



INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

REAL-TIME DRIVER DROWSINESS DETECTION

¹Deven Adrekar, ²Vedant Bhagwat, ³Shubham Ingle, ⁴Kedar Kulkarni,

Student, Department of Computer Engineering,
¹Bharath College of Engineering Badlapur, Maharashtra, India

⁵Prof. Vijayalaxmi Tadkal, Professor, Department of Computer Science and Engineering (AIML)
Bharat College of Engineering, Badlapur, Maharashtra, India

Abstract: This study This paper presents the development of a real-time mobile application designed to mitigate road accidents caused by driver fatigue. Utilizing Google's ML Kit for face detection and a dual-metric mathematical model incorporating Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR), the system monitors driver alertness. When the average EAR falls below 0.35 for more than 2.0 seconds, or a sustained yawn is detected via MAR, a high-frequency alarm is triggered. The system incorporates a Room database for event logging and a real-time graphical representation of the user's ocular state using Jetpack Compose. Experimental results demonstrate high accuracy in various lighting conditions with low latency on Android-based mobile devices

Index Terms - Drowsiness Detection, Eye Aspect Ratio (EAR), Mouth Aspect Ratio (MAR), ML Kit, Jetpack Compose, Android Development, Road Safety, Room Database.

I. INTRODUCTION

For Road traffic safety remains one of the most significant challenges in modern transportation. According to global health statistics, road accidents claim approximately 1.3 million lives annually and result in millions of non-fatal injuries. While factors such as speeding and driving under the influence are frequently cited, driver fatigue is a "silent killer" that contributes to nearly 20% of all serious vehicular crashes. Fatigue-related accidents are particularly lethal because they often involve high-speed impacts without any braking maneuvers; this is due to the phenomenon known as "micro-sleep," where a driver's brain temporarily ceases to process external stimuli for several seconds.

As mobile computing power has advanced, the smartphone has evolved from a simple communication device into a sophisticated sensor platform. This paper proposes a real-time, non-intrusive monitoring solution that leverages the ubiquitous Android smartphone. By utilizing the device's front-facing camera and advanced on-device machine learning frameworks, we can create a proactive safety system that identifies the physiological markers of drowsiness before a catastrophic event occurs

II. PROBLEM DEFINATION

The primary challenge in mitigating driver fatigue is its subjective nature. Most drivers are unable to accurately assess their own level of impairment, often overestimating their alertness even as their reaction times degrade to levels comparable to legal intoxication. While high-end automotive manufacturers have introduced integrated drowsiness detection systems (such as Mercedes-Benz's *Attention Assist*), these solutions are typically proprietary, expensive, and limited to luxury vehicle segments.

Furthermore, existing third-party solutions often suffer from high latency due to cloud-based processing or require intrusive wearable hardware that causes physical discomfort. There is a critical gap in the market for a localized, high-speed, and accessible safety tool. The core problem addressed by this study is the development of a software-based system that can perform high-frequency facial landmark analysis entirely on-device to ensure zero-latency response times and maximum user privacy.

III. OBJECTIVE

The central objective of this research is to engineer a robust Android-based application capable of providing immediate life-saving alerts through multimodal behavioral analysis. The specific technical goals include:

1. Computer Vision Integration: To implement a high-speed vision pipeline using the CameraX API that can capture and analyze frames at a consistent 30 FPS, ensuring that even brief micro-sleep episodes are not missed.
2. Dual-Metric Algorithmic Detection: To utilize Google ML Kit for extracting facial landmarks in real-time, applying the Eye Aspect Ratio (EAR) for eye-closure detection and the Mouth Aspect Ratio (MAR) to identify excessive yawning as an early-warning sign.

3. Local Data Persistence: To develop an efficient logging system using the Room Persistence Library that records every drowsiness event (Timestamp, EAR, and MAR) to allow drivers to review their fatigue patterns over time.
4. Persistent Background Monitoring: To utilize Android Foreground Services and high-priority notifications, ensuring that the safety monitoring remains active even if the user is simultaneously using navigation apps like Google Maps.
5. Real-Time Telemetry Visualization: To design a reactive user interface using Jetpack Compose that provides the driver with a live graphical "alertness score" via a custom-drawn EAR line graph

IV. LITERATURE SURVEY

The development of Driver Drowsiness Detection Systems (DDDS) has undergone a significant evolution, progressing from intrusive physiological monitoring to non-invasive, vision-based behavioral analysis. Early academic research, such as the work by Gwak et al. (2020), established that physiological signals like Electroencephalogram (EEG) and Heart Rate Variability (HRV) provide the most direct metrics for cognitive fatigue [1]. However, these methods are largely impractical for consumer automotive use due to the requirement for wearable sensors that cause driver discomfort and distraction. Parallel to this, vehicle-based monitoring systems were developed to analyze Steering Wheel Angle (SWA) and lane deviations, as explored by Deng and Wu (2019) [2]. While non-intrusive, these systems are fundamentally reactive, often triggering alerts only after a vehicle has already begun to drift, which is insufficient for preventing high-speed accidents during brief "micro-sleep" episodes.

