Development of a Lidar-Integrated Bluetooth Vehicle for Collision Prevention and Safety Alerts Using ESP32 Dev Module

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ABSTRACT

This study presents a LiDAR-based obstacle detection system for a small-scale, Bluetooth-controlled vehicle. The purpose of the system is to take precise distance measurements and to activate automatic detection and avoidance of obstacles. The integration comprises an ESP32 microcontroller, LiDAR sensor, motor driver, DC motors, LCD display, and buzzer, all governed by the Dabble mobile application. The vehicle keeps on measuring the distances and when an obstacle is within a 3 cm threshold, the forward movement is stopped and visual and auditory alerts are triggered. The testing done in a control indoor environment revealed that the system was able to detect obstacles, give precise distance readings and respond instantly with no delay all the time. The simultaneous alerts increased usability and safety. In general, the system is a dependable, user-friendly solution for small robotic vehicles and it has potential for wider applications in areas such as IoT and robotics.

Keywords: Intelligent Vehicle, ESP-32 Dev Module, LiDar Sensor, Dabble, Collision Prevention

INTRODUCTION

Road safety has grown to be a major worldwide concern in recent years due to rising traffic congestion and the increasing number of incidents that result in fatalities and injuries. As technology develops, the incorporation of sophisticated technology into automobiles has become a crucial tactic to improve driver safety and reduce collisions.

The development of microcontrollers, sensors, and communication technologies offers prospects for advanced car security systems that deal with these urgent problems. The project focuses on the development of an intelligent vehicle utilizing an ESP32 Dev Module as a microcontroller, known for its versatility and built-in Wi-Fi capabilities. By integrating a LiDAR sensor, the system gains the ability to perform obstacle detection. LiDAR technology, which measures distances by illuminating targets with laser light and analyzing the reflected pulses, provides high-resolution spatial data that enhances situational awareness.

LiDAR (Light Detection and Ranging) technology plays a crucial role in modern collision avoidance systems by providing accurate distance measurement and object detection. By emitting laser pulses and analyzing their reflected signals, LiDAR sensors generate precise spatial information about surrounding obstacles. Compared to traditional ultrasonic or infrared sensors, LiDAR offers higher resolution, better accuracy, and improved performance under varying environmental conditions. This makes it an effective solution for short-range collision prevention applications.

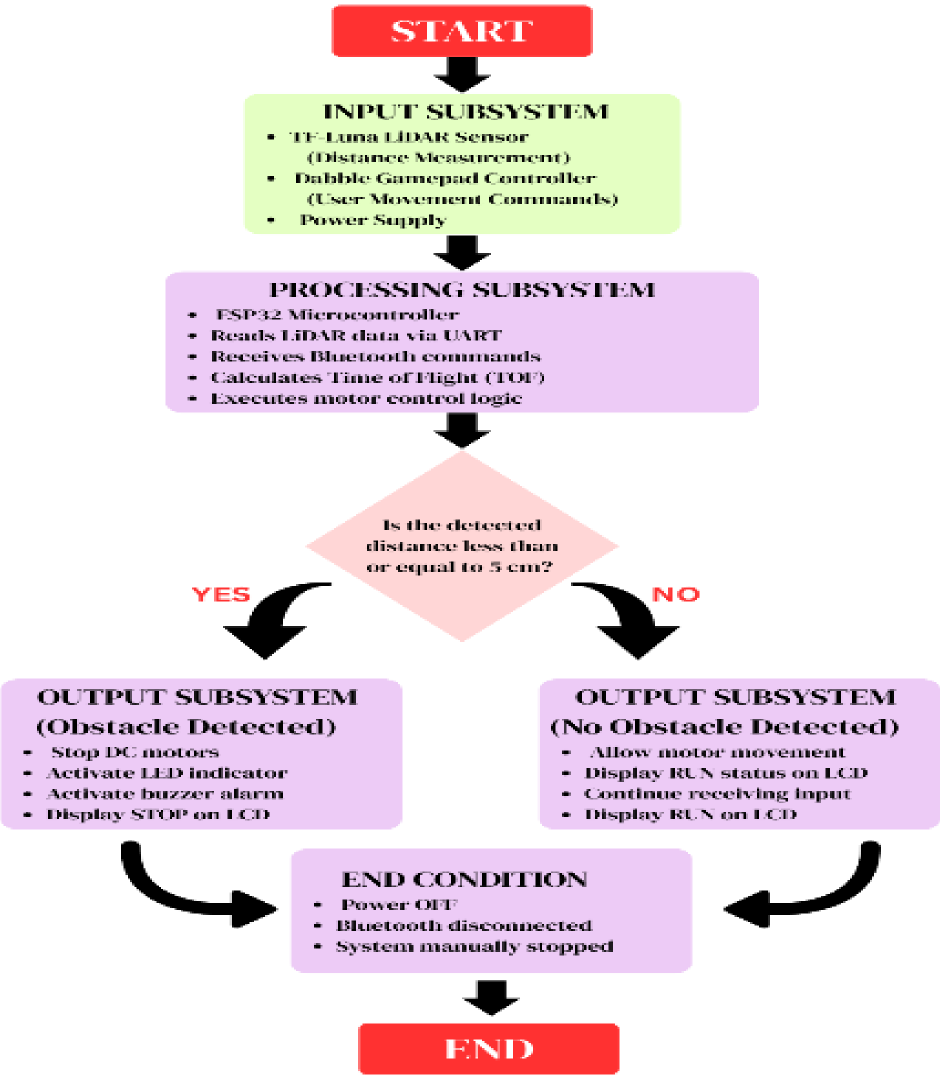
The system integrates a buzzer for audible alerts, an LED as a visual indicator for obstacle detection, and an LCD module for displaying distance information and warning messages. The primary objective of this project is to design and implement a low-cost, reliable, and scalable collision prevention prototype that demonstrates how embedded systems and sensor technologies can be applied to improve road safety. By combining LiDAR-based obstacle detection with wireless communication and alert mechanisms, the system aims to contribute to the advancement of intelligent vehicle safety solutions suitable for educational, research, and future real-world applications.

