Scout: A Smart Collision System Using Ultrasonic Technology

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Abstract—This project present, a smart vehicle safety system powered by the ESP32 microcontroller to the address two common cause of the road accidents: blind spot and slippery road surfaces. These proposed system uses the ultrasonic sensor mounted on the side of the vehicle to continuously monitor areas which are not clearly visible to the drivers. When an obstacle detects the driver receives immediate visual and the audible alert through the LCD display and the buzzer. A moisture sensor is used to identify wet road conditions and to warn the driver about the possible skidding. By combining real time monitoring with the affordable hardware and this prototype improve driver awareness and offers a practical safety solution for ordinary vehicles that which do not have advanced driver-assistance systems.

Index Terms-ESP32, blind spot detection, skid detection, ultrasonic sensor, moisture sensor, road safety, driver alert system, LCD display, buzzer alert, smart vehicle safety system.

I. INTRODUCTION

Increasing in the road traffic has made vehicle safety a major concern. Many accidents occur because drivers fail to notice vehicle or obstacle in blind spot, especially during lane changes, overtaking, and the parking. Another frequent cause of accidents is the loss of control on wet or a slippery roads, where sudden braking or turning may lead to skidding. Although many modern luxury vehicles are equipped with advanced driver assistance system, such features are often expensive and not available in ordinary vehicles. The aim of this project is to develop a simple, reliable, and low cost safety system using an ESP32 microcontroller. Ultrasonic sensors are used to detect nearby obstacles in blind spot areas, while a moisture sensor identify wet road conditions. When the system detects danger, it alerts the driver through an LCD display and buzzer. This helps the driver react in time, reduce risk, and make safer driving decisions. The system is especially useful for affordable vehicles, where built-in safety technologies are limited.

II. LITERATURE SURVEY

[1] Lakshmi Narayana Thalluri et al. (2022), "Smart Vehicle Tracking System with Collision Avoidance".

This work focuses on vehicle tracking and collision avoidance in crowded areas. The authors developed a Raspberry Pi based system supported by GPS, GSM, and a web application to track vehicle location. An ultrasonic sensor detects nearby vehicles and alerts the driver, helping reduce the chances of collision.

[2] AMSV Sushma et al. (2025), "Real-Time IoT-Based Vehicle Accident Detection and Emergency Response System".

This study proposes a low-cost emergency response system that uses sensors such as an accelerometer and GPS to detect accidents. Controlled by an Arduino, the system sends the accident location through SMS within a short time, which can improve emergency response in areas with limited rescue facilities.

[3] Md. Fahim Bin Amin et al. (2024), "Safe Trax: Smart Collision Prediction and Alert System Using IoT".

Safe Trax combines IoT, video input, cloud processing, and deep learning to predict possible accidents. The system analyzes surrounding vehicles, pedestrians, and animals and then warns the driver in advance, giving more time to take preventive action.

[4] Zijun Wang et al. (2022), "Design of a Vision Blind Spot Detection System Based on Depth Camera".

This research introduces a blind-spot detection method using a depth camera. The system identifies nearby objects and estimates their distance from the vehicle. It provides immediate feedback to the driver and offers an alternative to radar based blind-spot systems.

[5] Luqman Shahzad et al. (2021), "Cost Effective Accident Prevention System for Vehicles".

The authors present an affordable safety unit that combines ultrasonic sensors, laser sensors, GPS, and rain sensors. The system supports blind spot assistance, pre crash alerts, and weather related safety warnings, making it suitable for retrofitting in existing vehicles.

[6] Shreyas S. et al. (2014), "Adaptive Headlight System for Accident Prevention".

This paper addresses poor visibility during night driving and turning. A microcontroller adjusts the direction of headlights using stepper motors based on steering movement. The system also switches lights on automatically in low-light conditions, improving visibility around curves and blind spots.

[7] Sung Hyun Oh and Jeong Gon Kim (2025), "A IoT Platform of Accident Prevention in Alley Environments". This study focuses on accident prevention in narrow alleys, where both drivers and pedestrians may have limited visibility. The proposed A IoT system uses CCTV cameras and artificial intelligence to detect approaching vehicles and send warnings through ground lights and mobile alerts.

[8] Jo Verhaevert (2017), "Detection of Vulnerable Road Users in Blind Spots through Bluetooth Low Energy".

This work explores the use of Bluetooth Low Energy to detect vulnerable road users such as cyclists and pedestrians in blind spots. The detected information is displayed on an LCD screen, helping the driver become aware of road users who may otherwise remain unseen.

[9] Ramya Shri G. et al. (2024), "Rear Guard: LCD-Based Accident Prevention System for Large Vehicles".