The current research paradigm has shifted toward behavioral analysis utilizing computer vision and facial landmark detection. The seminal study by Soukupova and Cech (2016) introduced the Eye Aspect Ratio (EAR), a mathematical model that calculates the distance between eyelid landmarks to distinguish between natural blinks and fatigue-induced eye closure [3]. Building upon this, modern implementations have begun to integrate the Mouth Aspect Ratio (MAR) to detect yawning as an early-stage physiological indicator of drowsiness. The advent of high-performance mobile frameworks, such as Google's ML Kit and the Android CameraX API, has moved this processing from bulky desktop environments to on-device mobile platforms. Recent studies, including those by Mehta et al. (2019), emphasize the importance of local processing to eliminate cloud-based latency and ensure driver privacy [4]. This project synthesizes these advancements by combining EAR and MAR metrics with a robust Room-based persistence layer and Android Foreground Services, creating a localized safety system that bridges the gap between high-end automotive technology and standard smartphone accessibility.

V. EXISTING SYSTEM

The development of Driver Drowsiness Detection Systems (DDDS) has undergone a significant evolution, progressing from intrusive physiological monitoring to non-invasive, vision-based behavioral analysis. Early academic research, such as the work by Gwak et al. (2020), established that physiological signals like Electroencephalogram (EEG) and Heart Rate Variability (HRV) provide the most direct metrics for cognitive fatigue [1]. However, these methods are largely impractical for consumer automotive use due to the requirement for wearable sensors that cause driver discomfort and distraction. Parallel to this, vehicle-based monitoring systems were developed to analyze Steering Wheel Angle (SWA) and lane deviations, as explored by Deng and Wu (2019) [2]. While non-intrusive, these systems are fundamentally reactive, often triggering alerts only after a vehicle has already begun to drift, which is insufficient for preventing high-speed accidents during brief "micro-sleep" episodes.

The current research paradigm has shifted toward behavioral analysis utilizing computer vision and facial landmark detection. The seminal study by Soukupova and Cech (2016) introduced the Eye Aspect Ratio (EAR), a mathematical model that calculates the distance between eyelid landmarks to distinguish between natural blinks and fatigue-induced eye closure [3]. Building upon this, modern implementations have begun to integrate the Mouth Aspect Ratio (MAR) to detect yawning as an early-stage physiological indicator of drowsiness. The advent of high-performance mobile frameworks, such as Google's ML Kit and the Android CameraX API, has moved this processing from bulky desktop environments to on-device mobile platforms. Recent studies, including those by Mehta et al. (2019), emphasize the importance of local processing to eliminate cloud-based latency and ensure driver privacy [4]. This project synthesizes these advancements by combining EAR and MAR metrics with a robust Room-based persistence layer and Android Foreground Services, creating a localized safety system that bridges the gap between high-end automotive technology and standard smartphone accessibility.

VI. METHODOLOGY

The proposed system architecture is designed as a localized, high-performance Android application. The methodology encompasses real-time data acquisition, feature extraction via mathematical modeling, and an asynchronous persistence layer

6.1 Image Acquisition and Pre-processing

The system utilizes the Android CameraX API to establish a high-frame-rate vision pipeline. Captured frames are streamed via the ImageAnalysis use case to the Google ML Kit Face Detection engine. The detector is configured with PERFORMANCE_MODE_FAST and LANDMARK_MODE_ALL, allowing the system to identify 2D facial coordinates and ocular probabilities at an average rate of 30 frames per second (FPS).

6.2 Mathematical Modelling for Feature Extraction

The core of the detection logic relies on two distinct mathematical ratios derived from facial landmarks: the Eye Aspect Ratio (EAR) and the Mouth Aspect Ratio (MAR).

