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CHENNAI

PROJECT REVIEW 1

Smart Rear-End Collision Prevention and AI Violation Detection System for Night time Highways

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Smart Rear-End Collision Prevention and AI Violation Detection System for Night-time on Highways

Abstract

This project introduces a smart safety and monitoring system for multi-lane roads. Ultrasonic sensors placed in a 3-lane configuration detect the speed and distance between vehicles. Speed is calculated at three checkpoints by recording timestamps when vehicles pass the sensors. Tailgating or overspeeding triggers:

- Red LED warning
- Alert on driver's phone via Wi-Fi and a simple HTTP web interface

Repeated violations across all checkpoints raise an AI flag. Alerts are logged in MongoDB and forwarded to nearby police authorities via serial connection or webhook.

Novelty:

- Cost-effective method of calculating speed
- Real-time AI logic with distributed checkpoint validation
- Public alerting via a web interface

Problem Statement

The project aims to reduce rear-end collisions on night-time highways by preventing tailgating and speeding using a cost-effective IoT and AI system that monitors vehicle behavior and alerts drivers and authorities in real-time.

Architecture Diagram Description

The system architecture consists of three main checkpoints on a multi-lane highway, each equipped with ultrasonic sensors positioned to cover the lanes. Each sensor records the timestamp of a vehicle passing by. The ESP32 microcontroller processes the data to calculate the vehicle's speed by comparing timestamps from pairs of sensors based on the known fixed distance between them.

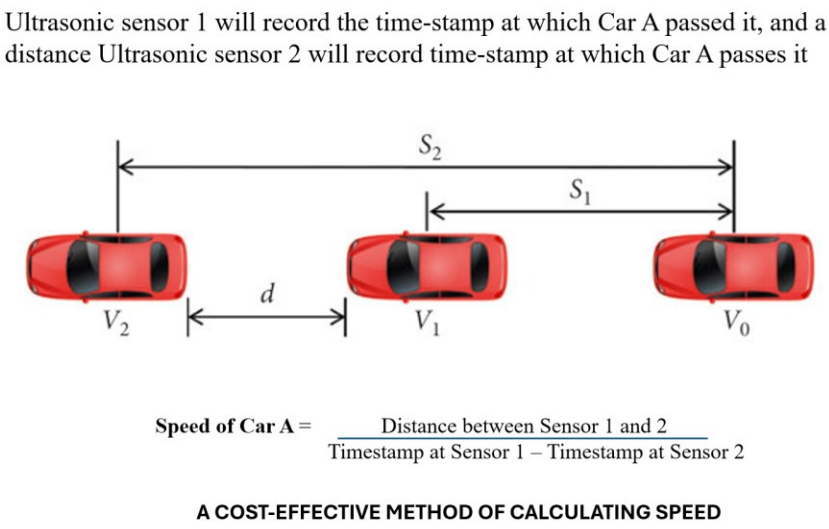

Fig.1 Diagram Demonstrating the Method of Calculating Speed

The flow is as follows:

1. Ultrasonic sensors at each checkpoint detect vehicle presence and record timestamps.
2. ESP32 calculates vehicle speed between sensors at each checkpoint.
3. If speeding or tailgating is detected, a Red LED warning lights up to alert the driver.
4. Simultaneously, an alert is sent to the driver's phone via Wi-Fi through an HTTP web interface.
5. Repeated violations trigger an AI-based flagging system.
6. Alerts and violation data are logged in a MongoDB database.
7. Relevant alerts are forwarded to local police authorities using serial communication or a webhook API.

This distributed checkpoint system enables real-time monitoring and alerting to improve night-time highway safety.