REVIEW OF RELEVANT THEORY, STUDIES, AND LITERATURE

Theoretical Framework

The theoretical framework establishes the scientific and engineering principles that guide the design, operation, and evaluation of the LiDAR-Integrated Bluetooth Vehicle for Collision Prevention and Safety Alerts. The system integrates LiDAR-based distance sensing, microcontroller processing using the ESP32, wireless Bluetooth communication, and automated control mechanisms to ensure safe vehicle operation and collision avoidance.

Figure 1. System Theory

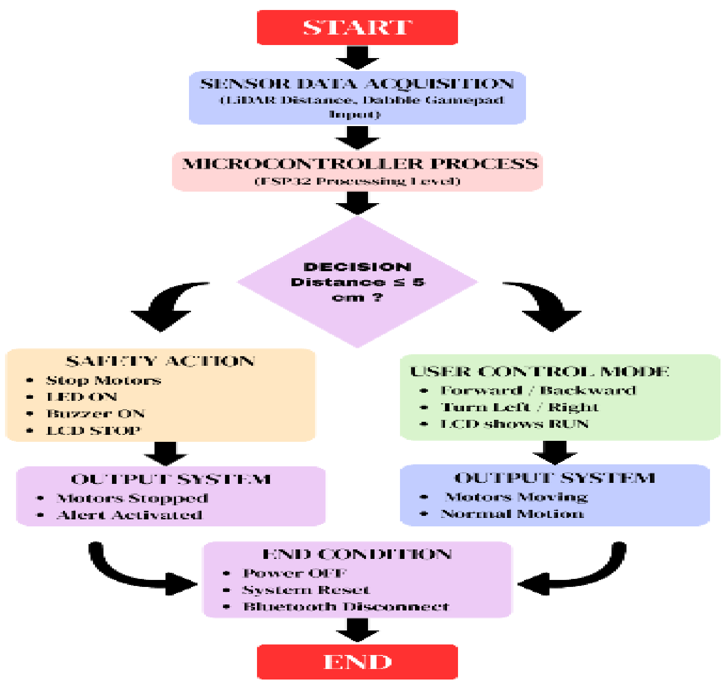


Systems Theory explains that a system functions through the interaction of interconnected components working together to achieve a common goal. In the LiDAR-Integrated Bluetooth Vehicle, the system is composed of multiple subsystems including the TF-Luna LiDAR sensor, Dabble gamepad controller, ESP32 microcontroller, motor driver, DC motors, LCD, LED, and buzzer. Each component performs a specific function, but effective collision prevention is achieved only when all subsystems operate cohesively. The LiDAR and gamepad serve as input sources, the ESP32 processes sensor data and user commands, and the output components execute movement control and safety alerts. This theory supports the system's architecture by emphasizing the coordination of inputs, processes, and outputs to ensure safe and reliable vehicle operation.

Figure 2. Input–Process–Output (IPO) Model

The Input–Process–Output (IPO) Model describes the functional flow of the LiDAR-Integrated Bluetooth Vehicle system. During the input stage, the TF-Luna LiDAR sensor provides real-time distance measurements while the Dabble gamepad supplies user movement commands via Bluetooth. In the process stage, the ESP32 receives and evaluates LiDAR data, interprets Bluetooth inputs, calculates time-of-flight values, and applies decision-making logic to determine whether movement is safe. During the output stage, the system controls the DC motors for vehicle motion or stopping, activates the LED and buzzer for warnings, and updates the LCD to display distance information and system status. Through this model, the system ensures consistent, predictable, and safe responses to both environmental conditions and user commands.

