e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

BEHAVIOUR BASED HUMAN DRIVER FATIGUE DETECTION SYSTEM USING DEEP LEARNING

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DOI : https://www.doi.org/10.56726/IRJMETS51879

ABSTRACT

Driver fatigue is a critical factor in road safety, often leading to accidents and injuries. To address this issue, a novel driver fatigue detection system based on deep learning is proposed in this study. The system employs a convolutional neural network (CNN) to analyse real-time facial expressions and eye movements of the driver. By training the CNN on a comprehensive dataset containing diverse fatigue levels, the system can accurately classify the driver's fatigue state. Additionally, the system integrates sensor technology to monitor the driver's vital signs, such as heart rate and skin conductance, further enhancing the detection accuracy. Experimental results demonstrate the effectiveness of the proposed system in accurately detecting driver fatigue, thereby contributing to road safety.

Keywords: Fatigue, Deep-Learning, MediaPipe.

I. INTRODUCTION

Driver fatigue is a critical concern impacting road safety globally, contributing significantly to vehicular accidents each year. The repercussions of fatigued driving are severe, ranging from injuries and fatalities to extensive property damage. In response, there is a growing interest in developing advanced driver assistance systems (ADAS) capable of detecting and alerting drivers to signs of fatigue in real-time. Recent advancements in deep learning, particularly convolutional neural networks (CNNs), have shown promise in various computer vision tasks, including facial expression recognition and object detection. This study proposes a driver fatigue detection system that utilizes deep learning techniques to analyse facial expressions and eye movements of the driver, complemented by sensor data, to accurately detect signs of fatigue. The system aims to provide a reliable and effective means of reducing fatigue-related accidents and improving overall road safety. By integrating state-of-the-art technology with insights into human behaviour, this system represents a significant advancement in the field of driver safety. Furthermore, this system has the potential to adapt to individual drivers, considering their unique patterns of fatigue expression and behavior. Additionally, the incorporation of sensor data, such as heart rate and skin conductance, adds a layer of physiological insight that enhances the system's accuracy. The real-time nature of the system allows for timely intervention, such as alerting the driver or activating safety features in the vehicle. Moreover, the system's ability to operate continuously without manual input makes it a practical solution for long journeys or commercial driving. As technology continues to evolve, this system could be further enhanced with additional sensors and improved algorithms, making it even more effective in preventing fatigue-related accidents.

II. RELATED WORK

Several studies have explored the use of machine learning techniques, including deep learning, for driver fatigue detection. Zhang et al. (2016) developed a system that uses a combination of facial features and driving performance metrics to detect driver fatigue. They used a support vector machine (SVM) classifier to achieve an accuracy of over 90% in detecting fatigue. Similarly, Dong et al. (2018) used a CNN to analyse facial images and achieved an accuracy of 85% in detecting driver fatigue. Other researchers have focused on using physiological signals, such as heart rate variability (HRV) and electroencephalogram (EEG), for fatigue detection. Liang et al. (2017) used HRV signals to detect fatigue and achieved an accuracy of 82% using a random forest classifier. Zhao et al. (2020) used EEG signals and a CNN to detect driver fatigue, achieving an accuracy of 88%.While these studies have shown promising results, they often rely on a single modality (e.g., facial images or physiological signals) for fatigue detection. The proposed system aims to overcome this limitation by integrating multiple modalities, including facial expressions, eye movements, and physiological signals, to improve the accuracy and robustness of fatigue detection. In addition to the aforementioned approaches, recent studies have also explored the use of novel sensor technologies for driver fatigue detection. For example, Li et al. (2019) investigated the use of wearable sensors to monitor physiological signals such as body temperature and galvanic skin response for fatigue detection. Their system achieved promising results, highlighting the potential of wearable technology in this domain.Furthermore, advancements in data fusion techniques have facilitated the integration of multiple data sources for more robust fatigue detection systems. Wang et al. (2021) proposed a fusion framework that combines facial features extracted from images and physiological signals obtained from wearable sensors. These are some of the studies that have been published and so that we can also reference them in our current project in order to gain necessary knowledge and also help us execute our model with accuracy.