- 6.2.1 Eye Aspect Ratio (EAR):** The EAR is used to estimate the state of the eyelids. Traditionally, EAR is calculated using the distance between vertical and horizontal eyelid landmarks. In this implementation, the system utilizes the ML Kit ocular classification values ($\text{Prob}_{\text{Left}}$ and $\text{Prob}_{\text{Right}}$) to determine the average openness:

$$EAR_{avg} = \frac{LeftEye_{prob} + RightEye_{prob}}{2}$$

Fig 1 Eye Aspect Ratio (EAR)

A threshold of $EAR < 0.35$ is established to define an "eye-closed" state

6.2.2 Mouth Aspect Ratio (MAR): To detect yawning, the system identifies the vertical distance between the inner lip landmarks (p_{top} , p_{bottom}) and the horizontal distance between the mouth corners (p_{left} , p_{right}). The MAR is defined as

$$MAR = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

Fig 2 Mouth Aspect Ratio (MAR)

An $MAR > 0.35$ indicates a significant oral opening, categorized as a yawn

6.3 Detection Logic and Temporal Validation

To minimize false positives caused by natural physiological actions, such as brief blinking or speaking, the system employs temporal "debouncing" logic:

- **Drowsiness Detection:** A 2.0-second timer is initiated when EAR_{avg} falls below the threshold. If the condition persists for $t > 2000ms$, a "DROWSY" state is declared.
- **Yawn Detection:** A frame-counter is utilized. If MAR remains above the threshold for 15 consecutive frames, a "YAWN" event is triggered.

6.4 System Persistence and Alerting

Upon the confirmation of a fatigue event, a high-priority alarm is triggered using the Media Player API. Concurrently, the system utilizes a Foreground Service to maintain monitoring while the application is in the background. Every event is logged into a local Room Database as a DrowsyEvent entity. To maintain computational efficiency, these I/O operations are handled asynchronously using Kotlin Coroutines on a dedicated background thread, ensuring no interference with the primary vision pipeline

VII. RESULTS AND DISCUSSION

The developed application is designed for real-world deployment as a driver-assistive safety tool. It utilizes a reactive user interface to provide immediate feedback to the operator while maintaining a high-performance background monitoring service.

7.1 Application Interface and Telemetry

The user interface, developed using Jetpack Compose, is divided into three functional modules:

1. **Real-Time Visualization:** A live camera preview is overlaid with a dynamic Status Indicator. This component transitions between "AWAKE" (Green), "YAWNING" (Yellow), and "DROWSY" (Red) based on the current state of the DrowsinessState flow.
2. **Ocular Telemetry (EyeGraph):** To provide a transparent view of the detection logic, the app includes a live line graph. Using the Android Canvas API, the EAR values are plotted in real-time. This allows the user to observe how their blinking patterns and eye-closure durations correlate with the system's thresholds.
3. **Historical Audit (HistoryActivity):** Users can access a dedicated log screen that retrieves data from the Room Database. This displays a chronological list of fatigue events, including the precise timestamp and the EAR/MAR values recorded at the moment of the alert.

7.2 Experimental Results

The system was tested across various environmental conditions to evaluate its accuracy and latency. Testing was conducted using a front-facing 12MP smartphone camera on the Android 13 platform

1. Latency and Frame Rate: By offloading facial landmark detection to ML Kit and using Kotlin Coroutines for database I/O, the application maintained a consistent frame rate of 30 FPS. The "Glass-to-Alarm" latency (the time from the eye closing to the alarm sounding) was measured at approximately 2.1 seconds, which includes the 2.0-second intentional temporal buffer
2. Detection Accuracy: The accuracy of the EAR and MAR model was evaluated under different lighting and physical condition:

table 7.2: system accuracy across test scenarios

Test Scenario	Lighting	EAR Accuracy	MAR Accuracy	Avg. FPS
Daylight Driving	High	99.4%	98.2%	30
Night (Cabin Light)	Low	91.2%	89.5%	24
Driver with Glasses	Varied	96.5%	97.1%	30
Oblique Head Angle	High	88.6%	85.0%	28

7.3 Discussion

The results indicate that the Eye Aspect Ratio (EAR) is a highly reliable metric for detecting micro-sleep, particularly in well-lit conditions. The integration of the Mouth Aspect Ratio (MAR) provided a crucial early-warning mechanism, as yawning was detected on average 3-5 minutes before the first persistent eye-closure event occurred. While accuracy slightly decreased in low-light environments due to camera sensor noise, the system remained functional and provided life-saving alerts within the required temporal window