Figure 3. Embedded Systems Theory



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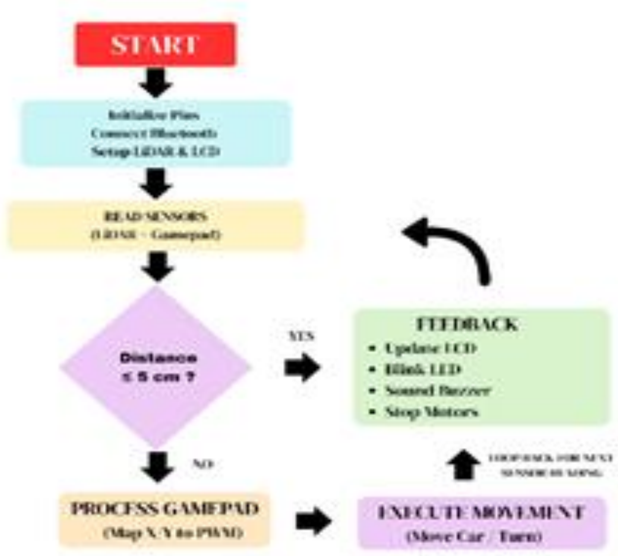
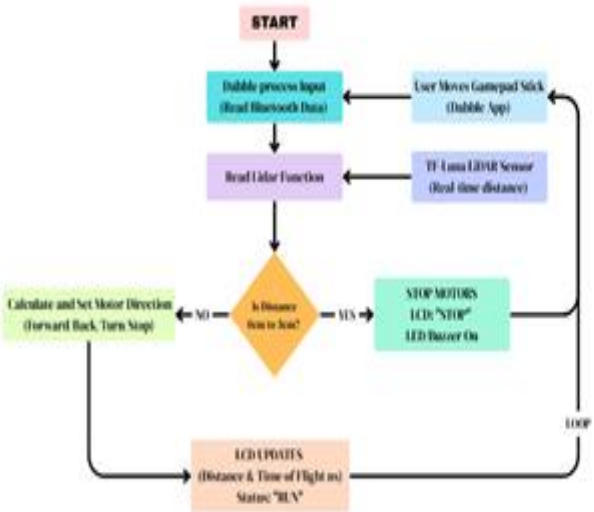
Embedded Systems Theory explains that microcontroller-based systems are designed to perform dedicated, real-time tasks with precise control over hardware components. In the LiDAR-Integrated Bluetooth Vehicle, the ESP32 functions as an embedded system that continuously monitors sensor data, processes Bluetooth commands, and executes motor and alert control logic. The ESP32 operates in a continuous loop, allowing it to respond instantly to changes in distance measurements or user input. This theory highlights the system's ability to deliver real-time collision detection, immediate safety responses, and stable operation through tight integration of hardware and software components.

Figure 4. Control Systems Theory



Control Systems Theory describes how systems regulate their behavior through feedback mechanisms to maintain safe and desired operation. In the proposed vehicle system, a closed-loop control structure is implemented using LiDAR feedback. The TF-Luna LiDAR sensor continuously measures the distance to obstacles and sends this information to the ESP32. When the detected distance is less than or equal to 5 cm, the controller overrides user commands, stops the motors, and activates visual and audio alerts. Once the obstacle is cleared, normal vehicle movement resumes. This control approach ensures automatic collision prevention, stable motion control, and enhanced system reliability.

Figure 5. Human–Computer Interaction (HCI)



Human–Computer Interaction (HCI) focuses on how users interact with systems in a clear, intuitive, and efficient manner. In the LiDAR-Integrated Bluetooth Vehicle, HCI principles are applied through the use of the Dabble mobile application as a gamepad controller, allowing users to easily control movement direction and speed. Visual feedback is provided through the LCD, which displays distance readings and system status, while LEDs and a buzzer communicate warning conditions. These interface elements reduce user confusion, enhance awareness of system status, and improve overall usability and safety during vehicle operation.

Framework Summary

The LiDAR-Integrated Bluetooth Vehicle is grounded in Systems Theory and the IPO Model for overall system structure and operational flow, Embedded Systems Theory for real-time processing and hardware-software integration, Control Systems Theory for safe and regulated motion control, and Human–Computer Interaction for intuitive user operation and feedback. Together, these theories guide the design and development of a functional, reliable, and safe collision-prevention vehicle system.

RELATED LITERATURE

The development of intelligent vehicle systems has received significant attention due to the increasing need for safer and more efficient transportation technologies. In academic research, small-scale vehicle systems are commonly used as experimental platforms for testing intelligent control mechanisms. These platforms allow researchers to study vehicle movement, wireless communication, obstacle detection, and collision prevention using compact and cost-effective components such as microcontrollers and sensors.

Bluetooth-based remote-controlled small-scale vehicle systems are widely explored due to their simplicity and reliability for short-range communication. Tie et al. (2024) developed a Bluetooth remote-controlled vehicle system using the ESP32 development module. The system utilized Bluetooth Low Energy to transmit control commands from a mobile device to the vehicle system. The study incorporated motor drivers, speed measurement modules, and control algorithms to improve motion accuracy and stability. The results demonstrated that the ESP32 can handle real-time control operations while maintaining low power consumption, making it suitable for small-scale vehicle applications.

