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Accident Prevention and Speed Detection System for Blind Spots with Real-Time Emergency Alerts

Dr. D Srinivasulu Reddy, B Harika Erri Sai, B Siva Kumar, C Saikrishna Prasad,
D Gireesh, A Teja Prakash

Professor, Department of ECE, SV College of Engineering, Tirupati, Andhra Pradesh, India

U.G. Student, Department of ECE, SV College of Engineering, Tirupati, Andhra Pradesh, India

U.G. Student, Department of ECE, SV College of Engineering, Tirupati, Andhra Pradesh, India

U.G. Student, Department of ECE, SV College of Engineering, Tirupati, Andhra Pradesh, India

U.G. Student, Department of ECE, SV College of Engineering, Tirupati, Andhra Pradesh, India

U.G. Student, Department of ECE, SV College of Engineering, Tirupati, Andhra Pradesh, India

ABSTRACT: Rising road accidents due to population growth and increased vehicles, negligence, and lack of safety measures are major contributors to accidents, especially on dangerous roads such as narrow mountain paths, curved roads, and rural areas. Limited visibility on curved roads increases the risk of accidents. With 2.3 million deaths annually in India, 137,000 are attributed to road accidents, and nearly 7,000 of these occur in blind curved areas. There is a growing need for faster, reliable wireless communication for road safety, as well as a demand for real-time alert systems that are compact and efficient. Our system aims to support increased driver awareness and reduced accident rates, overcoming limitations in existing safety measures and improving driver compliance. The system also provides emergency services in a short period. The existing methods are traditional approaches such as painted road markings, dynamic light systems, sequential LED lights, solar-powered blinking lights, and reflective bollards with lights. In this research, a system that uses ultrasonic sensors to identify vehicles as well as alter LED colours accordingly to inform drivers is proposed to be applied on mountain roads, curving roads, and bends. LED glows red to alert the motorist to slow down if a car is approaching. LED will turn green if the car is moving away.

KEYWORDS: Accident prevention, Speed detection, Blind spots, Real-time alerts, Vehicle safety, Emergency services.

I. INTRODUCTION

Road safety remains a critical issue globally, especially in areas where roads are narrow, winding, or poorly lit. The fast increase in the global population, along with more vehicles on the roads, has made the risk of accidents even greater. In India, this is particularly alarming, with 2.3 million deaths reported each year, 137,000 of which result from road accidents. Nearly 7,000 fatalities occur at blind curves and other known accident hotspots.

Blind spots, narrow mountain paths, and curved roads, especially in rural and hilly regions, create unique challenges for drivers and traffic management. Limited visibility, sharp bends, and unpredictable driving conditions can make navigating these roads quite perilous. What is more, the absence of proper signalling and safety measures on blind curves greatly increases the likelihood of collisions. Numerous accidents occur when drivers neglect to adjust their speed according to road conditions or fail to recognize risks in a timely manner.

This creates an urgent demand for more advanced safety solutions that can offer real-time, energetic alerts to drivers and enhance their awareness of road conditions. These systems should also be compact, efficient, and reliable across different environmental settings. In response to these challenges, we are proposing a solution that combines smart turning indicators, speed detection systems, and collision detection mechanisms, all linked to real-time

communication with emergency response services. This paper introduces a comprehensive accident prevention framework designed to reduce accident risks while enhancing overall road safety through advanced alert and detection technologies.

Fig 1 shows the Blind spot region where the driver visibility is limited and unable see the vehicle that is coming on the other side of the road.



Fig. 1. Blind Spot Region

The principal objective of the present research is to enhance driver awareness and provide dependable, economical solutions for accident-prone areas, specifically blind curves, mountainous roads, and rural regions that frequently lack sufficient safety measures. By implementing this system, we can considerably lower accident risks and enhance emergency response times. Road safety remains a critical issue globally, especially in areas where roads are narrow, winding, or poorly lit. The fast increase in the global population, along with more vehicles on the roads, has made the risk of accidents even greater. In India, this is particularly alarming, with 2.3 million deaths reported each year, 137,000 of which result from road accidents. Nearly 7,000 fatalities occur at blind curves and other known accident hotspots.