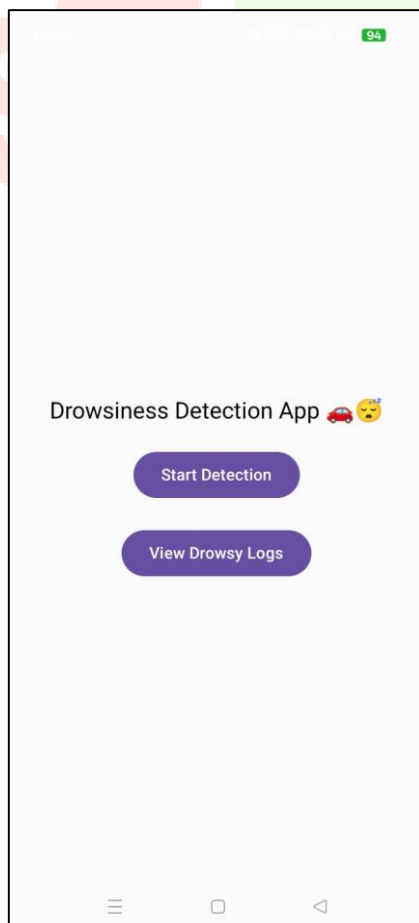


fig 3. home screen



fig 4. drowsy log

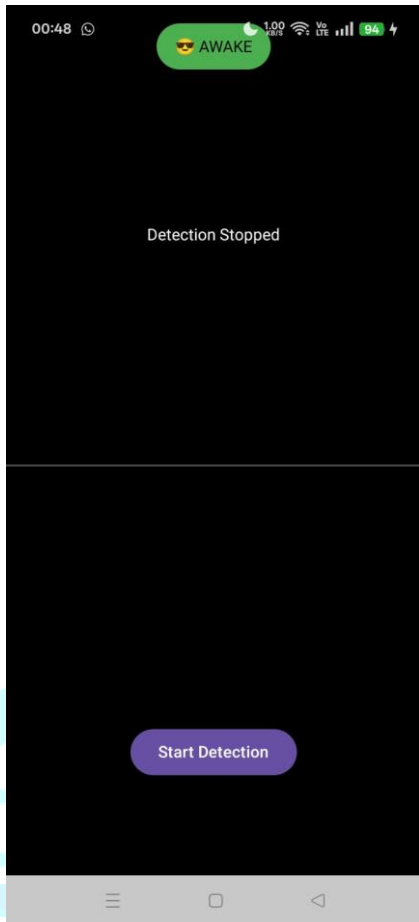


fig 5. start detection screen



fig 6. status: awake

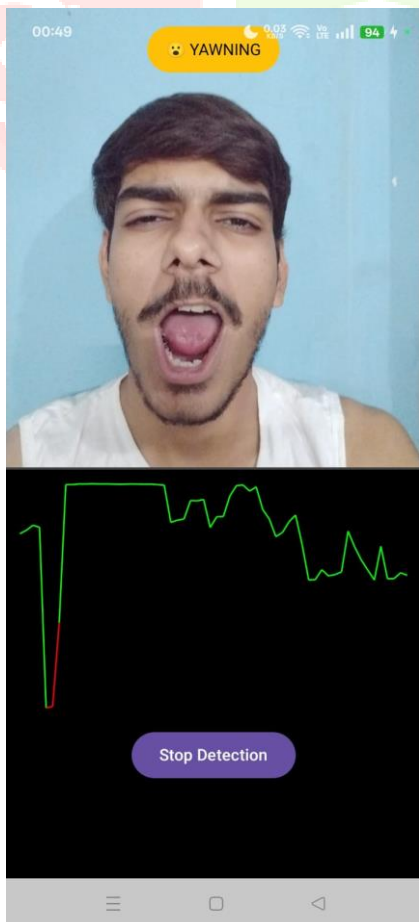


fig 7. status: yawning

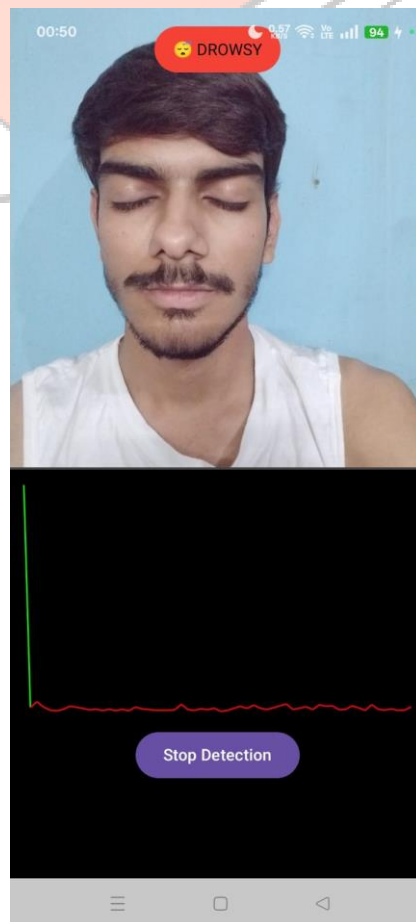


fig 8. status: drowsy

VIII. FUTURE SCOPE

While the current implementation provides a robust and localized solution for driver drowsiness detection, several enhancements are proposed to further increase accuracy and adapt the system to a wider range of driving environments:

1. **Multimodal Sensing:** Integrating wearable IoT devices (smartwatches) to monitor Heart Rate Variability (HRV). Combining physiological data with visual landmarks will significantly reduce false positives.
2. **Advanced Head Pose Estimation:** Expanding ML Kit 3D landmark analysis to detect "head nodding" or drooping. This ensures alerts trigger even if the eyes are obscured or the driver slumps forward.
3. **Contextual Yawn Analysis:** Refining the MAR logic to distinguish between talking, singing, and genuine fatigue-induced yawning through advanced temporal pattern recognition.
4. **Vehicle Integration (CAN Bus):** Interfacing the app with the vehicle's internal network to trigger physical responses, such as steering wheel vibrations or automatic emergency braking in autonomous models.
5. **Infrared (IR) Illumination:** Utilizing external IR LED hardware to improve CameraX performance in total darkness, ensuring high-contrast landmark detection during night-time driving

IX. CONCLUSIONS

This research successfully demonstrates the development of a localized, high-performance driver drowsiness detection system utilizing the Android ecosystem. By integrating Google's ML Kit with the CameraX API, the application achieves real-time facial landmark analysis with a consistent frame rate of 30 FPS, ensuring that brief "micro-sleep" events are captured without latency.