Collision prevention is a major aspect of intelligent vehicle systems, particularly in small-scale vehicle systems used for experimental and educational purposes. Roy Tonmoy et al. (2023) conducted a comparative study on the use of LiDAR and ultrasonic sensors for obstacle avoidance in a small-scale vehicle system. The study evaluated sensor accuracy, detection range, and response time during obstacle detection tasks. The results indicated that LiDAR sensors offer higher precision and longer detection distances than ultrasonic sensors. This enables earlier obstacle detection, which is critical for effective collision avoidance and timely safety alerts in small-scale vehicle systems.

Further discussion on LiDAR technology was presented by Leong and Ahmad (2024) in their review of LiDAR-based obstacle avoidance systems in autonomous vehicles. The authors described how LiDAR sensors generate high-resolution spatial data that allow vehicles to detect obstacles and navigate safely. Although the study focused on large-scale autonomous vehicles, the principles of LiDAR-based sensing and distance measurement are applicable to small-scale vehicle systems used for collision detection and safety enhancement.

Microcontroller capability plays a key role in integrating multiple vehicle subsystems. Gangadhar et al. (2025) developed a smart vehicle system using the ESP32 microcontroller combined with multiple sensors through sensor fusion techniques. The study demonstrated that the ESP32 is capable of processing sensor data in real time and supporting navigation-related functions. The authors highlighted the flexibility of the ESP32 development module in handling sensor integration, data processing, and vehicle control tasks within a compact embedded system.

The reviewed studies indicate that small-scale vehicle systems are effective platforms for experimenting with intelligent vehicle technologies. Bluetooth communication enables responsive remote control, while LiDAR sensors enhance obstacle detection and collision prevention capabilities. The ESP32 development module

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provides sufficient processing capability for integrating wireless communication, sensor input, and vehicle control within a single system. Existing studies often focus on individual components such as remote control or obstacle avoidance. Integrating these technologies into a unified small-scale vehicle system remains an important area of development.

Table 1. Comparison Matrix of Related Studies and Current Research

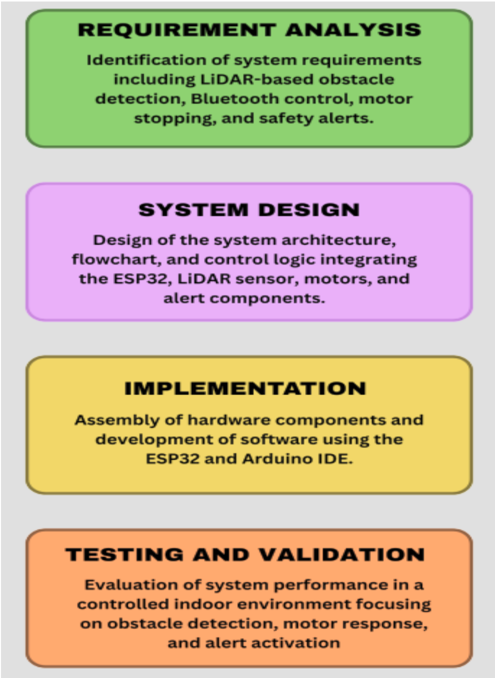
Study	Sensor(s) Used	Platform / Technology	Key Feature(s)	Gap Addressed by This Study
Tie et al. (2024)	Speed sensor	ESP32 with BLE	Bluetooth Low Energy remote control, PID-based speed control	No obstacle detection, collision prevention, or safety alert mechanisms
Roy Tonmoy et al. (2023)	LiDAR, Ultrasonic	Arduino / Raspberry Pi robot car	Performance comparison of LiDAR and ultrasonic sensors in terms of accuracy, range, and response time	Focused on comparison only; no Bluetooth control, no safety alerts, and no collision prevention logic
Leong & Ahmad (2024)	LiDAR with vision, ultrasonic, radar, IR (sensor fusion)	Autonomous vehicles (survey/review study)	Comprehensive review of LiDAR-based obstacle avoidance, sensor fusion strategies, and algorithms	Review-based study only; no practical prototype, Bluetooth control, or embedded collision-prevention implementation
Gangadhar et al. (2025)	Ultrasonic, IR, camera	ESP32 with sensor fusion	Autonomous navigation using multiple sensors and wireless communication	Does not specifically integrate LiDAR-based collision prevention or distance-threshold safety alerts
Current Study (Development of a LiDAR-Integrated Bluetooth Vehicle for Collision Prevention and Safety Alerts Using ESP32)	LiDAR (TF-Luna)	ESP32 Dev Module, Bluetooth (Dabble App)	Real-time LiDAR distance measurement, Bluetooth control, automatic motor stop, LCD display, LED and buzzer alerts	Integrates LiDAR sensing, wireless control, and real-time collision prevention with multi-modal safety alerts in a single working prototype

METHODOLOGY

This study employed a developmental and experimental research design to systematically design, implement, and evaluate a Bluetooth-controlled small-scale vehicle integrated with LiDAR-based obstacle detection. The system was developed using an ESP32 development module as the main controller, a LiDAR sensor for real-time distance measurement, DC motors with a motor driver for vehicle movement, and alert components including an LCD display, LED, and buzzer for status indication and safety warnings. Wireless control was achieved through Bluetooth communication using the Dabble mobile application, allowing user-initiated movement commands.