II. LITERATURE SURVEY

A blind zone alert system that uses intra-vehicular wireless sensor networks to improve driver awareness and safety by sending out timely notifications to avoid accidents was detailed in "Blind Zone Alert System Utilizing Intra-Vehicular Wireless Sensor Networks" (2015). [1] The 2017 publication "Traffic Management System" introduced a traffic management system designed to enhance traffic flow and lessen congestion by utilizing cutting-edge electronic solutions for urban mobility. [2] "The study "Blind Spot Monitoring System Using Ultrasonic Sensor" (2023) investigated a system that uses ultrasonic sensors to identify obstructions, greatly improving vehicle safety by instantly warning drivers. [3] The research "AI-Driven Driver Behaviour Assessment Through Vehicle and Health Monitoring for Safe Driving—A Survey" (2024) examined how to integrate health and vehicle monitoring systems to encourage safer driving habits. [4] "Moving Vehicle Speed and Distance Estimation in Autonomous Vehicles" (2023) discussed methods for estimating speed and distance in autonomous vehicles, emphasizing the importance of accurate data for navigation and safety. [5] To enhance traffic management, "Automatic Vehicle Classification and Speed Tracking" (2023) implemented an automatic vehicle classification and speed tracking system that uses cutting-edge algorithms for real-time monitoring. [6] To improve urban mobility and lessen congestion, the 2007 paper "Intelligent Traffic Control System" presented an intelligent traffic control system that uses technology to optimize traffic signals. [7] An object detection system for video surveillance was created using "Object Detection for Video Surveillance Using Edge-Cloud Collaboration" (2023), which enhanced detection capabilities and reaction times by leveraging edge-cloud cooperation. [8] The 2020 research "Simulation Analysis of Contributing Factors to Rider Visibility Issues for Car-Motorcycle Accidents" examined the variables influencing rider visibility in these collisions and offered suggestions for improving safety protocols for susceptible road users. [9] "A Method for Determining and Presenting Driver Visibility in Commercial Vehicles" (2007) described a methodology for assessing driver visibility in commercial vehicles,

emphasizing its critical role in safety and regulatory compliance. [10] A blind spot warning system based on real-time self-supervised deep learning models was created by "Blind Spot Warning System based on Vehicle Analysis in Stream Images by a Real-Time Self-Supervised DL Model" (2021), which improved driver assistance by sending out intelligent notifications. [11] The 2017 paper "A Blind Spot Detection and Warning System based on Millimetre Wave Radar for Driver Assistance" described a millimetre-wave radar-based blind spot detection and warning system that greatly increased driver safety when changing lanes and performing manoeuvres. [12] "Behavioural Impacts of Advanced Driver Assistance Systems (ADAS) on Road Safety" (2001) reviewed the behavioural impacts of ADAS on road safety, focusing on their effectiveness in reducing accidents. [13] With a focus on the role of contemporary technology in automobile safety, the 2018 study "A study on development of the blind spot detection system for the IoT-based smart connected car" examined the creation of a blind spot detection system for IoT-based smart connected cars. [14] The 2013 paper "Development of Vehicle Blind Spot System for Passenger Car" examined the design of a vehicle blind spot system for passenger cars, emphasizing real-time driver alerts and sensor integration for increased safety. [15] To improve road safety through continuous monitoring, the "IoT based Vehicle Over-Speed Detection and Accident-Avoidance System" (2021) proposed an IoT-based vehicle over-speed detection and accident-avoidance system. [16] "Vehicle Speed Control and Accident Prevention System in Smog Zone" (2021) addressed both safety and environmental issues by proposing a vehicle speed control and accident prevention system for smog zones. [17] "Impact analysis of ADAS regarding road safety – computing reduction potentials" (2024) analysed the impact of ADAS on road safety, quantifying potential reductions in accidents through effective implementation. [18] "Real-time Driver Drowsiness Detection for Android Application Using Deep Neural Networks (DNNs) Techniques" (2018) presented a real-time driver drowsiness detection system using DNNs, focusing on mobile applications to enhance driver alertness and safety. [19] The 2012 study "Detecting Driver Drowsiness Based on Sensors: A Review" examined techniques for sensor-based driver drowsiness detection, highlighting the significance of monitoring systems for enhancing traffic safety. [20]

III. EXISTING METHODS

When it comes to preventing accidents, we usually rely on things like painted road markings, energetic lights solar-powered blinking lights, convex mirrors and cautions as shown in Fig 2. Those painted markings help keep lanes separate, but they fade over time and can be tough to see when the weather gets bad. Solar-powered blinking lights are great for saving energy, but whether it is foggy they do not support same goes with the convex mirrors and the cautions provide some guidance, they do not really help warn the vehicle ahead. These traditional methods just do not help when it comes to delivering the real-time, adaptable safety solutions we need especially in blind spots on hazardous roads.



(a)



(b)

Fig. 2. (a) Convex mirror placed at U-turn. (b) Caution and lights at blind curve

IV. PROPOSED METHOD

The proposed system for blind systems integrates multiple components, each working together to improve driver awareness, speed detection, and provide real-time emergency alerts. The main functionalities are given below.