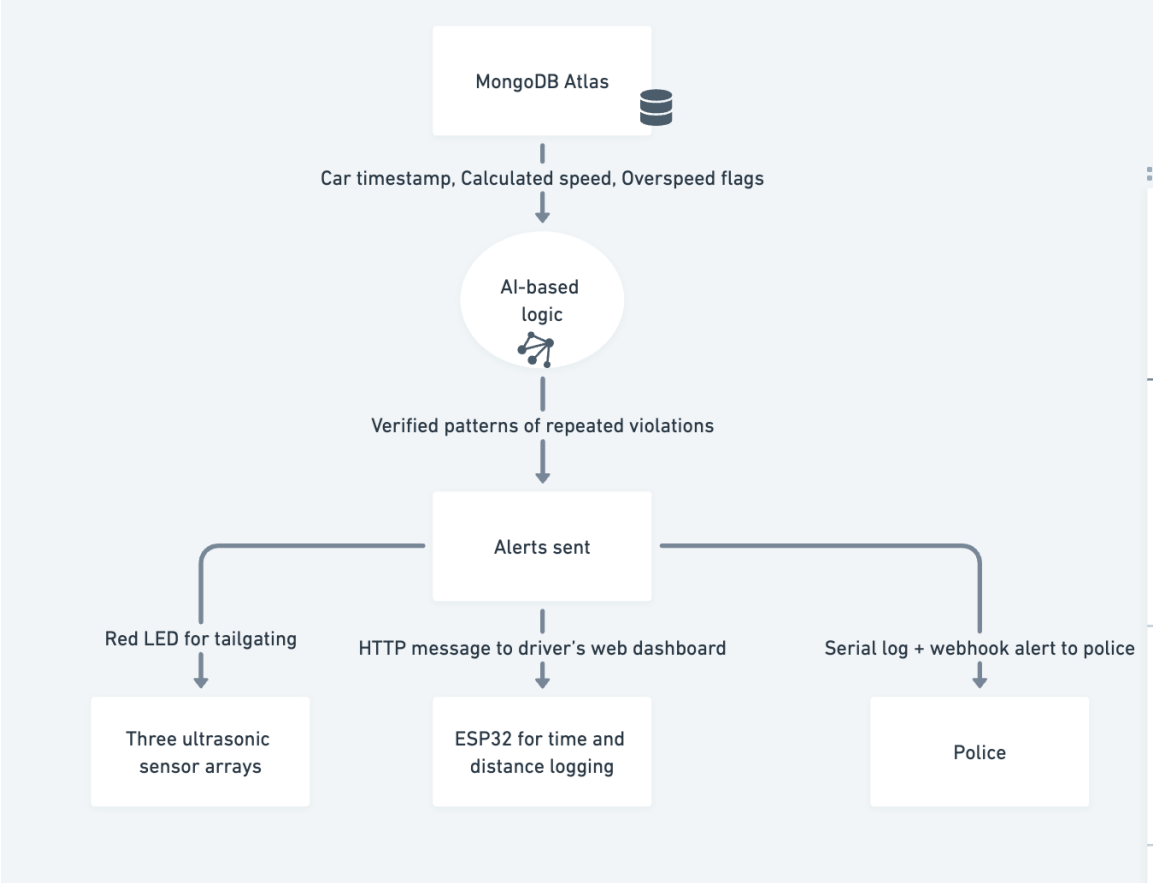

Fig.2 Flow-Chart Diagram demonstrating Flow of application

List of Modules

- Ultrasonic Sensor Module (3 lanes, 3 checkpoints)
- ESP32 Microcontroller Module (Data processing and communication)
- Speed Calculation Module (Timestamp-based speed calculation)
- Violation Detection Module (Tailgating and speed violations)
- Driver Alert Module (Red LED and HTTP web alerts)
- AI Violation Flagging Module
- MongoDB Logging Module
- Police Notification Module (Serial/Webhook)

Hardware and Software Details

Hardware Components

- Ultrasonic Sensors (3-lane setup)
- ESP32 Microcontroller
- Red LED Warning Lights
- Wi-Fi Module (on ESP32)
- Serial communication or Webhook

Software Components

- ESP32 firmware handling sensor data and alert logic
- HTTP web interface for driver alerts
- MongoDB database for logging alerts and violations
- AI logic for violation detection and flagging
- Alert forwarding to police authorities