# Real-Time Front And Rear Vehicle Distance Monitoring With Image Dehazing

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***Abstract-*** *Driving in hill stations and mountainous regions is highly challenging due to frequent fog, mist, and sharp curves, which significantly reduce road visibility and increase the risk of accidents. To address this issue, this project proposes a smart driver assistance system that enhances vehicle safety under low visibility conditions. The system integrates distance-based vehicle detection using ultrasonic sensors with real-time image dehazing techniques for improved road monitoring. Ultrasonic sensors are mounted at the front and rear of the vehicle to continuously measure the distance of nearby vehicles. The measured distances are displayed in meters on a visual display unit, and an audible warning is generated using a buzzer when any vehicle approaches within a critical range of 10–12 meters. This provides timely alerts to the driver and helps prevent collisions. In parallel, a dash camera captures real-time video of the road ahead, which is processed using an image dehazing algorithm to reduce the effects of fog and mist, thereby improving visibility. The proposed system offers a cost-effective and reliable solution for enhancing driving safety in fog-prone hill areas. By combining sensor-based distance monitoring with vision-based dehazing, the system assists drivers in making safer driving decisions under adverse weather conditions.*

## I. INTRODUCTION

Road safety is a major concern in hilly and mountainous regions due to challenging driving conditions such as frequent fog, mist, steep slopes, sharp curves, and narrow roads. These factors significantly reduce visibility and make it difficult for drivers to judge the distance of vehicles travelling in front of or behind them. As a result, the probability of rear-end and head-on collisions increases, especially during early morning hours, nighttime, and adverse weather conditions. Conventional vehicle safety systems often fail to provide sufficient assistance in such lowvisibility environments. To address these challenges, advanced driver assistance systems (ADAS) have gained importance in improving driving safety and reducing accident rates. One of the key requirements in such environments is real-time monitoring of nearby vehicles and timely warning to the driver when unsafe conditions arise. Accurate distance measurement between vehicles plays a critical role in preventing collisions and enabling safer driving decisions.Sensor-based approaches, particularly ultrasonic sensing, offer a reliable and cost-effective solution for short-range vehicle detection. In addition to distance monitoring, poor visibility caused by fog and mist further limits the driver's ability to observe road conditions. Image dehazing techniques can be applied to camera-based systems to enhance visual clarity by reducing the effects of atmospheric scattering. By restoring contrast and visibility in real-time video feeds, dehazing improves the driver's perception of the road ahead. This project proposes a real-time front and rear vehicle distance monitoring system integrated with image dehazing. Ultrasonic sensors are used to measure vehicle proximity, while a camera-based dehazing algorithm enhances road visibility. The combination of sensor-based alerts and vision enhancement provides a practical and effective solution for improving driving safety in fog-prone hill station environments. Furthermore, the proposed system is designed with simplicity, reliability, and cost-effectiveness in mind, making it suitable for real-world implementation in conventional vehicles. The use of readily available sensors and embedded platforms allows easy integration without major modifications to existing vehicle systems. Real-time visual and audio feedback ensures that the driver receives immediate warnings, reducing reaction time during critical situations. The modular design of the system also allows for future upgrades, such as the inclusion of advanced sensors, machine learning–based object detection, or vehicle-tovehicle communication, thereby extending its applicability tointelligent transportation systems and autonomous driving technologies.Overall, this system aims to bridge the gap between conventional driving and intelligent assistance by providing continuous environmental awareness to the driver. By addressing both distance estimation and visibility enhancement, the proposed approach contributes to safer, more confident driving in challenging hill stations and low visibility conditions.