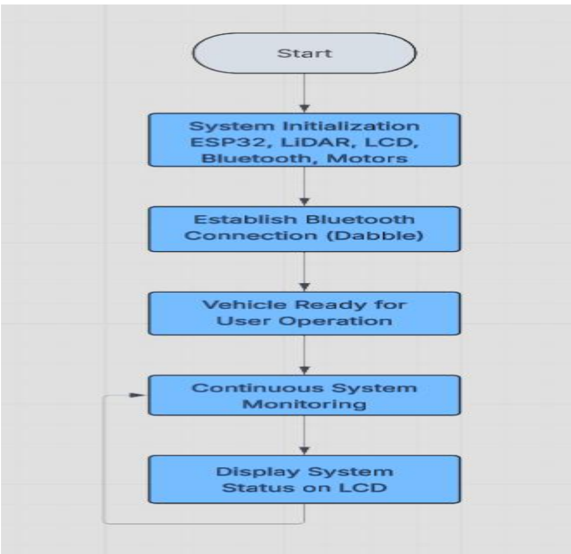
The system was assembled and programmed to continuously monitor the distance between the vehicle and nearby obstacles. When an object was detected within the predefined safety threshold, the system automatically restricted forward motion and activated visual and auditory alerts to prevent collision. Testing was conducted under controlled indoor conditions to evaluate obstacle detection accuracy, motor response, Bluetooth control reliability, and alert activation behavior. This approach enabled systematic assessment of the system's collision prevention capability, operational performance, and overall safety.

Figure 6. Waterfall Model



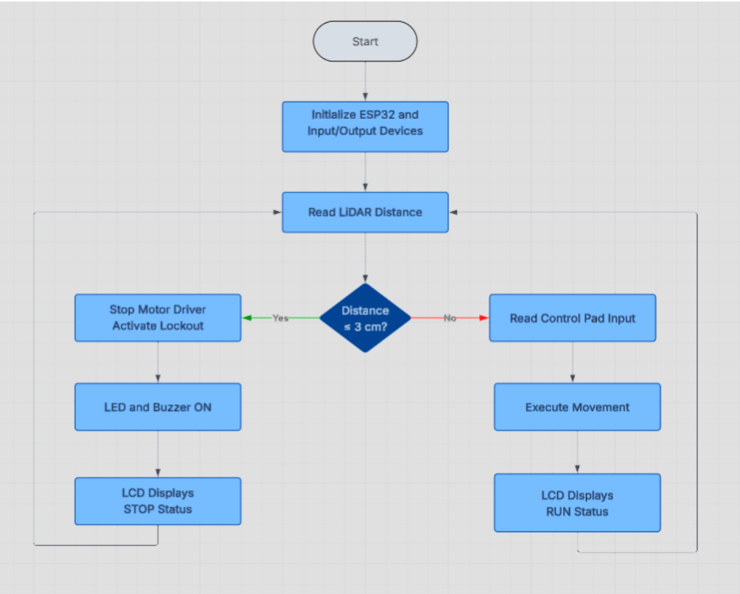
A structured and sequential development approach was applied in the study to ensure systematic implementation and evaluation of the proposed system. The development process followed four phases: requirement analysis, system design, implementation, and testing and validation. System requirements such as LiDAR-based obstacle detection, Bluetooth control, motor stopping, and safety alerts were first identified. The system architecture and control logic were then designed to integrate the ESP32, LiDAR sensor, motors, and alert components. Hardware assembly and software development were carried out using the ESP32 and Arduino IDE, followed by controlled testing to verify obstacle detection accuracy, motor response, and alert activation. This approach ensured reliable and safe system performance.

Figure 7. Flow Chart



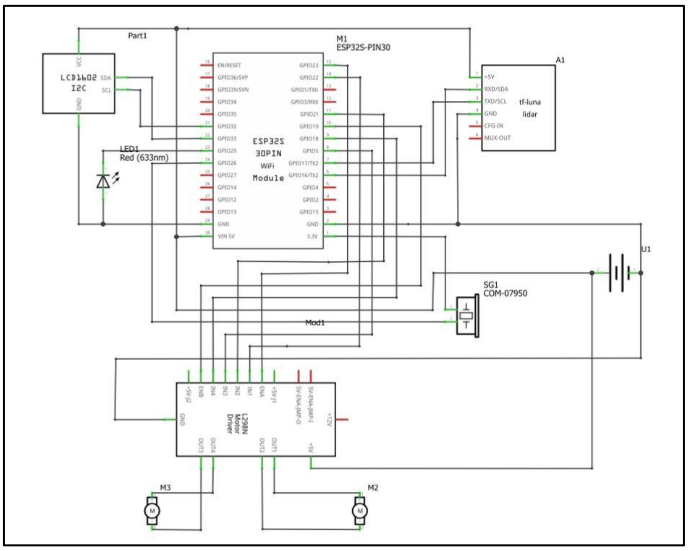
It presents the overall operational flow of the LiDAR-Integrated Bluetooth Vehicle, showing how the system processes initialization, Bluetooth connection, and continuous monitoring. The flow begins with system initialization, where the ESP32 and peripheral components are prepared for operation. The system then establishes a Bluetooth connection using the Dabble application and becomes ready for user operation. Once active, the vehicle enters a continuous monitoring state while displaying the system status on the LCD, providing a high-level view of the system's operation from startup to active use.