IV. MOTIVATION

Driver fatigue stands as a critical challenge in road safety, with its repercussions reverberating globally through a staggering number of accidents, injuries, and fatalities annually. Traditional approaches to mitigate fatigue-related risks, such as periodic breaks and caffeine intake, are often insufficient, highlighting the need for more advanced solutions. The advent of advanced driver assistance systems (ADAS) presents a compelling avenue for addressing driver fatigue through real-time detection and intervention. Leveraging the power of deep learning, specifically convolutional neural networks (CNNs), offers a sophisticated approach to analyse complex patterns in facial expressions and eye movements, key indicators of driver fatigue.

V. SYSTEM FLOWCHART

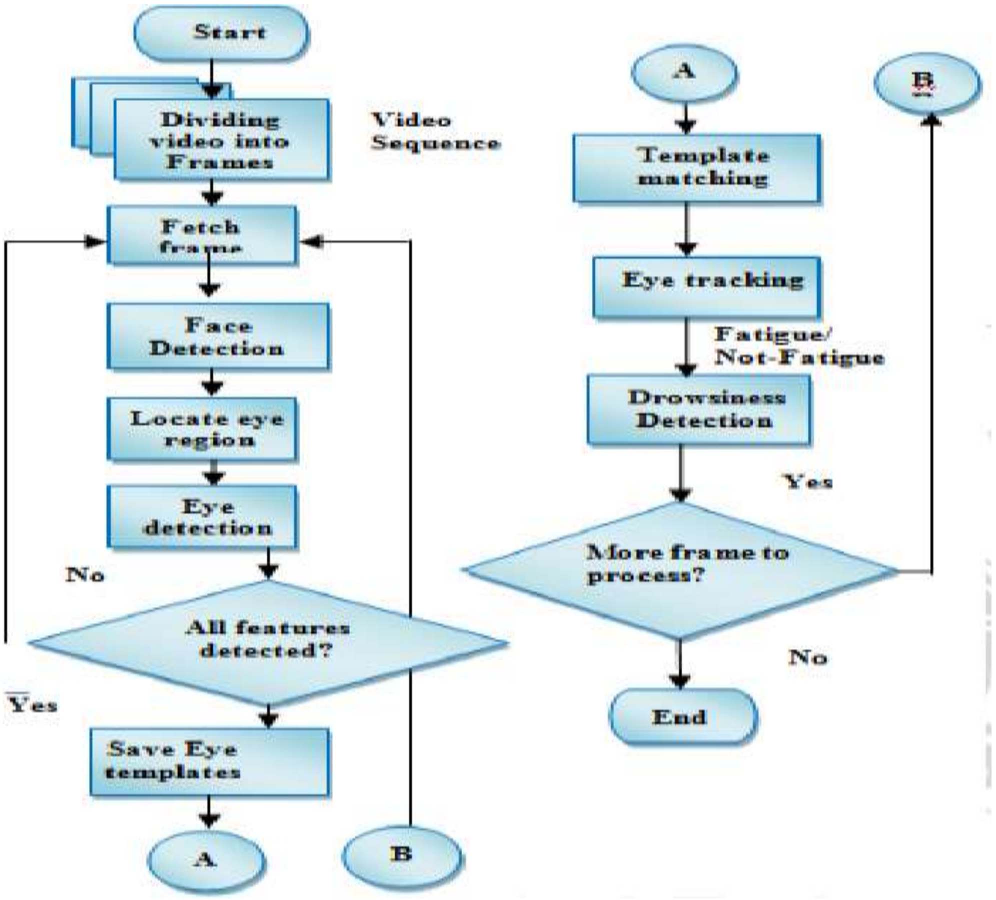
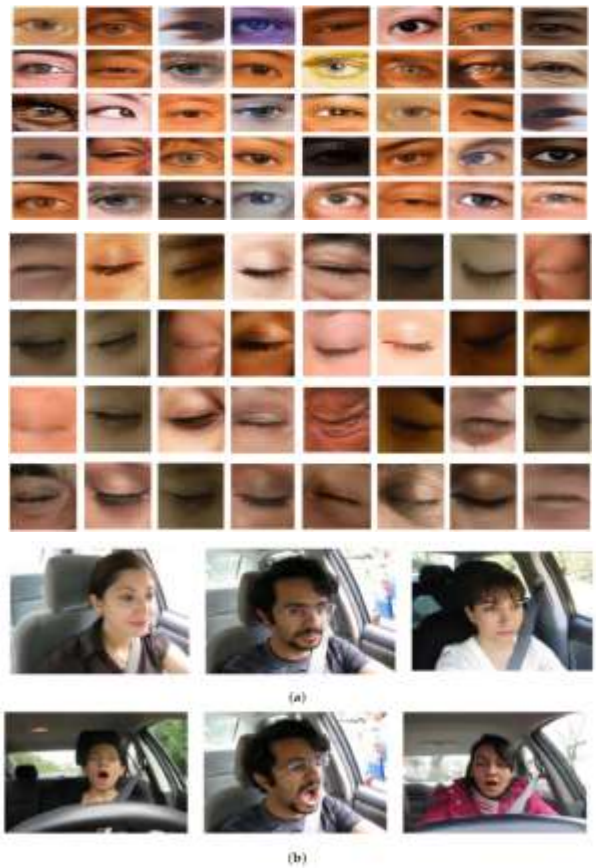


