Project Report

Deep Learning

[CSE4007]

Driver Drowsiness Detection

By

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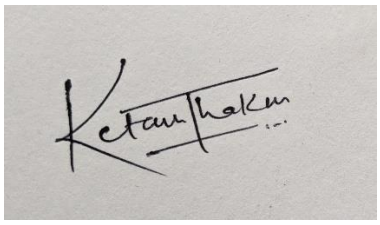
November 2023

Declaration by the Candidates

We hereby declare that the project entitled *"Driver Drowsiness Detection"* has been carried out to fulfill the partial requirements for completion of the coreelective course on **Deep Learning** offered in the 5th Semester of the Bachelor of Technology (B.Tech) program in the Department of Computer Science and Engineering during AY-2023-24 (odd semester). This experimental work has been carried out by us and submitted to the course instructor *Dr. Soharab Hossain Shaikh***.** Due acknowledgments have been made in the text of the project to all other materials used. This project has been prepared in full compliance with the requirements and constraints of the prescribed curriculum.

Akshay Kumar Jain

Ketan Thakur



Place: BML Munjal University

Date: 18th November 2023

Introduction

When a person is fatigue due to prolonged driving will tend to sleep during driving which can cause accident, which in result will harm himself and possibly people around him. Drowsiness is generally difficult to detect or monitor. Drunk driving is a big issue in India. The dangers of drowsy driving, as well as the often-disastrous consequences, are alarming. The most dangerous type of driving is drowsy driving.

Drowsiness and driving are a deadly combo. And exhaustion This usually occurs when a driver loses control of his or her vehicle. If he has not gotten enough sleep, although it can also be caused by Medications, alcohol, or shift work may all be contributing factors.

However, the number of people drinking, and driving is on the rise. Every year, approximately 200 individuals are killed as a result of drinking and driving. It is not only the driver who suffers, but also his passengers and other passengers. In 2016, it was estimated that 100 footsloggers and 390 car passengers were critically hurt or killed by drunk drivers.

Drunk drivers killed or seriously injured 40 children in that year. When our bodies go to sleep, no one knows exactly what happens.

It's obvious that falling asleep while driving is dangerous, but it also impacts the driver's ability to drive safely. Drowsy driving caused 72,000 collisions, 44,000 injuries, and 800 deaths in 2013, according to the National Highway Traffic Safety Administration.

Problem Statement

Driver drowsiness is a critical issue contributing to road accidents and fatalities worldwide. The increasing number of vehicles on roads and the demanding nature of modern lifestyles have led to a rise in instances where drivers, fatigued or sleepy, pose a significant threat to road safety. The consequences of drowsy driving can be severe, ranging from property damage to loss of life. The objective of this research is to address the pressing need for an effective Driver Drowsiness Detection System (DDDS) that can reliably identify signs of driver fatigue and alertness deterioration in real-time. Existing solutions often lack accuracy, adaptability to various driving conditions, and integration with modern vehicles. Moreover, the current research landscape necessitates a more comprehensive understanding of the diverse factors influencing drowsiness, including individual variations, environmental conditions, and driving patterns. This study aims to develop an innovative DDDS that leverages advanced technologies such as computer vision, machine learning, and physiological sensors to provide timely and accurate alerts to drivers, preventing potential accidents. The research will also explore the ethical implications and user acceptance factors associated with implementing such systems, ensuring a holistic approach to enhancing road safety. The successful development of a robust DDDS will contribute significantly to mitigating the risks associated with driver drowsiness, promoting safer roads and reducing the overall societal and economic impact of road accidents.

Abstract

Road safety is a paramount concern, and driver drowsiness contributes significantly to vehicular accidents. This project addresses the critical issue of drowsy driving by developing an advanced Driver Drowsiness Detection System (DDDS) employing Convolutional Neural Networks (CNNs) for open/closed eye classification. The methodology involves assembling a meticulously curated dataset of 2900 images, encompassing closed eye person pictures, open eye person pictures, no-yawn pictures, and yawn pictures. Through data preprocessing and splitting, the dataset is prepared for model training, validation, and testing.

A carefully selected CNN architecture is trained on the dataset, optimizing for accuracy in detecting open and closed eyes, as well as yawning behavior. Hyperparameter tuning and validation ensure the model's robustness and generalization to real-world scenarios. Ethical considerations are integrated into the development process, emphasizing privacy and user consent. Optionally, a user interface for real-time monitoring may be developed, providing visual alerts based on the model's predictions.

The project's contribution lies in the creation of an effective DDDS that enhances road safety by accurately identifying signs of driver drowsiness. The comprehensive methodology, ranging from data collection to model evaluation, ensures a systematic approach to project development. The results and findings are documented in a detailed report, offering insights into the model's performance, challenges faced, and potential areas for refinement. This project serves as a valuable contribution to the field of driver safety, striving towards the reduction of accidents associated with drowsy driving.

Literature Review

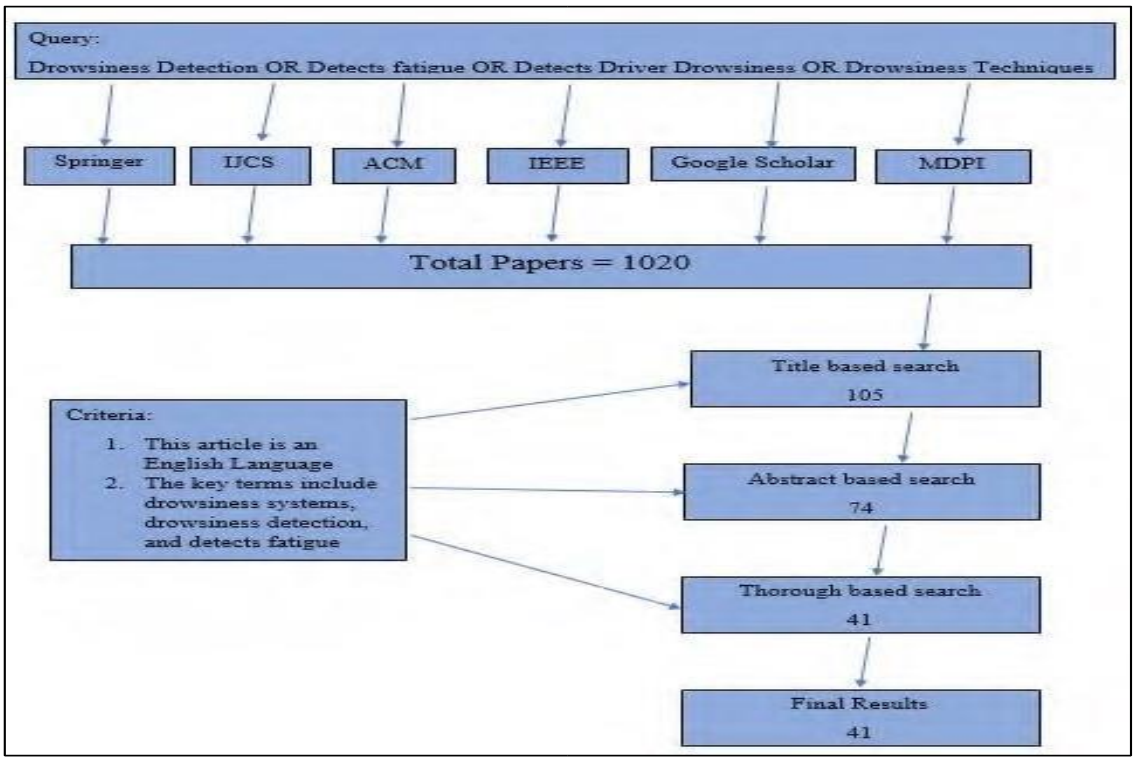
1.)A Survey on State-of-the-Art Drowsiness Detection Techniques:-

Abstract:

The research paper titled "A Survey on State-of-the-Art Drowsiness Detection Techniques" by Muhammad Ramzan, Hikmat Ullah Khan, Shahid Mahmood Awan, Amina Ismail, Mahwish Ilyas, and Ahsan Mahmood addresses the critical issue of drowsiness or fatigue as a major contributor to road accidents, emphasizing its implications for road safety. The abstract introduces the paper's focus on preventing accidents caused by drowsy drivers and presents a survey of various drowsiness detection methods. These methods involve extracting features from facial expressions, analyzing the driver's biological condition, and studying vehicle behavior. The paper provides a comprehensive analysis of existing driver drowsiness detection methods, categorizing them into behavioral, vehicular, and physiological parameters-based techniques, and reviews widely used classification techniques. The abstract concludes with research frameworks and findings, guiding future work in the field.