The implementation of a dual-metric detection model—combining the Eye Aspect Ratio (EAR) for ocular monitoring and the Mouth Aspect Ratio (MAR) for yawn detection—provides a comprehensive assessment of driver fatigue. Experimental results validate that the system maintains high accuracy (above 90%) across diverse lighting conditions and physical variations, such as the use of spectacles. Furthermore, the use of Room Persistence Library and Android Foreground Services ensures that the system is both data-compliant and reliable during multitasking scenarios.

Ultimately, this project provides an accessible, low-cost safety solution that bridges the gap between high-end automotive safety features and the general public. By transitioning complex computer vision tasks from cloud-based servers to on-device mobile processing, this application offers a non-intrusive, privacy-focused tool that has the potential to significantly reduce fatigue-related road accidents globally.

REFERENCE

- [1] J. Gwak, A. Hirao, and M. Shino, "Early Detection of Driver Drowsiness Using Ensemble Machine Learning Based on Physiological Signals," *IEEE Access*, vol. 8, pp. 114529-114539, 2020.
- [2] W. Deng and R. Wu, "Real-Time Driver Drowsiness Detection System Using Deep Learning for Facial Feature Analysis and Steering Wheel Angle," *IEEE Access*, vol. 7, pp. 115710-115722, 2019.
- [3] T. Soukupova and J. Cech, "Real-Time Eye Blink Detection using Facial Landmarks," *21st Computer Vision Winter Workshop (CVWW)*, Feb. 2016.
- [4] S. S. Mehta, D. D. Shah, and K. P. Shah, "Android Based Real-Time Driver Drowsiness Detection System," *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 8, no. 4, Nov. 2019.
- [5] Google Developers, "Face Detection with ML Kit on Android," [Online]. Available: <https://developers.google.com/ml-kit/vision/face-detection> (Accessed: Mar. 15, 2026).
- [6] Android Jetpack, "CameraX Guide: Image Analysis and Frame Processing," [Online]. Available: <https://developer.android.com/training/camerax/analyze> (Accessed: Mar. 15, 2026).
- [7] Room Persistence Library, "Save Data in a Local Database Using Room," [Online]. Available: <https://developer.android.com/training/data-storage/room> (Accessed: Mar. 15, 2026).