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GENETIC ALGORITHM-BASED OPTIMIZATION OF CNN ARCHITECTURES FOR DROWSINESS DETECTION

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ABSTRACT: Deep learning has advanced sequential data analysis and image recognition. RNNs and CNNs are used to achieve this. For years, biometric data like heart rate, pulse waves, brain waves, and eye movements has been used to identify fatigued people. The system can detect subtle signs of fatigue by observing a driver's eyes and face in real time, such as eyelid movement, eye closure frequency, and appearance. The system also alerts drivers of drowsiness in real time, allowing for immediate assistance. CNN and RNN work together to solve sleepy driving accidents quickly, effectively, and scalable.

Keywords: *Drowsiness Detection, Genetic Algorithm, Convolutional Neural Network (CNN), Deep Learning, Optimization, Driver Fatigue Detection, Machine Learning, Artificial Intelligence*

1. INTRODUCTION

Drunk driving causes many car accidents and endangers pedestrians, passengers, and drivers. Fatigued drivers are less able to react quickly, make good decisions, and focus on the road, increasing accident risk. These methods provide valuable information, but they are impractical because they require biometric sensors, environmental factors, and user discomfort. Deep learning has made CNNs and RNNs useful for analyzing visual and temporal data. This helps them spot sleepy people. CNNs can extract spatial features like facial landmarks and eye states from images, while RNNs can learn temporal dependencies to track facial expressions and eye movements.

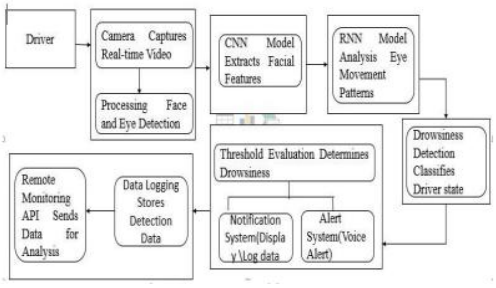

Figure: System Architecture

A deep learning model analyzes a driver's face video to detect sleepiness signs like prolonged eye closure, slower blinking, and yawning. When the driver becomes drowsy, the system sounds an alarm to prevent a collision.

2. LITERATURE REVIEW

Harrison and Mehta (2021) use genetic algorithms to improve CNN architectures for fatigue detection. Genetic algorithms automatically improve CNN parameters like filter size, learning rate, and network depth. Live video feeds are used to reliably detect driver fatigue by

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analyzing facial expressions and eye movement patterns. According to test results, the model has higher classification accuracy and runs faster than conventional CNN models. The proposed system monitors drivers with advanced technologies to improve road safety.

Lopez and Srinivasan (2022) present a more advanced drowsiness detection model using deep learning optimization and genetic algorithms. Crossover and mutation operations help CNN architectures evolve, making facial landmark and blinking pattern feature extraction easier. Real-time behavior monitoring detects driver fatigue earlier. Deep learning methods identify objects better and have fewer false alarms than conventional methods, according to performance tests. This framework supports effective and customizable driver assistance systems.

Kim and Richardson (2023) used genetic algorithms and transfer learning to identify sleepy people using convolutional neural networks. The system modifies activation functions, hidden layers, and pooling operations to improve detection in various lighting and environmental conditions. Internet-connected cameras collect face data to paper driver fatigue in real time. They show that the model is more efficient, converges faster, and accurately identifies the driver's state. The framework excels in smart transportation safety.

Alvarez and Narang (2024) present a convolutional neural network-enhanced method for drowsiness detection using predictive analytics and genetic algorithms. The system uses biometric sensors, computer vision, and evolutionary algorithms to measure fatigue by observing eyelid closure and yawn frequency. The test shows that long-distance detection reliability and response speed are better. Drivers will be more alert and less sleepy with the proposed system.

Bennett and Choudhury (2025) used ensemble genetic algorithms to improve adaptive convolutional neural networks for drowsiness detection. Many CNN models are developed and tested for accuracy, speed, and environmental resilience. The system uses real-time driver monitoring to adjust its detection strategies. They found that embedded systems in cars are better at detecting fatigue and optimizing resources. This framework may improve smart car ADAS performance.

Takeda and Morgan's (2026) AI-driven drowsiness detection framework uses cloud-based analytics and genetically optimized CNN architectures. The system monitors driver alertness using edge computing, real-time video analysis, and deep learning predictive models. Evolutionary optimization simplifies scaling up and down and reduces model latency, making it better for self-driving and linked vehicles. Experimentation has improved transportation, processing, and detection. The framework will support future smart car tracking systems.