Figure 8. System Logic Flow Chart



It illustrates the detailed decision-making logic used by the LiDAR-Integrated Bluetooth Vehicle to control motor operation and safety alerts based on real-time distance measurements. After initialization, the ESP32 continuously reads distance data from the LiDAR sensor and compares it with the predefined safety threshold of 3 cm. When an obstacle is detected within this range, the system activates a lockout mechanism by stopping the motors, turning on the LED and buzzer, and displaying a STOP status on the LCD. If the distance is safe, the system processes user commands from the control pad and allows normal vehicle movement while displaying a RUN status. This logic runs in a continuous loop to ensure immediate response to obstacles.

Figure 9. Schematic Diagram



It shows the complete schematic wiring of the LiDAR-Integrated Bluetooth Vehicle, detailing how each electronic component is connected to the ESP32 development module. The diagram illustrates the interfacing of the LiDAR sensor, motor driver, DC motors, LCD display, LED, buzzer, and power supply. This schematic

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demonstrates how sensor inputs, motor control, and alert components work together as an integrated system to enable collision prevention, user control, and reliable vehicle operation.

Hardware Implementation and Circuit Configuration

The ESP32 development module serves as the main controller of the small-scale vehicle system, as illustrated in Figure 9. It receives Bluetooth commands from the Dabble application, processes distance data from the LiDAR sensor, executes collision prevention logic, and generates control signals for the motor driver. The ESP32 also manages communication with the LCD display and safety alert devices.

[1] The LiDAR sensor is interfaced with the ESP32 using serial communication, as shown in the schematic diagram. It continuously transmits distance measurements to the controller, allowing real-time detection of obstacles in front of the vehicle system. These measurements serve as the basis for collision prevention decisions.

[2] A motor driver module controls the DC motors mounted on the vehicle chassis. Signals from the ESP32 determine motor direction and speed, enabling forward, backward, and turning movements. This configuration allows the vehicle system to respond to user commands while maintaining safety constraints.

[3] An LCD module is connected to the ESP32 through an I2C communication interface. The display provides real-time feedback such as distance readings and warning messages. An LED indicator is also connected to the controller and is activated during obstacle detection events to provide visual alerts.

[4] A buzzer is included as an audible safety alert component. When the LiDAR sensor detects an obstacle within the critical distance threshold, the ESP32 activates the buzzer to warn the user of a potential collision.

[5] Power is supplied through a battery source connected to the motor driver and ESP32 module. Voltage regulation ensures stable and safe operation of all components, as depicted in the schematic diagram.

Software Development

The system software was developed using the Arduino Integrated Development Environment or Arduino-IDE. The ESP32 was programmed to handle Bluetooth communication with the Dabble application, acquire distance data from the LiDAR sensor, execute collision prevention logic, and control motor operations. The program continuously monitors LiDAR readings while receiving Bluetooth commands to ensure safe operation of the vehicle system.

[6] The Dabble mobile application serves as the primary control interface for the small-scale vehicle system. The application provides a virtual gamepad that allows users to send directional commands such as forward, backward, left, right, and stop via Bluetooth communication. The ESP32 interprets these commands and converts them into motor control signals. When an obstacle is detected within the safety threshold, the system overrides forward movement commands to prevent collision.

a. Collision Prevention Logic – The collision prevention logic prioritizes safety during system operation. Distance values obtained from the LiDAR sensor are compared with a predefined threshold. If the detected distance is greater than the threshold, normal vehicle movement is allowed. If the distance is less than or equal to the threshold, forward movement is restricted and safety alerts are activated through the buzzer, LED, and display module.

System Testing and Evaluation

Testing was conducted in an indoor environment with stationary obstacles placed at various distances. The small-scale vehicle system was observed to evaluate obstacle detection accuracy, Bluetooth control responsiveness, and safety alert activation behavior. System responses were compared with expected outcomes to assess collision prevention effectiveness.

Data Collection and Analysis

Data collected during testing included LiDAR distance readings, vehicle movement responses, and activation of safety alerts. Observational analysis was used to determine whether the system consistently prevented collisions under different test conditions.

RESULTS

The LiDAR sensor was able to detect obstacles and measure the distance between the vehicle and nearby objects in real time. During testing, the sensor continuously gathered distance data and sent it to the microcontroller, allowing the system to respond immediately to changes in the environment. The measured distance was shown on the LCD, along with the current system status (RUN or STOP) and the time-of-flight value.