- Smart Turning Indicators:
- Smart Vehicle Speed Detection
- Smart Collision Detection System

A. Smart Turning Indicators

The smart turning indicator system is designed to operate on dangerous curves, bends, and narrow mountain paths. The device uses ultrasonic sensors to identify whether cars are coming around the bend from either side. LED (Light Emitting Diode) lights along the road change colour when a car is detected approaching the curve. A green LED light is displayed when no vehicle is detected, indicating that it is safe to proceed. However, when a vehicle is detected on the curve, a red LED light flashes, warning the driver to slow down. This real-time alert system significantly enhances visibility and improves decision-making for drivers.

B. Smart Vehicle Speed Detection

Excessive speed is a key factor contributing to accidents on dangerous roads, particularly in areas with poor visibility. This system is designed to monitor speed of approaching vehicles using IR (infrared) sensors and display speed of vehicle on an LCD (Liquid Crystal Display) screen. If the detected vehicle exceeds the threshold speed limit for the area, the buzzer turns on warning the driver to reduce speed. This system helps reduce the risk of accidents caused by high-speed vehicles in accident-prone areas, providing real-time feedback to ensure safer driving practices.

C. Smart Collision Detection System

The smart collision detection system is an innovative approach to accident prevention. It is placed on edges of the road. Upon detecting an accident, ESP32-CAM module takes pictures of the event and sends them to a cloud-based platform more precisely, a Telegram bot. This platform provides a rapid means of communication with emergency services, allowing for timely intervention and assistance. The images sent to the cloud help emergency responders to assess the severity of the accident and coordinate the appropriate response, including dispatching ambulances, fire services, and other first responders.

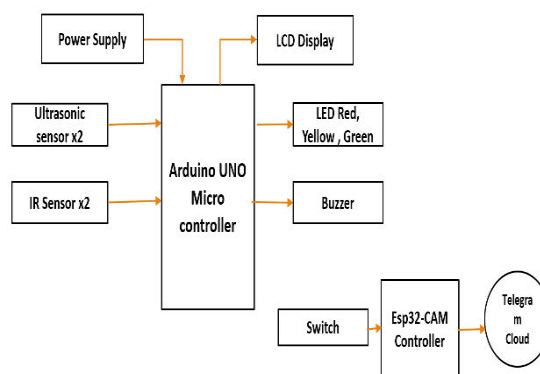


Fig. 3. Block Diagram

D. Hardware Specifications

Arduino UNO: Microcontroller board used for processing sensor data and controlling the system.

Ultrasonic Sensors: Detect objects from a threshold range using sound reflections.

IR Sensors: Measure the speed of the vehicle ESP32-CAM: Wireless camera module used to capture accident images and send them to the cloud. LEDs: Provide visual alerts to drivers Buzzer: Emits sound alerts for driver notifications.

Switch: Used to activate or deactivate certain system features.

LCD Display: Displays speed of the vehicles.

Power Supply: Powers the system components.

E. Software Specifications

Arduino IDE: Open-source platform for programming the Arduino board.

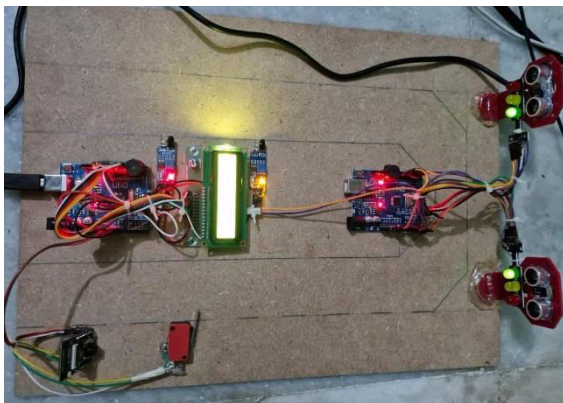
Personal Computer: Used to program the system and interface with sensors.