Introduction:

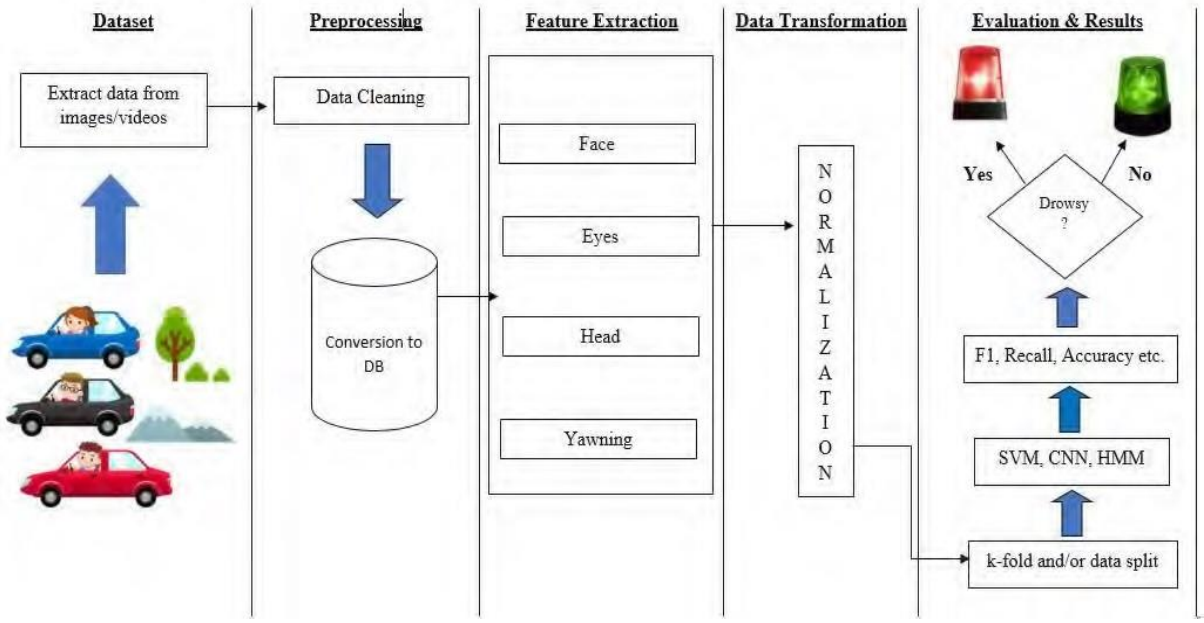
The introduction section of the paper sets the stage by highlighting the significance of addressing drowsiness or fatigue as a leading cause of road accidents. It emphasizes the importance of preventing accidents resulting from drivers' drowsy states and introduces various



drowsiness detection methods as a solution. The introduction provides an overview of the paper's structure, outlining the categorization of methods into behavioral, vehicular, and physiological parameters-based techniques. It serves to orient the reader to the paper's purpose and the critical issues it aims to address.

Methods Used/Methodology:

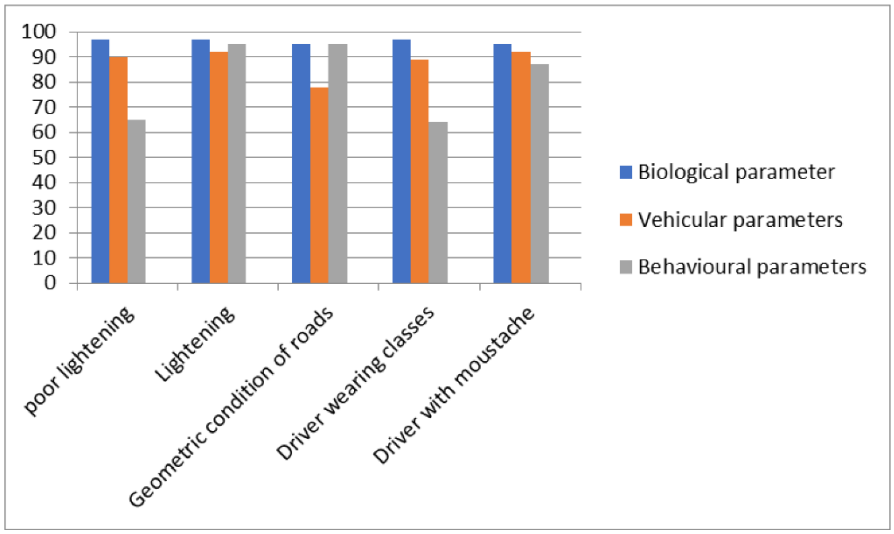
The methodology section outlines the systematic approach used in the research. The authors conducted a systematic review to identify and categorize the best techniques, measures, tools, and classification methods for driver drowsiness detection. The data acquisition and selection process involved a well-organized search across platforms such as IEEE Xplore, ACM, Springer, Google Scholar, IJCS, and MDPI. The paper details the selection of 105 papers based on title relevance, further filtering down to 41 research papers through abstract examination. The methodology also includes a comprehensive review of drowsiness detection techniques, a comparative analysis, and discussions on hybrid approaches and classification methods. This section provides a roadmap for the reader to understand how the research was conducted and how the conclusions were derived.



Results and Accuracy:

The results and accuracy section of the paper presents a detailed review of drowsiness detection techniques, categorizing them into behavioral, vehicular, and physiological parameters-based methods. The section discusses the strengths and weaknesses of each technique, offering a comparative study. The research findings, based on an extensive survey, aim to guide young researchers in identifying potential future work in the field of driver drowsiness detection. The emphasis is on providing insights into the current state-of-the-art techniques and their classification, offering a valuable resource for researchers and practitioners in the domain.

Technique	Parameters	Pros	Cons
Behavioral parameters-based DDT	Eye blinking, Eye closeness ratio, Head movement, Yawning	Non-intrusive Easy to use	Effected by illumination, Lightening conditions
Vehicle parameters-based DDT	Steering wheel behavior, yaw angle, lane changing pattern	Non-intrusive	Effected by geometric characteristics of roads, Unreliable
Physiological parameters-based DDT	Heart rate, pulse rate, brain activity, respiratory rate, body temperature	Efficient, reliable	Intrusive



2.) AD3S: Advanced Driver Drowsiness Detection System Using Machine Learning:-

Abstract:

The research paper titled "AD3S: Advanced Driver Drowsiness Detection System Using Machine Learning" introduces an innovative solution to address the critical issue of driver drowsiness as a significant contributor to road accidents. Authored by Sukrit Mehta, Parimal Mishra, Arpita Jadhav Bhatt, and Parul Agarwal, the paper presents AD3S, an Advanced Driver Drowsiness Detection System implemented through an Android application. AD3S employs real-time facial landmark tracking to compute parameters such as Eye Aspect Ratio (EAR), Nose Length Ratio (NLR), and Mouth Opening Ratio (MOR) using adaptive threshold techniques. This approach effectively detects signs of drowsiness in drivers.

Introduction:

The introduction of the paper emphasizes the prevalent problem of driver drowsiness leading to road accidents. It introduces the proposed solution, AD3S, highlighting its methodology centered around facial landmark analysis. The system aims to enhance drowsiness detection by employing machine learning and deep learning techniques. The focus is on providing a nonintrusive and cost-effective solution, making it applicable and accessible for a wide range of users. The authors outline the significance of the research problem and the potential impact of AD3S on improving road safety.

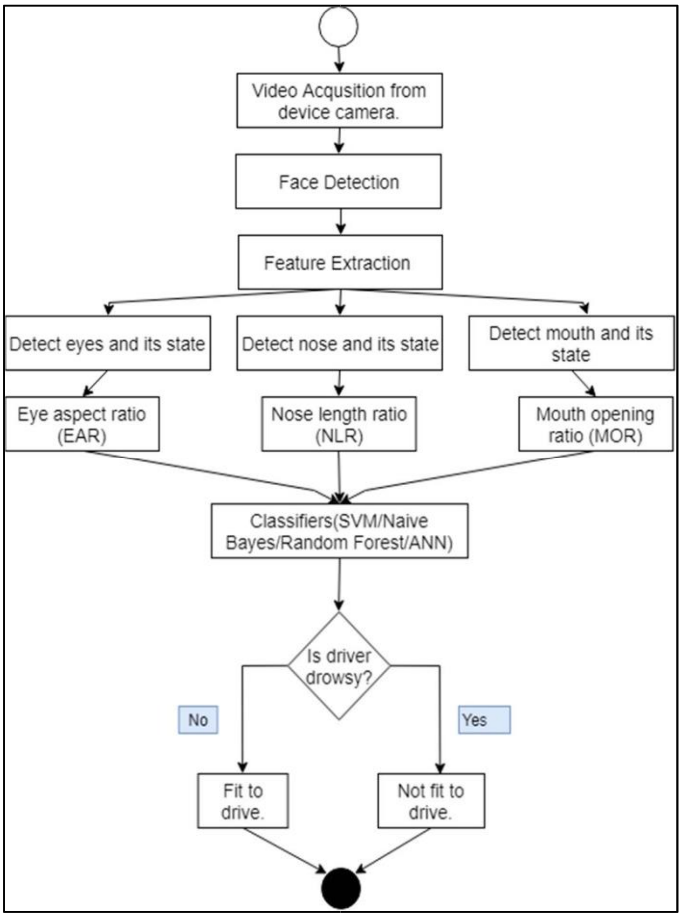
Methodology:

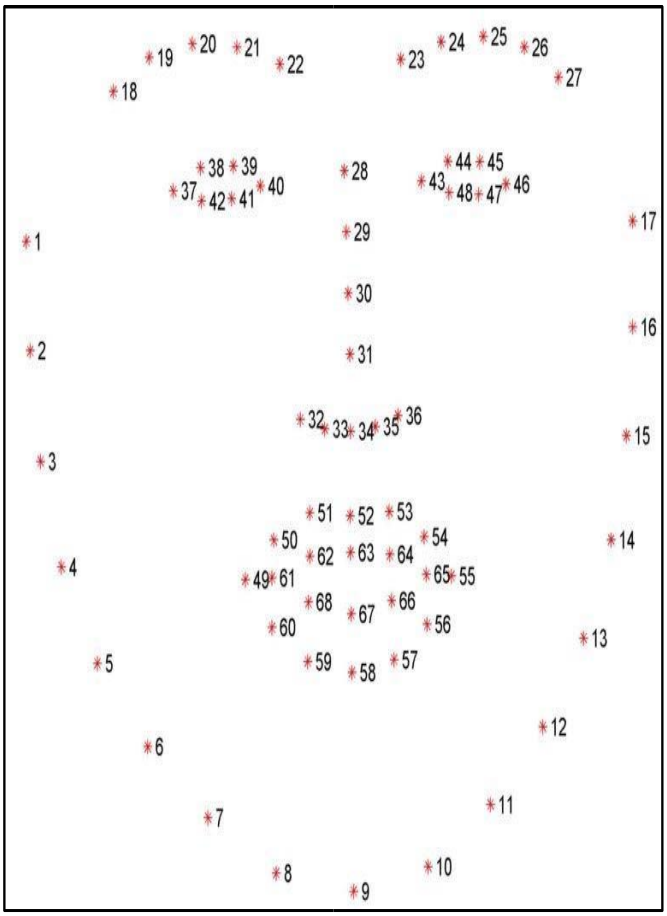
The methodology section outlines the approach taken to develop and implement AD3S. The authors describe the data acquisition process involving 1200 application users, emphasizing the importance of diverse and extensive datasets. The core of the methodology revolves around facial landmark tracking and the computation of key parameters (EAR, NLR, and MOR) using adaptive thresholds. The paper provides insights into the machine learning and deep learning techniques applied to test the effectiveness of AD3S in detecting driver drowsiness. This section forms the technical foundation of the research, elucidating the systematic steps taken to achieve the desired results.

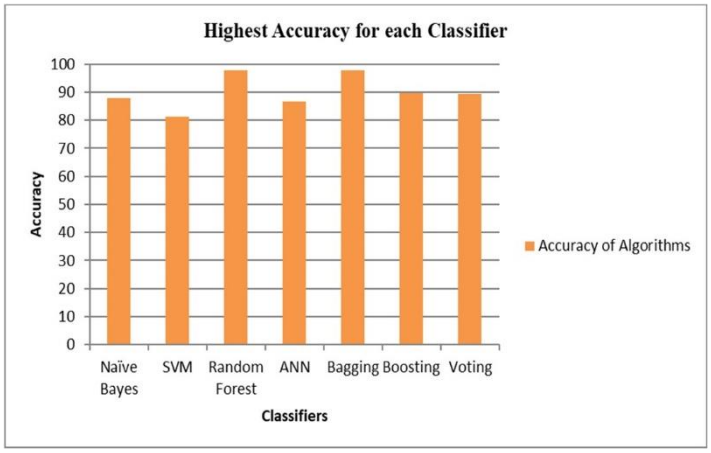
Results and Accuracy:

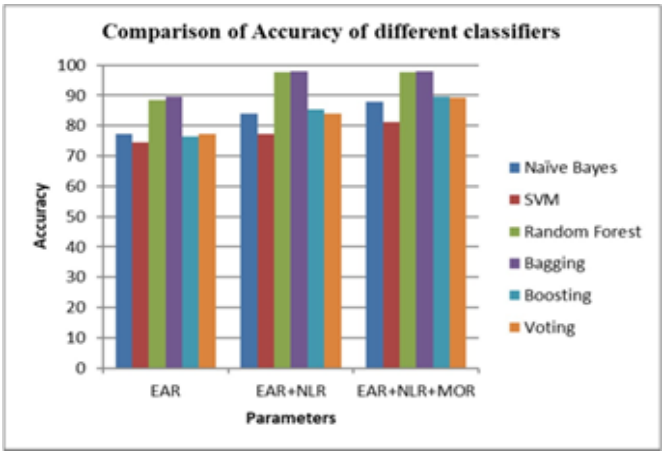
The results and accuracy section presents empirical findings demonstrating the effectiveness of AD3S. The authors report a remarkable accuracy rate of approximately 98% when utilizing the

Bagging classifier. The section highlights the significance of these results in the context of improving driver safety and preventing accidents caused by drowsy driving. The emphasis is on the practical implications of the proposed system, its non-intrusive nature, and cost-effectiveness. The high accuracy achieved underscores the potential of AD3S as a valuable tool for researchers and practitioners in the field of driver drowsiness detection, offering insights that contribute to the state-of-the-art in this domain.









3.) Detecting Driver Drowsiness in Real Time Through Deep Learning Based Object Detection:-

Abstract:

The research paper titled "Detecting Driver Drowsiness in Real Time Through Deep Learning Based Object Detection" authored by Muhammad Faique Shakeel, Nabit A. Bajwa, Ahmad Muhammad Anwaar, Anabia Sohail, Asifullah Khan, and Haroon-ur-Rashid addresses the issue of vehicle accidents caused by drowsy driving. The paper proposes a novel deep learning methodology utilizing Convolutional Neural Networks (CNN), specifically the MobileNet architecture with Single Shot Multibox Detector (SSD), for drowsiness detection. This approach treats drowsiness detection as an object detection task, focusing on localizing open and closed eyes in a driver's video stream. The authors compiled and labeled a custom dataset of approximately 6000 images, including objects such as face, eye open, and eye closed. The trained model achieved a Mean Average Precision (mAP) of 0.84 on these categories. The proposed methodology is highlighted for its computational efficiency, cost-effectiveness, and real-time processing capability on standalone mobile devices, making it suitable for deployment in vehicles without the need for expensive hardware.

Introduction:

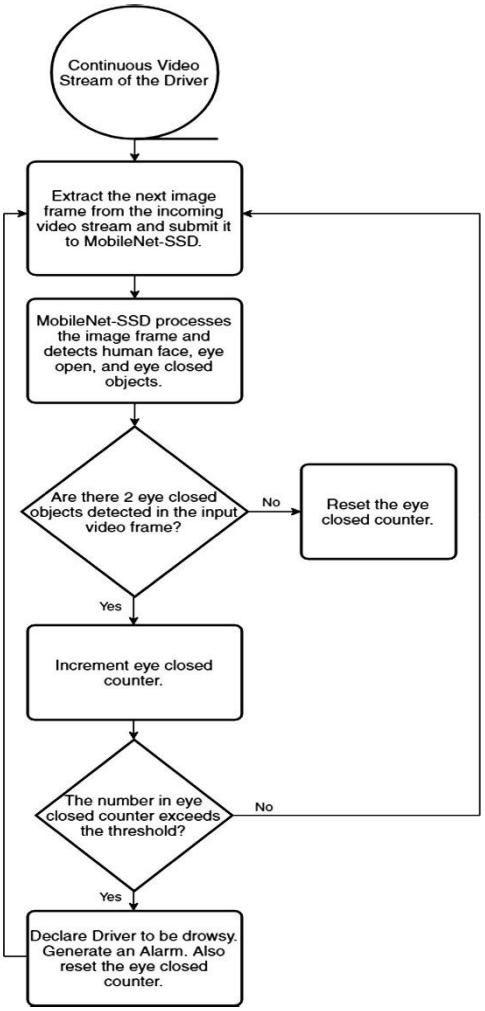
The introduction section outlines the primary concern of the paper, which is vehicle accidents resulting from drowsy driving. It introduces the proposed solution, a deep learning methodology for real-time drowsiness detection using CNN, and emphasizes the unique approach of treating drowsiness detection as an object detection task. The section sets the context by discussing the significance of the issue, and it provides an overview of the MobileNet CNN architecture with SSD as the chosen method. The introduction serves to engage the reader and establish the motivation for the research.