## II. LITERATURE REVIEW

Recent research has increasingly focused on improving road safety in low-visibility environments such as hill stations and fog-prone regions through the use of intelligent driver assistance systems. Conventional safety mechanisms rely mainly on driver perception, which becomes unreliable under conditions of fog, mist, and sharp road curvature. To address this limitation, several studies have explored sensor-based vehicle detection techniques for real-time distance monitoring. Ultrasonic sensors are widely used due to their low cost, ease of implementation, and effectiveness in shortrange vehicle detection. These sensors enable continuous measurement of the distance between vehicles, allowing timely warnings to prevent collisions. In parallel, vision based approaches have been extensively studied to enhance road visibility under adverse weather conditions. Image dehazing techniques aim to reduce the effects of atmospheric scattering caused by fog and mist, thereby improving image contrast and clarity. Various dehazing algorithms, including atmospheric models and contrast enhancement methods, have been implemented using realtime image processing frameworks. Such techniques have demonstrated significant improvements in driver perception and situational awareness. Recent studies emphasise the integration of multiple sensing and vision-based methods to enhance system reliability. Combining ultrasonic-based distance monitoring with camera-based image dehazing provides both quantitative proximity information and enhanced visual feedback. This integrated approach improves driver response time, reduces accident risk, and offers a costeffective solution for real-time driving assistance in challenging hill station environments.

## III. PROPOSED METHOD

The proposed method presents a real-time driver assistance system designed to improve vehicle safety in low-visibility environments such as hill stations and fog-prone regions. The system integrates sensor-based vehicle distance monitoring with vision-based image dehazing to provide both quantitative proximity information and enhanced road visibility. The overall architecture consists of distance sensing, data processing, alert generation, and image enhancement modules working in coordination. Front and rear ultrasonic sensors are mounted on the vehicle to continuously detect the presence of nearby vehicles. These sensors emit ultrasonic pulses and measure the time taken for the reflected signal to return, allowing accurate calculation of the distance between vehicles. The measured distances are transmitted to a microcontroller, which processes the data in real time. The distance values are displayed in meters on a visual display unit, enabling the driver to monitor the surrounding vehicles easily.

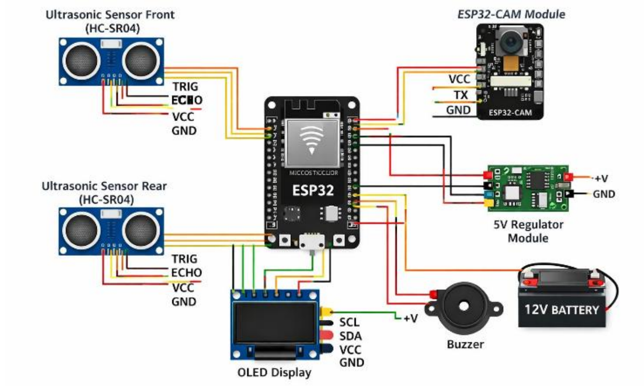


*Fig. 1. Circuit Diagram*

To ensure driver safety, a warning mechanism is incorporated using a buzzer. When the detected distance falls within a predefined threshold range of 10–12 meters, the system generates an audible alert. An intermittent buzzer is activated when the distance is between 10 and 12 meters, while a continuous buzzer is triggered if the distance drops below 10 meters. This alert logic provides timely warnings and reduces the likelihood of collisions. In parallel, a dash camera captures real-time video of the road ahead. The captured video frames are processed using an image dehazing algorithm to reduce the effects of fog and mist. The dehazing technique enhances image contrast and visibility by minimising atmospheric scattering effects, thereby improving the driver's perception of road conditions. The enhanced video output is displayed to the driver in real time. By combining ultrasonic-based proximity detection with image dehazing, the proposed method delivers a cost effective and reliable solution for enhancing driving safety. The modular design allows easy integration with existing vehicle systems and supports future upgrades for advanced driver assistance applications.