The Rear Guard system is designed to improve overtaking safety near large vehicles. A wireless camera mounted at the front of a truck sends live video to a display at the back, allowing following drivers to see the road ahead and decide when it is safe to overtake.

[10] Jahnavi Chinthaguntla et al. (2023), "A Smart Anti-Collision System for Car Doors".

This paper proposes a simple solution to prevent dooring accidents. An ultrasonic sensor detects approaching vehicles or riders from behind, and an Arduino-based control unit locks the door when danger is detected. The system is useful in preventing collisions caused by sudden door opening.

[11] Jack Madiba et al. (2026), "Wi-Fi Enabled Speech Automated Guided Vehicle Using Android and Node MCU". This study presents a voice controlled automated guided vehicle using an Android application, Node MCU, and ultrasonic sensors. The vehicle responds to speech commands while also detecting and avoiding obstacles, showing the role of sensor-based automation in safer mobility systems.

[12] Kriti Agrawal et al. (2023), "Automated Traffic Monitoring Control for Improved Visibility on Curved Hilly Roads".

The authors address accident risks on hilly roads caused by sharp curves and poor visibility. Their IoT-based system uses sensors and display units near curves to warn drivers about oncoming vehicles, improving safety in difficult road conditions.

[13] Mortezaadl et al. (2025), "Roadside Fisheye Vision for Cooperative Perception in V2I-Assisted Automated Driving".

This research proposes the use of roadside fisheye cameras to support vehicle-to-infrastructure communication. By giving vehicle a wider view of intersections and blind zones, the system improves cooperative perception and supports safer automated driving.

[14] Nouf Abdullahalmujally et al. (2024), "A Novel Framework for Vehicle Detection and Tracking in Nighttime Surveillance Systems".

This paper focuses on detecting and tracking vehicles in low-light conditions. The proposed framework uses image enhancement and the YOLOv5 model to improve vehicle recognition in nighttime surveillance, supporting traffic monitoring and road safety.

[15] Noor Jannah Zakaria et al. (2023), "Lane Detection in Autonomous Vehicles: A Systematic Review".

This review analyzes different lane-detection approaches used in autonomous vehicles. It finds that combining deep learning with conventional image processing methods improves accuracy and reliability, which is essential for safe autonomous navigation.

[16] Yanzhao Yang et al. (2025), "Evaluation System of Blind Spot Warning Algorithm Based on Vehicle-to-Everything".

This study evaluates blind spot warning algorithms using C-V2X technology. Instead of depending only on onboard sensors, vehicles and road units share information with each other, allowing faster and more reliable detection of collision risks.

[17] Rahman Shafique et al. (2024), "Advancing Autonomous Vehicle Safety: Machine Learning to Predict Sensor-Related Accident Severity".

The authors use machine learning models to study accident severity linked to sensor related failures in autonomous vehicles. Their work helps identify risk patterns and supports the improvement of sensor reliability in future vehicle safety systems.

[18] Swanand Patwardhan et al. (2023), "Vehicle Accident Prevention on Mountain Roads".

This project focuses on accident prevention on narrow mountain roads and blind curves. Image processing techniques are used to identify approaching vehicles, while warning signals alert drivers on both sides of the curve, reducing the risk of head-on collisions.

[19] Michael D. Keall and Stuart Newstead (2026), "Estimated Real-World Safety Benefits Associated with Blind Spot Monitoring Systems".

This study uses real world crash data to examine the benefits of blind spot monitoring systems. The findings suggest that such systems can reduce lane change crashes and injury related incidents, supporting the practical value of blind spot detection technology.

[20] Kalaichelvi K. et al. (2025), "Smart Blind Spot Detection System Using Ultrasonic Sensor for Ordinary Vehicles".

This work presents a cost-effective blind spot detection system designed for ordinary vehicles. Ultrasonic sensors, filtering methods, LEDs, and buzzer alerts are used to provide real-time warnings, making advanced safety support more accessible to low-cost vehicles.

III. CONCLUSION

The developed blind spot and skid detection system provides a practical and cost-effective improvement in vehicle safety, especially for ordinary vehicles that do not include built in advanced driver assistance systems. Using the ESP32 microcontroller, ultrasonic sensors, and a moisture sensor, the system continuously monitors nearby obstacles and wet road conditions. When a potential risk is detected, it gives immediate alerts through an LCD display and buzzer, helping the driver respond more carefully and quickly. The prototype shows that affordable sensor based technology can improve driver awareness, reduce avoidable accidents, and make road safety features more accessible for everyday vehicles.

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