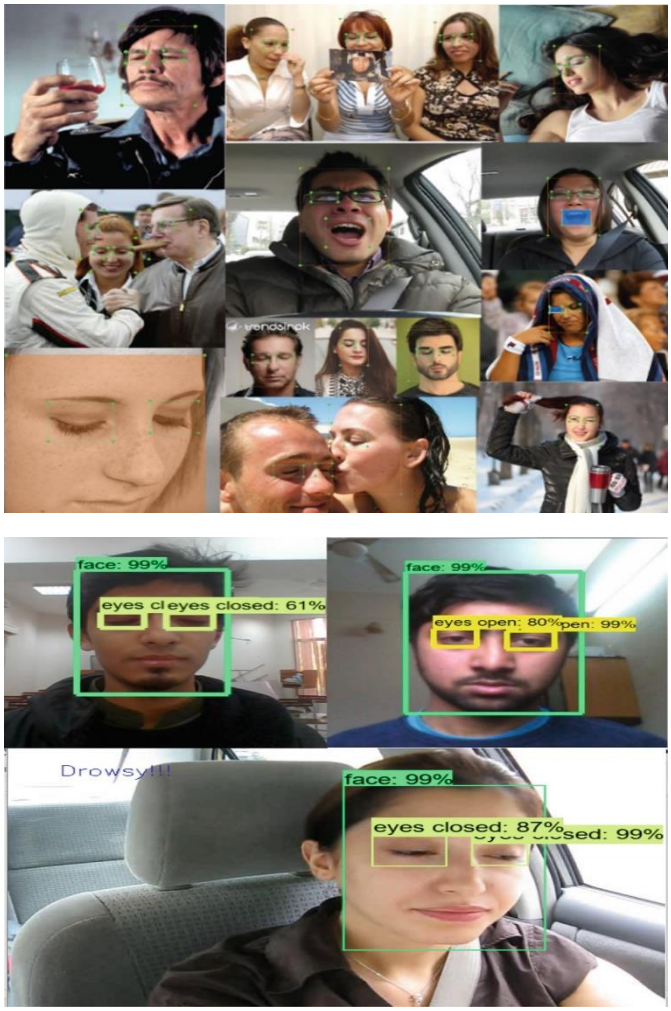
Method Used/Methodology:

The methodology section describes the approach taken to address the issue of drowsy driving. The authors treat drowsiness detection as an object detection task, employing the MobileNet CNN architecture with SSD. A custom dataset of 6000 images is compiled and labeled with objects like face, eye open, and eye closed. The trained model is evaluated using the PASCAL VOC metric on a test dataset. This section provides a clear and detailed explanation of the steps involved in the methodology, from dataset creation to model evaluation, enabling readers to understand the technical aspects of the proposed approach.

Results and Accuracy:

The results and accuracy section reports that the trained model achieved a Mean Average Precision (mAP) of 0.84 on the specified categories—face, eye open, and eye closed. The discussion emphasizes the computational efficiency, cost-effectiveness, and real-time processing capability of the proposed methodology. The findings underscore the robustness and accuracy of the drowsiness detection system under real driving conditions. The section serves to validate the effectiveness of the methodology and its suitability for deployment on affordable embedded devices in vehicles, such as the Raspberry Pi 3 or a mobile smartphone.





4.) Deep CNN: A Machine Learning Approach for Driver Drowsiness Detection Based on Eye State:-

Abstract:

The research paper titled "Deep CNN: A Machine Learning Approach for Driver Drowsiness Detection Based on Eye State," authored by Venkata Rami Reddy Chirra, Srinivasulu Reddy Uyyala, and Venkata Krishna Kishore Kolli, presents a novel framework for detecting driver drowsiness based on eye state using deep learning. The proposed system utilizes the Viola-Jones face detection algorithm to identify and extract the eye region from face images. A stacked deep convolutional neural network (CNN) is developed to extract features from dynamically identified key frames in camera sequences during the learning phase. The CNN classifier employs a SoftMax layer to classify the driver's state as either asleep or non-asleep. The system includes an alert mechanism, triggering an alarm when the driver is detected as being in a sleepy mood. Evaluation on a collected dataset demonstrates a superior accuracy of 96.42% compared to traditional CNN approaches. The proposed Stacked Deep CNN addresses limitations of traditional CNNs, particularly in pose accuracy during regression. The model comprises three phases: preprocessing, feature extraction, and a deep CNN classifier with four convolutional layers, pooling layers, ReLU layer, and fully-connected layer. The findings indicate promising results, suggesting the proposed approach's potential to mitigate road accidents caused by driver drowsiness.

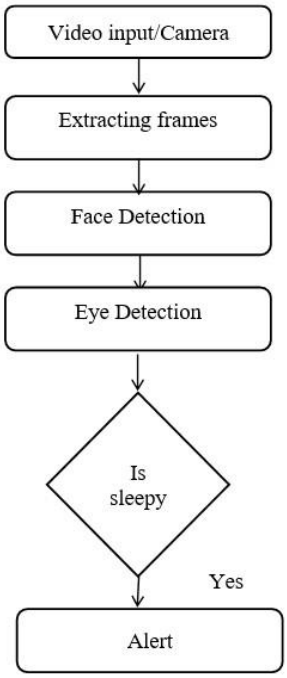
Introduction:

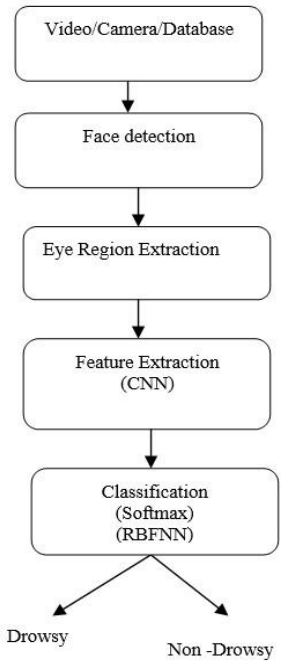
The introduction section outlines the research problem, emphasizing the significance of driver drowsiness as a contributing factor to road accidents. It introduces the proposed solution, a machine learning framework based on deep CNN for detecting drowsiness by analyzing the driver's eye state. The Viola-Jones face detection algorithm is briefly discussed, and the motivation for employing a stacked deep CNN is presented. The section aims to engage readers, providing context for the research and justifying the need for an advanced approach to drowsiness detection.

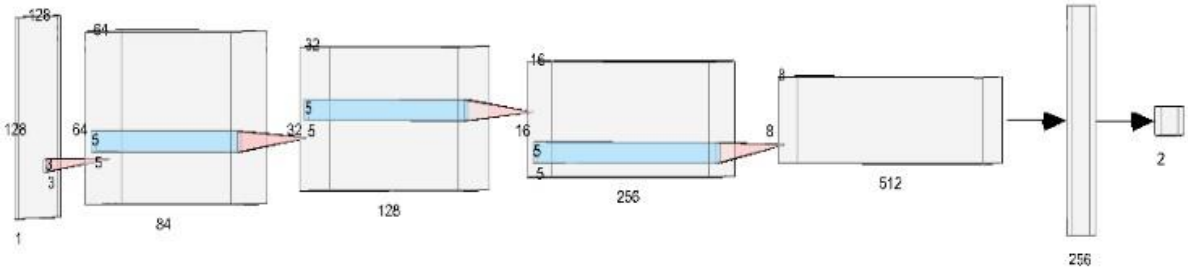
Methodology:

The methodology section details the steps involved in the proposed approach. It begins with the preprocessing stage, where the Viola-Jones algorithm is used for face detection and eye region extraction. Feature extraction is explained, involving dynamically identified key frames from camera sequences. The development and architecture of the deep CNN classifier are discussed,

highlighting its four convolutional layers, pooling layers, ReLU layer, and fully-connected layer. The SoftMax layer for classification is specified. The section provides a comprehensive overview of the entire process, guiding readers through the technical aspects of the proposed methodology.