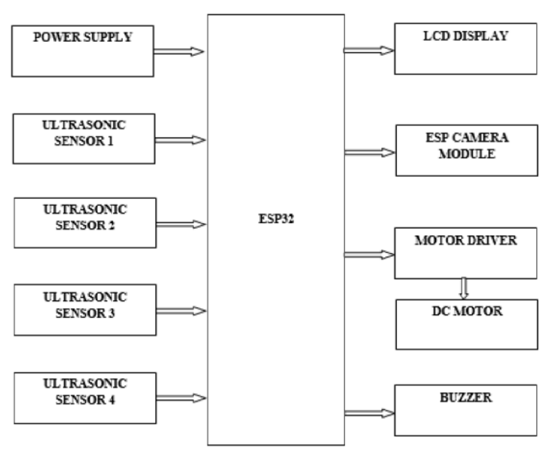


*Fig. 2. Block Diagram*

System Overview:

The proposed system is a real-time driver assistance solution that combines front and rear vehicle distance monitoring with image dehazing. Ultrasonic sensors measure nearby vehicle distances, while a camera-based dehazing algorithm enhances road visibility. Visual and audio alerts improve driving safety in low-visibility hill station environments. The proposed system consists of seven major modules,

*A. ESP 32 module:*

The ESP32 is a powerful and energy-efficient microcontroller used as the central processing unit of the proposed system. It features a dual-core processor, integrated Wi-Fi and Bluetooth connectivity, and multiple GPIO pins, making it suitable for real-time sensor interfacing and data processing. In this project, the ESP32 collects distance data from front and rear ultrasonic sensors, processes warning logic, controls the display unit, and activates the buzzer when unsafe distances are detected. Its high processing speed, low power consumption, and flexible interfacing capabilities make it ideal for embedded driver assistance applications. [Fig. 3]


Fig. 3. ESP 32

*B. Power Supply Unit:*

The power supply unit provides a stable and regulated voltage required for the reliable operation of the proposed system. Since automotive power sources typically supply 12 V DC, a voltage regulation circuit is used to step down the voltage to 5 V and 3.3 V suitable for the ESP32, sensors, display, and camera module. Voltage regulators and filtering components ensure protection against voltage fluctuations, noise, and transients commonly present in vehicle electrical systems. A stable power supply is essential for accurate sensor readings, consistent image processing, and uninterrupted system performance under varying operating conditions. [Fig. 4]

*Fig. 4. Voltage Regulator*

*C. Arduino Ide:*

The Integrated Development Environment (IDE)is a combination of an editor, linker and a compiler which helps the developer to make their Firmware for their Innovative Projects. Arduino IDE play a major role in the open source platform for fast prototyping and easy to access of library. It is user friendly tool for beginners and it supports programming language like embedded C, Luna etc. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. Its supports all the variant of Arduino boards like Arduino Uno, Nano and Mega etc. As soon as it reaches a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. [Fig. 5]

*Fig. 5.* Arduino Ide software:

D. Sensing Units*:*

Ultrasonic sensors are used in the proposed system to measure the distance between the vehicle and nearby objects or vehicles. The sensor operates by transmitting highfrequency ultrasonic waves and receiving the reflected echoes from obstacles. The time interval between transmission and reception is used to calculate the distance based on the speed of sound. In this project, ultrasonic sensors are mounted at the front and rear of the vehicle to provide continuous real-time distance monitoring. Their low cost, simple interfacing, and reliable short-range detection make them suitable for collision avoidance and driver assistance applications.[Fig 6]

*Fig. 6. Voltage Sensor*

E. Display and Communication Interface:

system status, alarms, and battery metrics are shown on a 16x2 LCD with an I2C interface. The I2C protocol conserves microcontroller I/O pins and reduces wiring complexity. Remote monitoring and data transfer to other apps or cloud platforms are made possible by IoT connectivity. [Fig. 7]

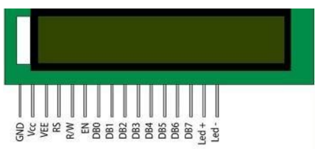


*Fig. 7. LCD Display*

*F. Alert and Protection Mechanisms:*

The buzzer is used as an audible alert device in the proposed driver assistance system to warn the driver about unsafe vehicle proximity. It is controlled by the ESP32 microcontroller based on the distance data received from the ultrasonic sensors. When the detected distance falls within the warning range of 10–12 meters, the buzzer produces an intermittent sound, and when the distance drops below 10 meters, a continuous alarm is generated. This audio feedback helps capture the driver's attention immediately, especially in low-visibility conditions, thereby reducing reaction time and preventing potential collisions. [Fig. 8]