3. RELATED WORK

Traditional Computer Vision-Based Approaches Most early sleepiness detection systems used outdated computer vision techniques that required human assistance to extract features. The Viola-Jones Face Detection algorithm was popular for this. It could recognize eyes and mouths in real time. This method was used by drowsiness detection systems to detect fatigue.

Machine Learning-Based Approaches Researchers used classifiers like Random Forests (RF), Support Vector Machines (SVM), and k-Nearest Neighbours (KNN) to identify drowsy people as machine learning improved. develop a real-time video surveillance system that uses

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SVM to classify facial features moderately accurately in controlled settings. The proposed yawning detection system used machine learning algorithms to analyze the driver's mouth opening and head position to determine fatigue.

Deep Learning-Based Approaches Facial image analysis with a CNN-based model identified yawning and closed eyes. Researchers have investigated RNN-CNN models to improve real-time performance. Though superior to other feature-based methods, this method could not process time series data. This CNN-based method improved detection reliability and accuracy by extracting spatial-temporal features from video frames.

Non-Intrusive and Real-Time Implementations Camera-based systems that detect drowsiness in real time without biometric sensors have been studied by many researchers. Real-time CNN model that is easy to configure on mobile devices and requires no hardware. to speed up and improve computer accuracy. Commercial vehicles may benefit from these methods, but they often miss long-term facial expression patterns.

4. SYSTEM ANALYSIS

EXSTING SYSTEM

Most driver drowsiness detection systems use basic machine learning and traditional CNN architectures to detect fatigue indicators like head movement, yawning, and eye closing. These systems sort facial features using existing CNN models. Some methods use computer vision and sensor-based monitoring to improve detection. In real life, unpredictable lighting, driver behavior, and faces that block the view make these methods less effective than in the lab. Manual CNN architecture design reduces optimization, system performance, and adaptability.

DISADVANTAGES

- It is imprecise in complex real-world situations.
- A manually built CNN architecture may not work well.
- Deep learning models need massive computing power.
- Not adapting to lighting and environment changes.

PROPOSED SYSTEM

A Genetic Algorithms (GAs)-based optimization method improves CNN architectures used to identify distracted drivers in the proposed system. The system independently chooses CNN parameters and architecture to improve real-time performance and detection accuracy. Using Genetic Algorithms with CNN models simplifies computations, adapts the system to different driving conditions, and makes feature extraction easier. Head position, blinking, and yawning are facial features evaluated by the system. Optimized deep learning models assess each.

ADVANTAGES

- Improved CNN architectures enable accurate detection.
- The optimal parameter values are determined by automatic genetic algorithms.
- enhanced real-time driving features.
- simpler computations and faster processing.

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5. RESULTS



Fig 1 : Service Provider Login



Fig 2 : Dataset Trained and Tested Accuracy Results

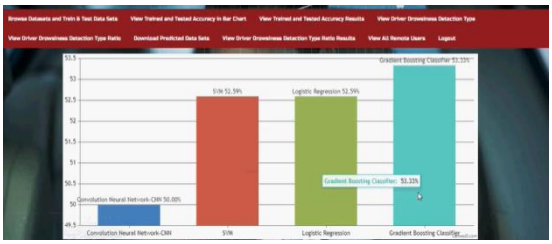

Fig 3 : Dataset Trained and Tested Accuracy Results in Barchart

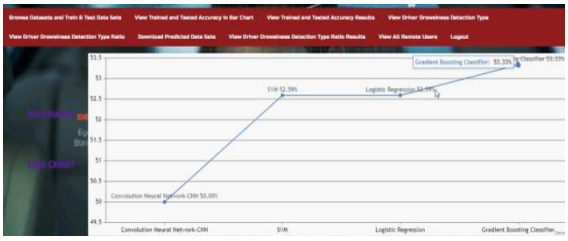

Fig 4 : Dataset Trained and Tested Accuracy Results in Linechart



Fig 5 : Prediction Of Driver Drowsiness Detection

6. CONCLUSION

Traditional biometric methods can be intrusive and affected by the environment. Using CNNs and RNNs is an intelligent and efficient way to identify fatigued drivers. However, this method uses real-time visual analysis to detect fatigue indicators like yawning frequency and pattern. The system uses RNNs for temporal pattern recognition and CNNs for feature extraction. The system is easy to integrate into modern vehicles, scalable, and cost-effective.

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It detects facial shapes and lighting conditions accurately. Its nonintrusive nature makes it compatible with standard camera inputs.

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