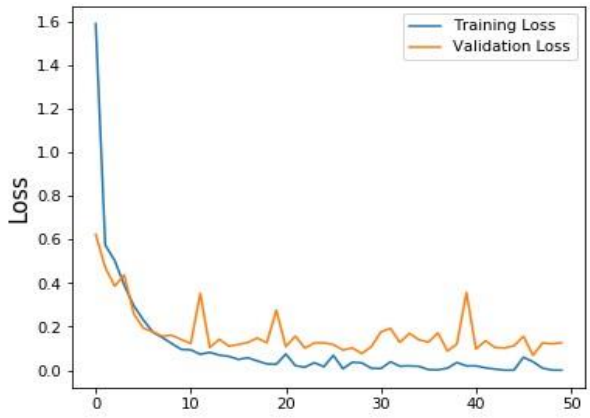






Results and Accuracy:

The results and accuracy section reports the performance of the proposed system on a collected dataset. The system achieves a commendable accuracy of 96.42%, surpassing traditional CNN approaches. The discussion emphasizes the significance of the proposed Stacked Deep CNN in overcoming limitations related to pose accuracy in regression. The section concludes by highlighting the promising outcomes of the research and its potential impact on reducing road accidents attributable to driver drowsiness.


Training Loss
Validation Loss
Loss
1.6
1.4
1.2
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0.8
0.6
0.4
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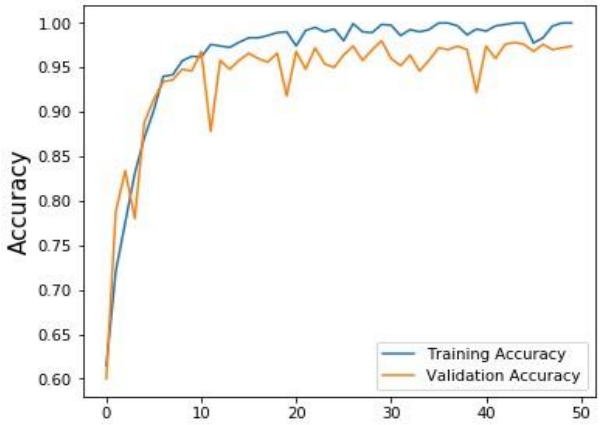
Accuracy
1.00
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0.90
0.85
0.80
0.75
0.70
0.65
0.60
Training Accuracy
Validation Accuracy
0
10
20
30
40
50

5.) An Efficient Approach for Detecting Driver Drowsiness Based on Deep Learning:-

Abstract:

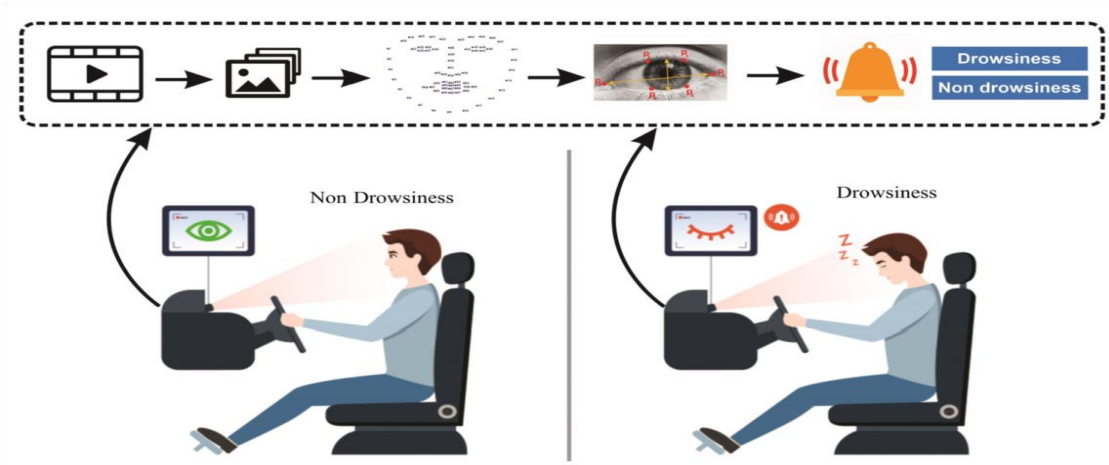
The research paper titled "An Efficient Approach for Detecting Driver Drowsiness Based on Deep Learning," authored by Anh-Cang Phan, Ngoc-Hoang-Quyen Nguyen, Thanh-Ngoan Trieu, and Thuong-Cang Phan, presents two efficient methods for detecting driver drowsiness. The first method utilizes facial landmarks to identify blinks and yawns, employing driver-specific thresholds. The second method employs adaptive deep neural networks, specifically MobileNetV2 and ResNet-50V2, to analyze videos and automatically detect driver activities in each frame. Trained on a collected dataset, both methods achieve a high accuracy of 97%. These approaches address the limitations of traditional methods that rely on eyelid and mouth movement detection, which may be impractical in vehicles due to the unavailability of measuring devices and discomfort for drivers. The proposed methods offer practical solutions to prevent automobile accidents caused by drowsiness, demonstrating feasibility and substantial advantages over alternative methods combining behavioral and physiological features.

Introduction:

The introduction outlines the research focus, emphasizing the significance of detecting driver drowsiness to prevent accidents. It introduces the limitations of traditional methods relying on specific measurements and proposes two novel approaches using facial landmark identification and deep learning. The motivation for these methods is grounded in the impracticality of traditional approaches in vehicular settings. The introduction sets the stage for the reader, highlighting the need for more feasible and effective drowsiness detection methods.

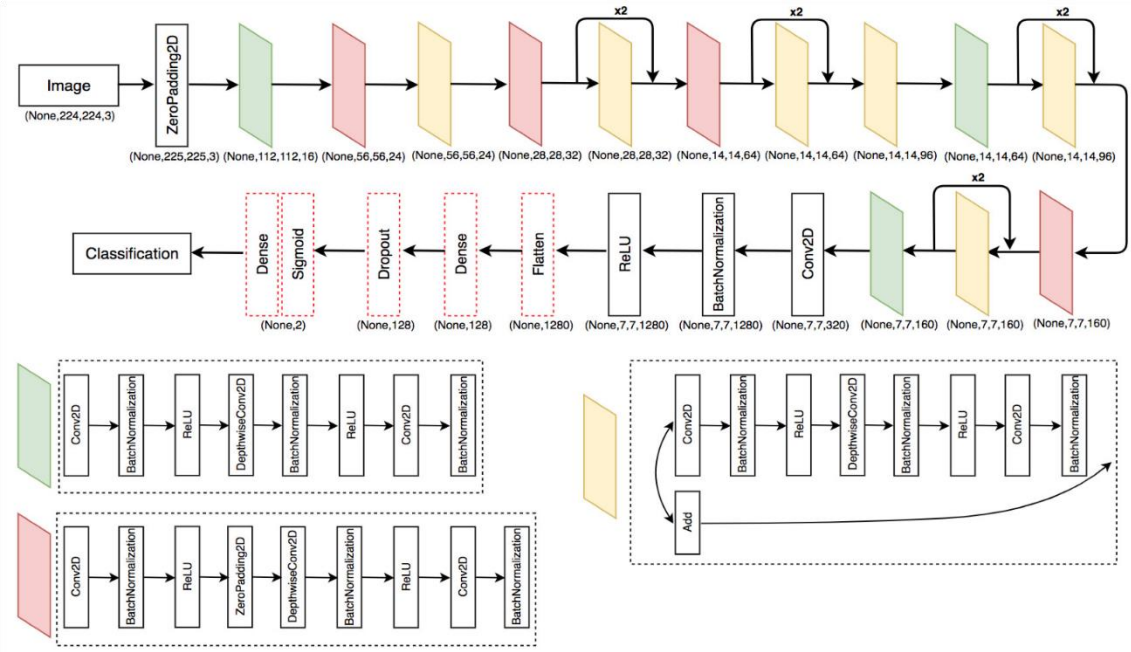
Methodology:

The methodology section details the two proposed approaches. The first method involves using facial landmarks for blink and yawn detection, with driver-specific thresholds for enhanced accuracy. The second method employs adaptive deep neural networks, MobileNet-V2 and ResNet-50V2, to analyze video frames and automatically detect driver activities. The section explains the training process on a collected dataset, emphasizing the achieved high accuracy of 97%. The advantages of these methods over traditional approaches are discussed, emphasizing practicality and improved feasibility in real-world driving scenarios.



Results and Accuracy:

The results and accuracy section presents the performance of the proposed methods. Both approaches achieve a high accuracy of 97%, demonstrating their effectiveness in detecting driver drowsiness. The discussion highlights the significance of overcoming limitations associated with traditional methods, especially in the context of vehicular applications. The promising outcomes underscore the practicality and advantages of the proposed methods in preventing automobile accidents caused by driver drowsiness. The section concludes by summarizing the key findings and their implications for enhancing road safety.