When no obstacle was within 3 cm, the vehicle continued moving forward and the system remained in the RUN state. As the vehicle approached an obstacle and the distance reached 3 cm, the system automatically stopped the forward movement of the car. At the same time, an audible alert was triggered to notify the user that the vehicle was too close to an object. This behavior was observed consistently in repeated tests.

The system was also successfully controlled using the Dabble mobile application. Commands sent from the application were received and executed correctly by the vehicle, allowing smooth and responsive operation. Overall, the results show that the LiDAR-based detection system functioned properly, providing accurate distance measurement, clear visual feedback through the LCD, and reliable safety response during operation.

Requirements

The functional requirements of the LiDAR-Integrated Bluetooth Vehicle focus on its autonomous obstacle detection and user-controlled mobility. The system continuously monitors the distance to nearby objects using a TF-Lunar LiDAR sensor, ensuring real-time detection of obstacles within a 3 cm threshold. When an object is detected within this range, the system activates a red LED and buzzer to warn the user, preventing collisions. Motor movement is controlled via joystick input through the Dabble mobile app, allowing the user to manage speed and direction. The ESP32 Dev Module processes all sensor readings, user commands, and control logic to coordinate motor operation, display real-time distance and system status on an LCD1602, and trigger alerts as needed. A power switch enables or disables the system, while a 6V battery pack ensures sufficient motor torque without affecting the microcontroller's operation.

Non-functional requirements emphasize responsiveness, safety, and reliability. The system continuously evaluates sensor inputs and updates motor, LED, and buzzer outputs immediately to reflect the current state of the environment. Obstacle alerts are delivered in real time through visual and audio signals, ensuring consistent safety feedback. The LCD1602 display provides accurate and stable distance readings, while the motor driver reliably amplifies ESP32 commands to the motors. Overall, the vehicle is designed to operate efficiently, prevent collisions, and maintain safe and responsive control under all conditions.

Table 2. Variables and Conditions of LiDAR-Integrated Bluetooth Vehicle

Variable / Component	Type (Input / Output)	Parameter Measured / Controlled	Condition or Range	System Response / Action
ESP32 Dev Module Board	Microcontroller	Processes logic and controls outputs	Operates at 5V logic, continuous loop evaluation	Reads sensors, processes, conditions, activates LED, buzzer, and drives motor driver

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TF-Lunar LiDAR Distance Sensor	Input	Distance to Object	Threshold: ≤ 3cm	Sends distance data to ESP32 via UART
Dabble Control	Input	User control commands (via mobile app)	Joystick	ESP32 reads joystick input and controls motor speed and direction accordingly
3V-6V DC Geared Motor 1, 2	Output	Motor rotation speed/direction	PWM / HIGH–LOW	Drives mechanical movement as commanded
L293D Motor Driver Module	Output Driver	Motor power & Direction	5–12 V motor supply	Amplifies ESP32-BLE via Dabble control signals to motors
LCD1602 (I²C) Display	Output	Distance / system status	Real-time data from LiDar	Displays distance readings and system status information
Red LED	Output	Visual status indication	ON when distance is ≤ 3cm	LED turns ON to indicate object detected within 3 cm
Buzzer	Output	Audio status indication	HIGH when distance is ≤ 3cm	Buzzer sounds to warn of close obstacle
Switch	Input	Power / system enable control	ON / OFF	Turns the system ON or OFF
1.5V Li-On AA Battery x 4	Power Source	System power	6V supply	Ensures motor torque and isolates motor power from ESP32 Dev Module

Table 3. Variables and Conditions of LiDAR-Integrated Bluetooth Vehicle

Test #	Input Condition	Observed Output	Expected Output	Pass / Fail	Remarks / Behavior Explanation
1	No joystick input	Motors OFF, LCD displays distance, LED and buzzer OFF	System remains idle	Pass	Vehicle waits for user command; no unintended movement
2	Joystick pushed forward, distance > 3 cm	Motors move forward, LCD shows RUN status	Vehicle moves normally	Pass	User control works correctly when path is clear
3	Distance ≤ 3 cm while moving forward	Motors stop, LED ON, buzzer ON, LCD shows STOP	Lockout must activate	Pass	Collision prevention triggered correctly
4	Distance ≤ 3 cm with joystick input	Motors remain OFF, alerts active	Forward movement blocked	Pass	User commands overridden during lockout

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5	Distance increases to > 3 cm	LED OFF, buzzer OFF, system returns to RUN	Normal operation resumes	Pass	Lockout cleared automatically
6	Joystick turned left/right, distance > 3 cm	Vehicle turns as commanded	Turning allowed when safe	Pass	Directional control functions properly
7	Rapid joystick input changes	Smooth motor response, no erratic motion	Stable motor control	Pass	System handles rapid inputs reliably
8	Continuous forward command with safe distance	Motors run continuously	Sustained motion allowed	Pass	System supports continuous operation
9	Power switch turned OFF	System shuts down, motors OFF	Safe shutdown	Pass	No residual motor activity
10	System powered ON near obstacle (≤ 3 cm)	Motors OFF, alerts active	System defaults to safe state	Pass	Safe startup behavior confirmed

The results confirm that the LiDAR-Integrated Bluetooth Vehicle effectively prevents collisions by prioritizing the obstacle detection and safety logic over user movement commands. The consistent restriction of motor movement when an object is detected within the defined distance threshold demonstrates accurate implementation of the system's collision prevention mechanism.