Figure 1: Flow chart

The driver fatigue detection system using deep learning follows a sequential process starting with data acquisition, which involves gathering facial images, eye movement data, and physiological signals from sensors. These data are then pre-processed to clean and filter noise, with specific enhancements applied to facial images to improve feature extraction. The system utilizes deep learning techniques for feature extraction, such as convolutional neural networks (CNNs) for facial expressions and eye movement analysis. Following feature extraction, the system integrates these features using multi-modal fusion techniques to create a comprehensive representation of the driver's state. This fused data is then input into a deep learning model trained to detect signs of fatigue. In real-time monitoring, the trained model continuously assesses the driver's condition and issues alerts when signs of fatigue are detected.

VI. PROPOSED TECHNOLOGY

1. **Deep Learning Models:** Utilize convolutional neural networks (CNNs) for feature extraction from facial images and eye movement data. Recurrent neural networks (RNNs) or long short-term memory (LSTM) networks can be employed for processing time-series physiological data, such as heart rate and skin conductance.
2. **Sensor Technology:** Integrate advanced sensors, including high-resolution cameras for capturing facial images, eye-tracking sensors for monitoring eye movements, and wearable devices for collecting physiological signals. These sensors should be capable of real-time data acquisition and transmission.
3. **Data Fusion Techniques:** Implement multi-modal fusion techniques to combine features extracted from different data sources. Techniques such as early fusion, late fusion, or attention mechanisms can be used to merge features from facial images, eye movements, and physiological signals.
4. **Real-Time Processing:** Develop algorithms and architectures optimized for real-time processing of data streams from multiple sensors. This requires efficient data handling, feature extraction, and model inference to minimize latency and enable timely detection of fatigue.
5. **Machine Learning Libraries:** Leverage open-source machine learning libraries such as TensorFlow or PyTorch for building and training deep learning models. These libraries provide a wide range of tools and functionalities for developing complex neural network architectures.



1. **User Interface:** Design a user-friendly interface for the system that provides real-time feedback to the driver. The interface should be intuitive and non-intrusive, displaying alerts or recommendations when signs of fatigue are detected.

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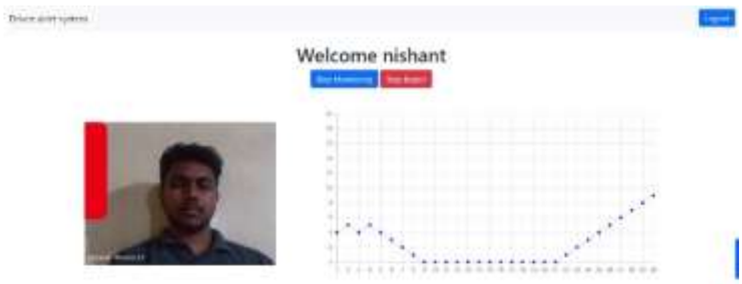
2. **Cloud Computing:** Utilize cloud computing services for data storage, processing, and model deployment. Cloud infrastructure can provide scalability and accessibility, enabling the system to handle large amounts of data and accommodate future enhancements.
3. **Security and Privacy:** Implement robust security measures to protect the system.