6.) Deep Learning based Drowsiness Detection and Monitoring using Behavioural Approach:-

Abstract:

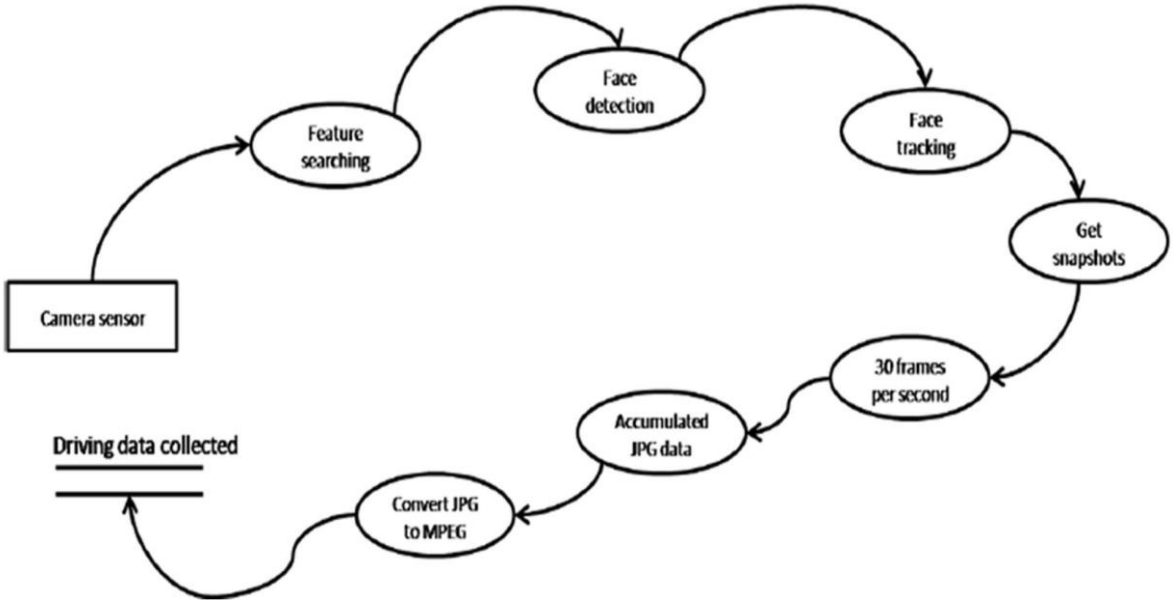
The research paper titled "Deep Learning based Drowsiness Detection and Monitoring using Behavioural Approach," authored by P. William, Dr. Durgaprasad Gangodkar, Dr. Mohd Shamim, Swati Vashisht, Ajay Reddy Yeruva, and Dr. Amarendranath Choudhury, introduces a real-time drowsiness detection and monitoring system for tired drivers. The paper aims to develop software that captures real-time driver behavior during driving and utilizes convolutional neural networks (CNNs) to predict the driver's actions. Leveraging an intelligent video-based device, a dataset of drowsy drivers, and a CNN architecture, the system achieves a remarkable 99.8% accuracy rate for anomaly detection. The implementation is carried out using MATLAB and deep learning technology, resulting in a prototype model for drowsiness detection.

Introduction:

The introduction highlights the necessity for affordable and accurate tired driver detection systems, criticizing the limitations of traditional methods like physiological and vehicle-based approaches. It underscores the efficacy of the behavioral approach, employing sensors such as cameras to record and process the driver's actions. The integration of deep learning methods is emphasized for creating a user-friendly, cost-effective, and real-time drowsy driver behavior monitoring and control system. This section sets the stage for the detailed exploration of the proposed system.

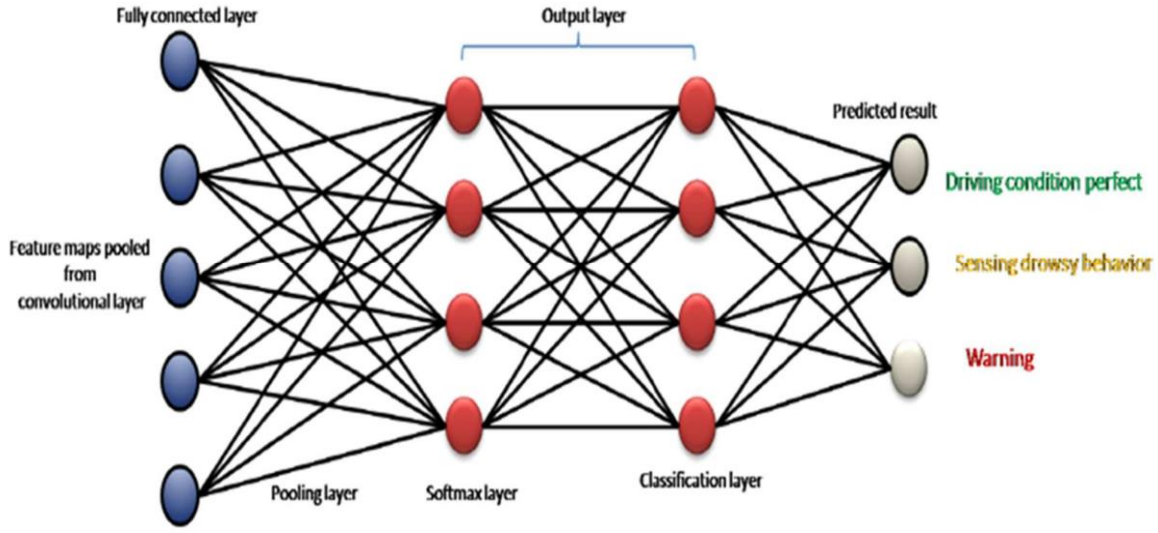
Methodology:

The methodology section delves into the intricacies of the proposed system. It details the components, including an intelligent video-based gadget, a dataset of drowsy drivers, and the CNN architecture. MATLAB and deep learning technologies are employed for implementation, and the system achieves an impressive 99.8% accuracy rate for anomaly detection. The training process involves a dataset of video clips, feature extraction utilizing deep learning algorithms, and the utilization of CNN architecture with input layers, convolutional layers, pooling layers, fully connected layers, and output layers. The section provides a step-by-step description of the design and implementation, covering video acquisition, face tracking and recognition, computer vision, and feature extraction.



Results and Accuracy:

The results and accuracy section showcases the high performance of the proposed system. With a 99.8% accuracy rate for anomaly detection, the system proves its effectiveness in real-time drowsiness detection and monitoring. The section underscores the significance of the achieved accuracy and discusses its implications for enhancing road safety. Overall, the comprehensive methodology and successful outcomes presented in this paper contribute to the advancement of drowsiness detection systems using a behavioral approach and deep learning.



7.) Driver Drowsiness Detection Model Using Convolutional Neural Networks Techniques for Android Application:-

Abstract:

The research article titled "Driver Drowsiness Detection Model Using Convolutional Neural Networks Techniques for Android Application," authored by Rateb Jabbar, Mohammed Shinoy, Mohamed Kharbeche, Khalifa Al-Khalifa, Moez Krichen, and Kamel Barkaoui, introduces a methodology for detecting microsleep and drowsiness through neural network-based techniques. The proposed algorithm employs facial landmarks captured by a camera, which are then processed by a Convolutional Neural Network (CNN) for drowsiness classification. By leveraging facial landmarks, the accuracy of the model is significantly enhanced. The CNN-based model attains over 88% accuracy for the category without glasses, more than 85% for the category night without glasses, and an overall accuracy exceeding 83% across all categories. The article emphasizes the applicability of the CNN-based model for constructing real-time driver drowsiness detection systems on embedded systems and Android devices, highlighting its high accuracy and user-friendliness. The utilized method is CNN combined with facial landmark detection (D2CNN-FLD).

Introduction:

The introduction outlines the primary focus of the article, highlighting the significance of detecting microsleep and drowsiness for ensuring driver safety. It introduces the proposed algorithm, emphasizing the role of facial landmarks in enhancing accuracy. The section sets the context for the subsequent discussion on the CNN-based model and its application in real-time drowsiness detection for Android devices.

Method Used:

The methodology section details the approach employed in the research, namely CNN and facial landmark detection (D2CNN-FLD). It explains the rationale behind choosing this method and how it contributes to the enhanced accuracy of the drowsiness detection model. The integration of facial landmarks and CNN is elaborated, providing insights into the technical aspects of the proposed system.

Results and Accuracy:

The results and accuracy section presents the performance metrics of the CNN-based model. The model achieves commendable accuracy, surpassing 88% for the category without glasses, more than 85% for the category night without glasses, and an average accuracy exceeding 83% across all categories. The section underscores the potential applications of the model for realtime drowsiness detection on Android devices and embedded systems, highlighting its accuracy and ease of use. The results affirm the effectiveness of the chosen methodology in addressing the research objectives.