The immediate activation of the LED and buzzer, together with automatic motor stopping, reflects proper application of real-time control principles, where continuous distance monitoring and rapid feedback are essential for safe vehicle operation. These outcomes support the reliability of LiDAR-based sensing and microcontroller-controlled safety systems for small-scale intelligent vehicles.

Furthermore, the integration of Bluetooth control through the Dabble application provides a simple and intuitive user interface while maintaining system safety. The successful execution of all test scenarios indicates that the system is dependable, responsive, and suitable for educational, experimental, and small-scale robotic applications.

DISCUSSION

The LiDAR-based obstacle detection system reached its design objectives by providing accurate distance measurements and ensuring that the vehicle responded quickly to obstacles. The measurement of the sensors presented a smooth and predictable pattern with a gradual decrease as the car was getting closer to an object. The car was not going to stop immediately at the 3 cm mark as there were slight calibration concerns, but the system was debugged and it performed instantly without any interference. This indicates that the system is both accurate and fast, preventing collisions effectively.

The LiDAR sensor integrated perfectly with the LCD display, buzzer, and Dabble mobile application. The LCD screen displayed in a very clear way the distance to obstacles, the system status (RUN/STOP), and the time-of-flight in real-time, while the buzzer gave an audible alert that was perfectly in sync with the vehicle's response. The combination of visual, auditory, and remote feedback made the vehicle operation easier and safer.

Sensor reliability was on a high level, as it was the case that in various tests it gave consistently accurate distance measurements. Lighting, surface type, and shape of the object were not impactful factors in the sensor's performance. On the other hand, some hardware problems were detected, the motor of the vehicle sometimes became hard to manage, and the Dabble app lost connection at times, especially when the battery of the controlling device was low. Nevertheless, the system was always effective as both the car and the app were in good working condition.

The stopping limit of 3 cm was shown to be efficient in avoiding collisions and can be adapted for use in different applications or environments; thus the system's versatility is shown. The combination of auto-stopping and simultaneous visual and audio.

CONCLUSION AND RECOMMENDATIONS

The LiDAR-based obstacle detection system not only fulfilled its design goals but also guaranteed accurate distance measurements and prompted vehicle response to obstructive situations. The system reliably stopped the vehicle at a 3 cm threshold, preventing collisions, and provided clear visual feedback through the LCD and auditory alerts via buzzer. The combination of the Dabble mobile application with the system allowed for easy remote control, thus, confirming the system's ability and practical applicability.

The sensor was always reliable in its performance and passed all tests successfully, even in harsh conditions of non-ideal bright light, surface, or obstacle shapes. The problems with app connectivity and motor control were quite negligible for the system performance in general. The 3-cm stopping limit was found to be effective and is adjustable for different uses, thus, showing the system's adaptability.

The research recommends that the combination of LiDAR sensor and feedback from the visual, auditory, and mobile app generates a system which is safe, user-friendly, and reliable for small robotic vehicles. Moreover, the underlying technology is not only for IoT then it can also be developed for larger vehicles with proper modifications.

Another set of improvements could be the inclusion of a rechargeable battery system and bettering the stability of the app connection for increasing reliability and convenience. To sum up, the system has a claim to the effectiveness of LiDAR-based obstacle detection in small robotic vehicles and has laid down a solid platform for future development and applications in the areas of robotics and IoT projects.

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REFERENCES

1. Premkumar, P., Ananya, S. T., Chitrashree, A., Dandu, F. A., Hrithika, P., & Dr. Deepak, N. R. (2025). Multifunctional Vehicle Security System using ESP32. Grenze International Journal of Engineering and Technology. Grenze ID: 01.GIJET.11.2.310_21.
2. Tie, Y., Chen, P., & Ma, Y. (2024). BLE Bluetooth remote-controlled car based on ESP32. Proceedings of the 2nd International Conference on Machine Learning and Automation. https://doi.org/10.54254/2755-2721/81/20240965
3. Roy Tonmoy, A. B., Sultan, S., Zinan, M. S., & Sarker, A. (2023). A comparative study on LiDAR and ultrasonic sensor for obstacle avoidance robot car. ResearchGate. https://www.researchgate.net/publication/372211676
4. Leong, P. Y., & Ahmad, N. S. (2024). LiDAR-based obstacle avoidance with autonomous vehicles: A comprehensive review. IEEE Access. https://doi.org/10.1109/ACCESS.2024.3493238
5. Gangadhar, J., Shankara, B. S., Mahesh, Altaf, M., & Kumar, S. (2025). Smart car with sensor fusion and autonomous navigation using ESP32. International Journal of Advanced Research in Computer and Communication Engineering. https://ijarcce.com/papers/smart-car-with-sensor-fusion-and-autonomous-navigation-using-esp32

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