

Pothole Detection and Dimension Measuring

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Abstract — Potholes and driver drowsiness are two major causes of road accidents, leading to vehicle damage, traffic delays, and loss of human life. Traditional road inspection methods are manual, time-consuming, and inefficient, while existing driver monitoring systems often fail to provide timely warnings. To address these issues, this project presents a real-time intelligent road safety monitoring system that detects potholes and driver fatigue simultaneously. The system uses the YOLOv8 deep learning model for accurate pothole detection from images, videos, and live camera feed. Driver drowsiness and yawning detection is performed using facial landmark analysis by calculating Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR). The system generates instant visual and voice alerts through the in-vehicle display, and also provides an emergency SMS notification feature for critical situations. A web-based interface is implemented using Flask and OpenCV for monitoring, report generation, and data management. Experimental results show that the proposed system provides efficient realtime performance with reliable detection accuracy, making it suitable for smart transportation and road safety applications.

Keywords: YOLOv8, Deep Learning, Computer Vision, OpenCV, Facial Landmark Detection, EAR, MAR, RealTime Monitoring, Alert System, Smart Transportation, Road Safety Monitoring, Flask, Mobile Application

I. INTRODUCTION

Road transportation plays an important role in daily life, but road accidents are increasing due to potholes and driver fatigue. Potholes are formed because of poor road maintenance, heavy traffic, and weather conditions. They can cause serious vehicle damage, traffic delays, and accidents. At the same time, driver drowsiness and frequent yawning are major reasons for accidents, especially during long journeys and night driving.

Traditional pothole detection methods depend on manual inspection, which is time-consuming and not suitable for real-time monitoring. Similarly, many driver monitoring systems are not integrated with road hazard detection, leading to delayed warnings.

To solve this problem, this project proposes a real-time intelligent road safety monitoring system that detects both potholes and driver drowsiness simultaneously. The system uses the YOLOv8 deep learning model for pothole detection and facial landmark analysis to detect eye closure and yawning in real time. The detected results are displayed on the vehicle screen with instant alerts, helping drivers take quick action and improving overall road safety.

II. LITERATURE REVIEW

Many researchers have worked on pothole detection using both traditional image processing and deep learning methods.

Earlier approaches used techniques like thresholding, segmentation, stereo vision, and watershed algorithms. Although these methods provide acceptable results, they are highly affected by lighting changes, shadows, and road texture variations.

Recent studies introduced deep learning models such as Faster R-CNN and Mask R-CNN for road damage detection, which improved accuracy but required high computational power. YOLO-based models gained popularity due to their fast real-time detection capability. YOLOv8 offers improved speed and accuracy, making it suitable for pothole detection in real-world driving environments.

For driver monitoring, facial landmark-based methods using Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) are widely used to detect drowsiness and yawning in real time. However, most existing systems focus on either pothole detection or drowsiness detection separately. This project integrates both into a single real-time road safety monitoring system.

III. PROPOSED SYSTEM

The proposed system is a real-time road safety monitoring platform developed mainly as a mobile application with multiple integrated features. The system is designed to detect road potholes and also monitor driver fatigue conditions such as drowsiness and yawning. It combines deep learning and computer vision techniques to provide accurate detection and instant alerts for improving road safety. For pothole detection, the system uses the YOLOv8 deep learning object detection model to identify potholes from road images, video streams, and real-time camera input. Detected potholes are highlighted with bounding boxes and confidence scores, and the system also estimates pothole dimensions such as width and height for severity analysis. For driver monitoring, the system performs real-time drowsiness and yawning detection using facial landmark analysis. It calculates Eye Aspect Ratio (EAR) to detect eye closure and Mouth Aspect Ratio (MAR) to detect yawning behavior. If the driver shows continuous signs of fatigue, the system identifies it as drowsiness and triggers warning alerts. An important feature of the proposed system is the alert system. Whenever a pothole is detected or driver fatigue is identified, the system generates instant alerts through visual warnings and voice notifications to warn the driver. This helps the driver take quick action, reducing the risk of accidents. Additionally, the system supports integration with a car dashboard screen, where pothole and drowsiness alerts can be displayed directly to the driver for safer driving without depending on mobile phone usage. Overall, the proposed system provides an automated, efficient, and user-friendly solution for real-time pothole detection and driver safety monitoring.

IV. METHODOLOGY

The implementation of the proposed system was carried out through a structured phase-wise methodology to ensure accuracy, real-time performance, and successful integration of all modules.

A. Phase 1: Requirement Analysis

In this phase, the major causes of road accidents such as potholes and driver fatigue were studied. System requirements were identified, including real-time pothole detection, drowsiness and yawning monitoring, alert generation, mobile application support, and dashboard integration.

B. Phase 2: Data Collection and Dataset Preparation

A pothole dataset was collected and prepared for training the detection model. Images were labeled and organized into training and testing sets. Different road conditions such as shadows, cracks, and lighting variations were included to improve model generalization.