8.) Driver Drowsiness Detection using Behavioral Measures and Machine Learning Techniques: A Review of State-of-Art Techniques:-

Abstract:

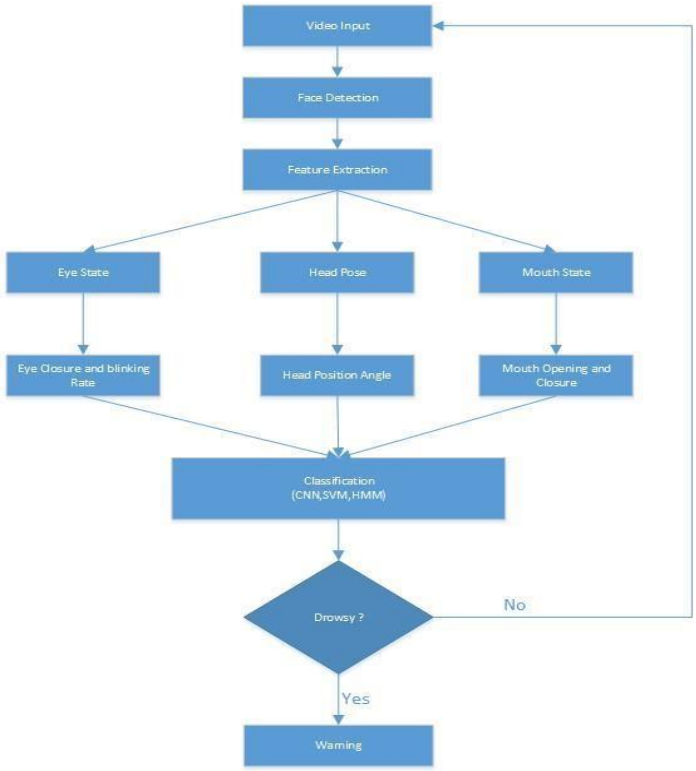
The research paper titled "Driver Drowsiness Detection using Behavioral Measures and Machine Learning Techniques: A Review of State-of-Art Techniques," authored by Mkhuseli Ngxande, Jules-Raymond Tapamo, and Michael Burke, provides a comprehensive literature review focusing on driver drowsiness detection. The emphasis is on utilizing behavioral measures, specifically facial features like eye blinks, head movements, and yawning, interpreted through machine learning techniques. The paper explores various machine learning approaches, including support vector machines, convolutional neural networks, and hidden Markov models, within the context of drowsiness detection. A meta-analysis of 25 papers employing machine learning for drowsiness detection is conducted, revealing the superior performance of convolutional neural networks. Additionally, the paper identifies publicly available datasets suitable for benchmarking drowsiness detection systems.

Introduction:

The introduction sets the stage by highlighting the critical importance of drowsiness detection for road safety. It introduces the focus on behavioral measures, particularly facial features, and outlines the key machine learning techniques under consideration. The section emphasizes the gap in standardized datasets for benchmarking, laying the foundation for the subsequent discussion.

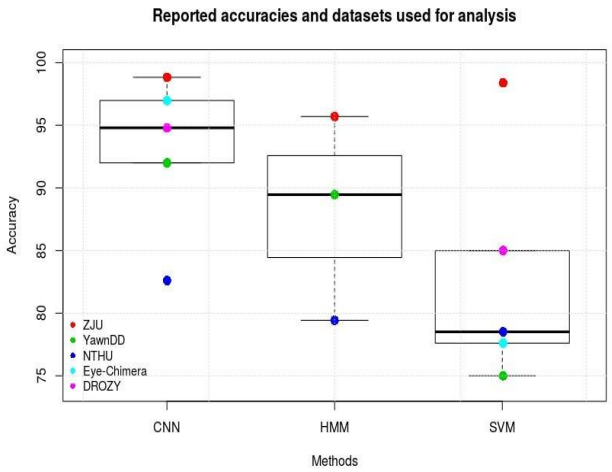
Method Used:

The methodology section provides insights into the research approach, detailing the review methodology employed in evaluating machine learning techniques for drowsiness detection. It introduces the use of behavioral measures, such as eye blinks and head movements, and explains the role of machine learning algorithms, including support vector machines, convolutional neural networks, and hidden Markov models. The challenges associated with dataset variability across races and skin pigments are highlighted.



Results and Accuracy:

The results and accuracy section reports the findings of the meta-analysis conducted on 25 papers. While specific accuracy percentages for individual papers are not provided, the section emphasizes the superiority of convolutional neural networks in drowsiness detection. The discussion touches upon the significance of these findings in advancing the field and suggests that future research should address challenges related to dataset standardization. The paper concludes by summarizing the key contributions of the literature review, including the preference for convolutional neural networks and the identified need for standardized datasets. The findings contribute valuable insights to the domain of driver drowsiness detection, guiding future research endeavors.



9.) Driver Drowsiness Detection Using Condition-Adaptive Representation Learning Framework:-

Abstract:

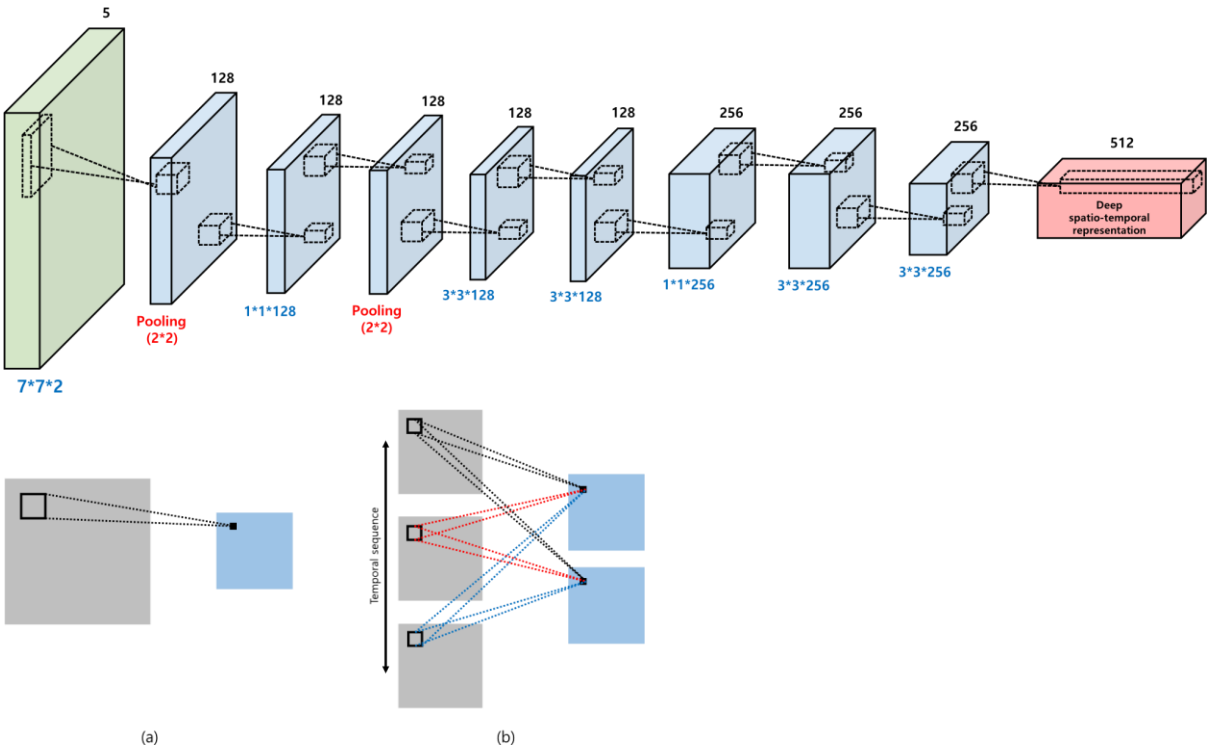
The research paper titled "Driver Drowsiness Detection Using Condition-Adaptive Representation Learning Framework," authored by Jongmin Yu, Sangwoo Park, Sangwook Lee, and Moongu Jeon, introduces a novel approach to drowsiness detection employing a conditionadaptive representation learning framework. The framework, centered around a 3D-deep convolutional neural network, comprises four key models: spatio-temporal representation learning, scene condition understanding, feature fusion, and drowsiness detection. The spatiotemporal representation learning extracts features concurrently describing video motions and appearances. Scene condition understanding classifies diverse conditions related to drivers and driving situations, including glasses-wearing status, illumination conditions, and facial element motion. Feature fusion generates a condition-adaptive representation by integrating features from the aforementioned models. The drowsiness detection model utilizes this representation to identify the driver's drowsiness status. Evaluation using the NTHU drowsy driver detection video dataset demonstrates the framework's superiority over existing visual analysis-based drowsiness detection methods.