*Fig. 8. Buzzer Sensor*

*G. Load Unit (DC Motor):*

A DC motor is used in the proposed system to demonstrate vehicle movement during testing and simulation. It converts electrical energy into mechanical motion and operates on direct current supplied by the power unit. The speed and direction of the DC motor can be controlled using a motor driver circuit interfaced with the ESP32 microcontroller. In this project, the DC motor represents the motion of the vehicle in a prototype setup, enabling the evaluation of distance monitoring and warning responses under dynamic conditions. Its simple control mechanism and reliability make it suitable for experimental validation of the system. [Fig. 9]

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*Fig. 9. DC Motor*

## IV. RESULTS AND DISCUSSION

The proposed real-time front and rear vehicle distance monitoring system with image dehazing was successfully designed and tested under various operating conditions. The system demonstrated reliable performance in detecting nearby vehicles and providing timely alerts to the driver, particularly in low-visibility scenarios such as fog and mist. The ultrasonic sensors accurately measured the distance of vehicles positioned in front of and behind the prototype setup, and the measured values were continuously updated and displayed in meters on the display unit. When the detected distance exceeded 12 meters, the system operated in normal monitoring mode without generating any alerts. As the distance reduced to the warning range of 10–12 meters, the buzzer produced an intermittent sound, effectively alerting the driver of a potential hazard. For distances below 10 meters, a continuous buzzer was activated, indicating animmediate risk of collision. This alert mechanism proved effective in reducing driver reaction time and improving situational awareness. The image dehazing module significantly enhanced visual clarity in foggy conditions. Real-time video captured by the camera showed noticeable improvement in contrast and visibility after applying the dehazing algorithm. Road boundaries, vehicles, and obstacles that were initially obscured by fog became more distinguishable in the enhanced video output. The system operated reliably with minimal delay and stable performance throughout testing. Overall, the results confirm that the proposed system effectively improves driving safety in hill station and fog-prone environments while offering a costeffective and scalable solution for real-world applications.

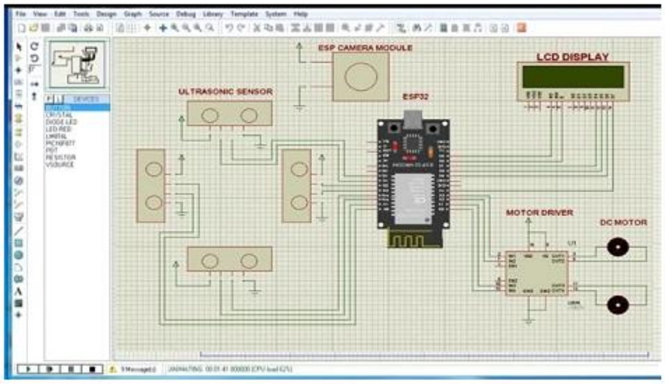


*Fig.10. Hardware simulation*

## IV. CONCLUSION

This project successfully developed a real-time front and rear vehicle distance monitoring system integrated with image dehazing to enhance driving safety in low-visibility hill station environments. By utilizing ultrasonic sensors, the system continuously measured the distance of nearby vehicles and provided timely visual and audible alerts when unsafe proximity conditions were detected. The buzzer-based warning mechanism effectively reduced driver reaction time and helped prevent potential collisions. In addition, the implementation of image dehazing significantly improved road visibility under foggy and misty conditions. The enhanced video output allowed better identification of road boundaries and obstacles, thereby improving driver awareness and confidence. The system demonstrated reliable performance, low latency, and stable operation during testing. Owing to its cost-effective design and modular architecture, the proposed solution can be easily integrated into existing vehicles and further extended with advanced sensing and communication technologies. Overall, the project proves to be a practical and efficient driver assistance system that contributes to safer driving in challenging environmental conditions.

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