Mobile/PC with Telegram Chatbot: Used for receiving emergency alerts and notifications from the system

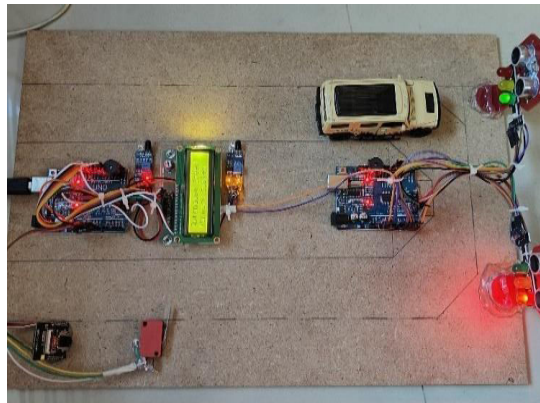
V. EXPERIMENTAL RESULTS

A. Smart Turning Indicators

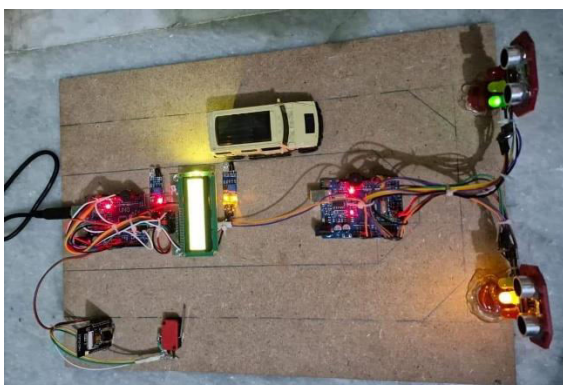
Vehicles approaching hazardous bends, curves, and tight roads from both directions are detected by the system using ultrasonic sensors. Fig 2 (a) shows in the absence of vehicle detection, a green LED light signifies that it is safe to advance (b) shows when a vehicle is detected, a red LED light flashes, warning the driver to slow down. (c) shows if a vehicle is detected approaching from a distance, a yellow LED light flashes, signalling caution. (d) shows if vehicles approach from both the sides the red LED light flashes warning the drivers to slow down



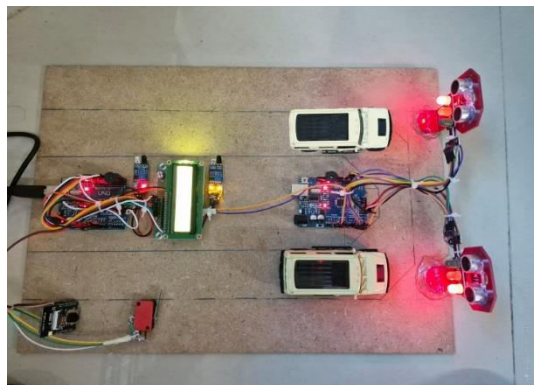
(a)



(b)



(c)



(d)

Fig. 4. (a) When no vehicles are detected (b) When any vehicle gets detected Blind Spot Region (c) When vehicle gets detected

(d) When vehicles get detected on both sides of the road from a threshold distance

B. Smart Vehicle Speed Detection

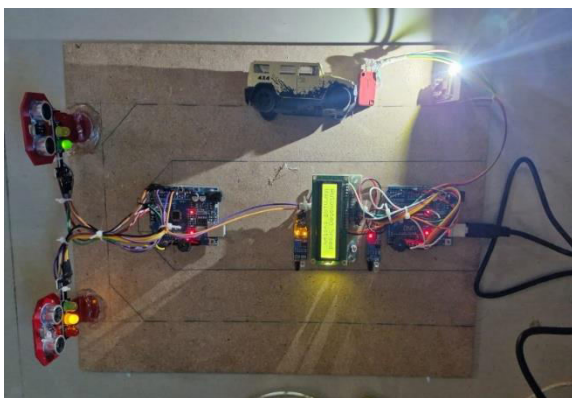
Fig 5 shows the vehicle's speed is presented on an LCD panel in real-time. A buzzer warns the driver to slow down if the car goes over the speed limit.



Fig. 5. Speed of the vehicle and number of vehicles passed (122.45kmph and one vehicle)

C. Smart Collision Detecting System

The collision detection system monitors the edges of the road for accidents. If an accident is detected, the ESP32-CAM module captures images of the incident as shown in Fig 6 (a). The images are sent to a cloud-based platform, alerting emergency services for a quick response through a telegram bot. (b) shows the image sent to telegram bot.



(a)



(b)

Fig. 6. (a) Collision detected and captured by ESP-32 cam (b) Image received to telegram bot

VI. CONCLUSION

The proposed system integrates several advanced technologies to enhance road safety by providing real-time alerts and monitoring. By utilizing ultrasonic sensors, IR sensors, and camera modules, the system effectively detects approaching vehicles, monitors speed, and identifies accidents, ensuring timely intervention. Smart turning indicators, speed detection, and collision detection systems work together to reduce accidents, especially in hazardous areas like curves, bends, and high-risk roads. With its ability to communicate with emergency services via cloud platforms, the system can significantly improve emergency response times and help mitigate accident-related injuries. Overall, this system demonstrates a proactive approach to accident prevention, driver awareness, and enhanced road safety.

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