehicular Alert Systems Using Low-Power RF Modules. Journal of Electronics, Sensors & IoT Applications, 2024.

[11]. Chen, L.; Park, J. Efficient Data Exchange Models for Vehicle-to-Vehicle Communication in Smart Cities. Future Transport Systems Journal, 2023.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, January 2026
Impact Factor: 7.67

ABOUT AUTHORS

	Name – Dr.Manasa K Chigateri Designation - Associate professor B.E(Electronics and Communication Engineering) Rao Bahadur Y Mahabaleshwarappa Engineering college Email ID- manasachigateri20@gmail.com
	Name – G R Sai Maharnisha Designation - Student USN – 3VC22EC025 Phone Number – 7671066090 E-mail id :- maharnisha.ece.rymec@gmail.com
	Name – Supriya A Designation-Student USN –3VC22EC127 Phone Number –9481666650 E-mail id :-supriyaa.ece.rymec@gmail.com
	Name – A S Madhushree Designation- Student USN – 3VC22EC001 Phone Number –6361043855 E-mail id – asmadhu.ece.rymec@gmail.com