C. Phase 3: System Design

The overall system architecture was designed by dividing the project into modules such as pothole detection, drowsiness detection, alert system, mobile application, database storage, and admin monitoring. Data flow and interaction between modules were planned for smooth integration.

D. Phase 4: Model Development and Training

YOLOv8 was selected for pothole detection due to its real-time detection efficiency. The model was trained using the prepared dataset. For driver monitoring, facial landmark detection was implemented using Dlib, and EAR/MAR calculations were used to detect eye closure and yawning.

E. Phase 5: Application Development and Integration

A mobile application was developed as the main interface, including features such as login, real-time monitoring, detection history, and alerts. Flask and OpenCV were integrated to handle image/video processing and model inference. Database support was added to store detection logs and user information.

F. Phase 6: Alert and Notification Implementation

An alert system was implemented to provide instant visual and voice warnings whenever potholes, drowsiness, or yawning were detected. Emergency SMS notification was also integrated to alert saved contacts during critical situations.

G. Phase 7: Testing and Performance Evaluation

The system was tested using real-time road videos and live camera feeds. Accuracy, response time, and alert performance were evaluated. Issues such as false detection under poor lighting were analyzed and improved.

H. Phase 8: Final Deployment and Documentation

In the final phase, all modules were successfully integrated into a single working system. The complete system was deployed for demonstration, and project documentation including report preparation, results analysis, and future scope was completed.

V. IMPLEMENTATION

The proposed system was implemented mainly as a mobile application integrated with real-time pothole detection and driver monitoring features. YOLOv8 deep learning model is used to detect potholes from images, videos, and live camera feed. OpenCV is used for frame extraction and preprocessing, and pothole dimensions are estimated using bounding box measurements.

Driver drowsiness and yawning detection is implemented using Dlib facial landmark detection by calculating Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR). An alert system generates instant visual and voice warnings whenever potholes or fatigue conditions are detected. All detection logs are stored in the database for future reference. The system can also be integrated into a car dashboard screen for real-time alert display.

A. Technologies Used

| Component | Technology Used |
|-------------------------|-------------------------|
| Programming Language | Python |
| Pothole Detection Model | YOLOv8 |
| Image/Video Processing | OpenCV |
| Drowsiness Detection | Dlib (EAR & MAR) |
| Backend Framework | Flask |
| Mobile Application | Flutter |
| Database | MySQL / Firebase |
| Alerts | Visual + Voice Alerts |
| Emergency Notification | SMS API |
| Tools | VS Code, Android Studio |
| Version Control | GitHub |

Table I: Technologies Used in The Proposed System

VI. RESULTS AND DISCUSSION

A. Detection Performance

The proposed system was tested using pothole image datasets, road videos, and real-time camera feed. The YOLOv8 model successfully detected potholes by generating bounding boxes with confidence scores. The system achieved reliable performance under different road surface conditions and varying lighting environments. The detection module produced accurate results with minimal delay, making it suitable for real-time road monitoring.

B. Drowsiness and Yawning Detection Performance

The driver monitoring module was evaluated using realtime webcam input. Facial landmark detection was used to calculate Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR). Continuous low EAR values indicated drowsiness, while high MAR values indicated yawning behavior. The system successfully identified fatigue conditions and generated warnings, improving driver safety during long journeys.

C. Alert System Effectiveness

The alert system generated instant visual warnings and voice alerts whenever potholes or driver fatigue conditions were detected. This real-time alert mechanism enabled quick driver response, reducing accident risk. The system also maintained

detection logs and alert history for further monitoring through the mobile application.

D. System Integration and Reliability

The integration between the pothole detection module, driver monitoring module, mobile application, and backend services was seamless. The system ensured smooth realtime processing of video frames, accurate detection, and consistent performance across different devices. Detection results and user activity logs were stored successfully in the database for future reference.

E. Limitations and Improvements

Although the system performed effectively in normal road conditions, detection accuracy may decrease under poor lighting, heavy rain, or unclear camera input. Similarly, facial monitoring accuracy may be affected by sunglasses, face masks, or improper camera angle. Future improvements can include larger training datasets, severity classification of potholes, GPS-based location tracking, and deployment on edge devices for faster processing.

VII. CONCLUSION

This project successfully developed a real-time intelligent road safety monitoring system capable of detecting potholes and identifying driver fatigue conditions such as drowsiness and yawning. The system utilizes the YOLOv8 deep learning model for accurate pothole detection and facial landmark-based EAR and MAR analysis for driver monitoring. Instant visual and voice alert mechanisms were implemented to ensure timely warnings and improved driver awareness.

The solution was primarily developed as a mobile application with integrated logging and monitoring features, and it is also suitable for integration with an in-vehicle dashboard display. Overall, the proposed system provides an efficient, reliable, and scalable approach for enhancing road safety and supporting smart transportation systems.

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