

ABSTRACT

Road safety is a crucial issue, given the high number of traffic accidents predominantly caused by driver fatigue. To address this problem, this research develops a machine learning-based driver fatigue detection system through eye analysis. The main objectives of this study are to develop a fatigue detection method using real-time Eye Aspect Ratio (EAR) observation and camera processing, and to design an early warning system to prevent accidents.

The research methodology involves collecting a driver face image dataset from 30 participants (totaling 9000 frames of open and closed eyes), data pre-processing using computer vision techniques (including facial landmarks detection), training machine learning models (Convolutional Neural Network/CNN and *hybrid* CNN + EAR), and evaluating system accuracy. Model testing shows that the *hybrid* CNN + EAR approach achieves an accuracy of 94.22%, significantly outperforming the pure CNN model which only reached 92.54%.

The integrated system is capable of detecting drowsy conditions (closed eyes or head nodding) and providing early warnings in the form of audio alarms via a *speaker* and visual indications via an LED (like a *hazard* light). The effectiveness of this warning has been proven in driving simulation scenarios. Thus, this research successfully developed an accurate and responsive solution for driver fatigue detection, contributing to improved road safety.

Keywords: Road safety, Driver fatigue, Drowsiness detection, Machine learning, *Warning*