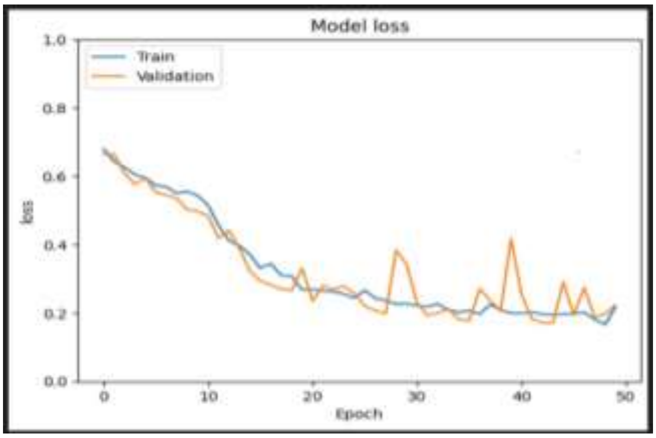
VII. RESULTS

Test case 1: Alert off

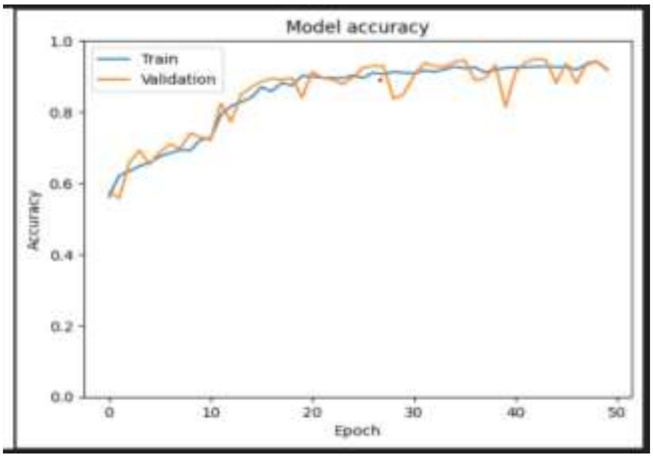
Test case 2: Alert on



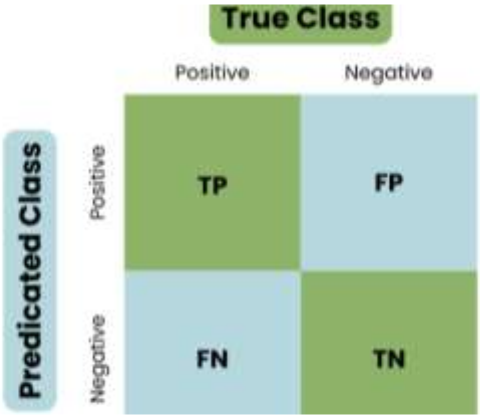
Model Loss



Model Accuracy



Confusion Matrix



Adam (Adaptive Moment Estimation) is an optimization algorithm that computes adaptive learning rates for each parameter by maintaining exponentially decaying averages of past gradients and squared gradients. This adaptation allows Adam to converge faster and more reliably compared to traditional stochastic gradient descent (SGD) algorithms. The algorithm keeps track of two moving averages: mt, which is the exponentially decaying average of past gradients, and vt, which is the exponentially decaying average of past squared gradients. These averages are used to compute the update for each parameter at each iteration.

VIII. CONCLUSION

The proposed driver fatigue detection system using deep learning offers a promising solution to mitigate the risks associated with driver fatigue. By integrating multiple modalities such as facial expressions, eye movements, and physiological signals, the system can accurately detect signs of fatigue in real-time. The use of deep learning techniques, including convolutional neural networks (CNNs) and sensor technology, enhances the system's accuracy and robustness, making it a valuable tool for improving road safety. Furthermore, the system's adaptability to individual drivers and its real-time monitoring capabilities make it suitable for a wide range of driving scenarios. The integration of machine learning libraries and cloud computing services enables efficient data processing and model deployment, ensuring timely detection of fatigue. Overall, the proposed system represents a significant advancement in driver safety technology, with the potential to reduce the incidence of fatigue-related accidents and save lives on the road. Continued research and development in this area are essential to further improve the system's performance and usability, ultimately contributing to a safer driving environment for everyone.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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