Introduction:

The introduction underscores the significance of addressing driver drowsiness in ensuring road safety. It introduces the proposed condition-adaptive representation learning framework, highlighting its components and their roles in achieving improved drowsiness detection. The section sets the context for the subsequent detailed exploration of the framework's methodology.

Method Used:

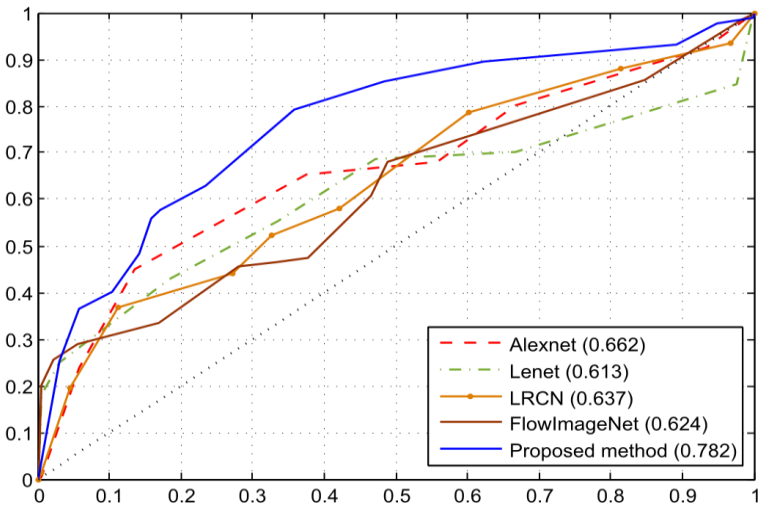
The methodology section delineates the components of the proposed framework and their functionalities. It introduces the 3D-deep convolutional neural network and the four models, explaining how each contributes to the overall process. The section emphasizes the role of spatio-temporal representation learning, scene condition understanding, feature fusion, and drowsiness detection in creating an adaptive framework.



Results and Accuracy:

The results and accuracy section reports the outcomes of the framework's evaluation using the NTHU drowsy driver detection video dataset. Although specific accuracy percentages are not provided, the section conclusively states that the proposed framework surpasses existing drowsiness detection methods based on visual analysis. The discussion outlines the implications of these results for the advancement of drowsiness detection technology.

In conclusion, the paper summarizes the key contributions of the proposed condition-adaptive representation learning framework, showcasing its effectiveness in outperforming current visual analysis-based methods. The findings offer valuable insights into the realm of driver drowsiness detection, paving the way for further advancements in road safety technology.



10.) Detection of Driver Drowsiness in Driving Environment using Deep Learning Methods:-

Abstract:

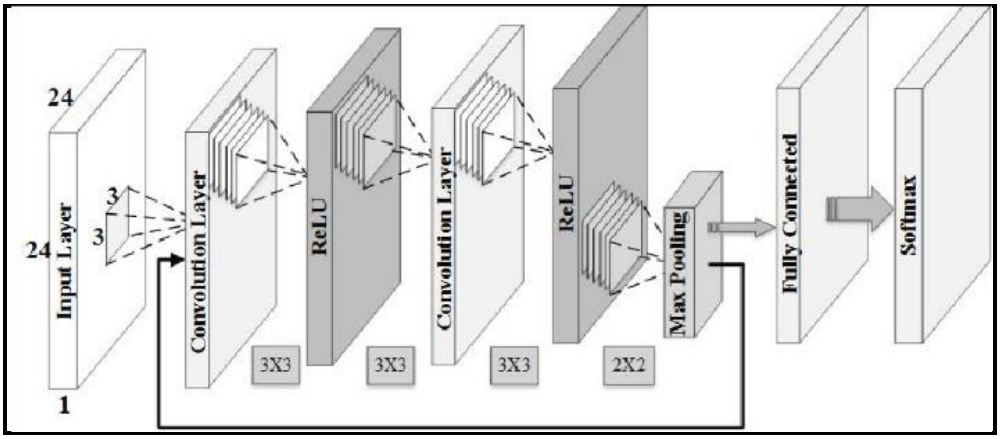
The research paper, titled "Detection of Driver Drowsiness in Driving Environment using Deep Learning Methods" and authored by Vedat Tu men and O zal Yıldırım, focuses on employing deep learning techniques to identify the sleep states of drivers within a driving environment. The study utilizes a Convolutional Neural Network (CNN) model, applying it to 4,846 authentic eye images sourced from the Closed Eyes In The Wild (CEW) database. The CNN model's performance is compared with commonly used CNN models using the same dataset. The classification results reveal that the designed model achieved success rates of 96.5% and 92.99%, demonstrating the efficacy of this structure in addressing the problem of detecting driver drowsiness.

Introduction:

The introduction outlines the motivation behind the study, emphasizing the critical importance of detecting driver drowsiness for road safety. It introduces the application of deep learning methods, specifically the CNN model, as a promising approach to address this concern. The section sets the stage for the subsequent exploration of the study's methodology and results.

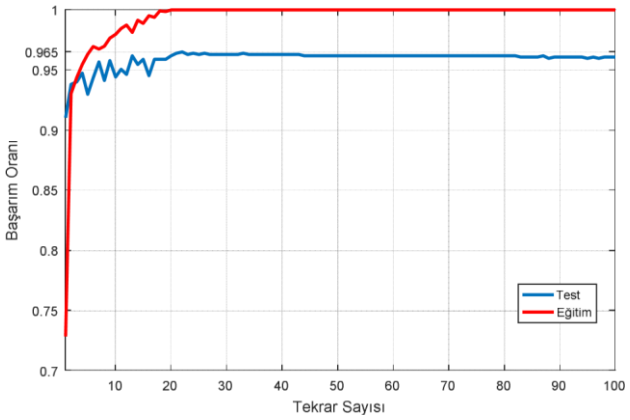
Method Used:

The methodology section details the approach taken in the study, highlighting the utilization of a CNN model for detecting driver drowsiness. The use of real eye images from the CEW database is specified, and the rationale for employing this dataset is discussed. The section underscores the significance of comparing the performance of the designed model with other commonly used CNN models.



Results:

The results section reports the outcomes of the study, indicating the success rates achieved by the designed CNN model. Specific figures of 96.5% and 92.99% are provided, showcasing the effectiveness of the proposed method in accurately detecting driver drowsiness. The section emphasizes the practical relevance of these results for real-world applications.



11.) Driver Drowsiness Detection Using Convolutional Neural Networks:-

Abstract:

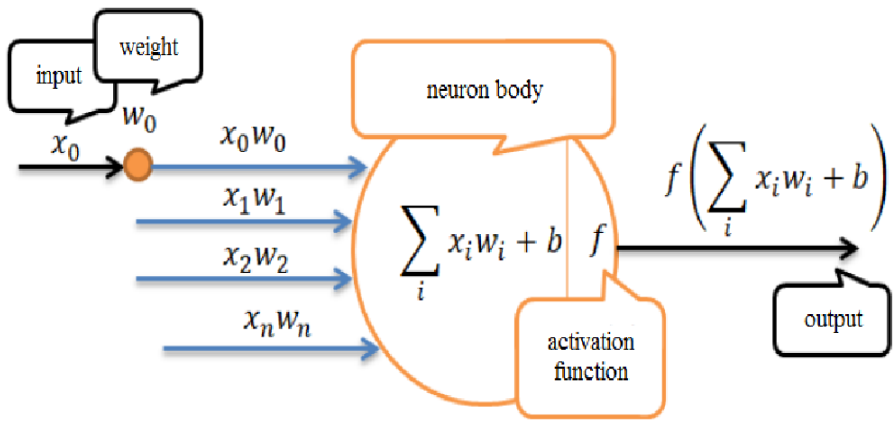
The paper titled "Driver Drowsiness Detection Using Convolutional Neural Networks," authored by Zuzana Ke pes iova , Ja n Ciga nek, and S tefan Koza k, addresses the imperative task of automatically detecting driver drowsiness to mitigate road accidents. Leveraging Convolutional Neural Networks (CNNs), the study employs an autocamera to capture facial expressions, allowing the neural network to assess the driver's wakefulness. The methodology involves evaluating individual frames and averaging the last 20 frames, corresponding to approximately one second in the training and test datasets. The paper explores image segmentation methods and develops a CNN-based model using an annotated dataset of over 2000 image slices to extract the driver's emotional status.

Introduction:

The introduction outlines the primary objective of the study: reducing road accidents by implementing an automatic driver drowsiness detection system. It introduces the significance of leveraging CNN technology and autocamera capture for real-time assessment of the driver's state. The section establishes the foundation for the subsequent exploration of the paper's methodology, results, and conclusions.

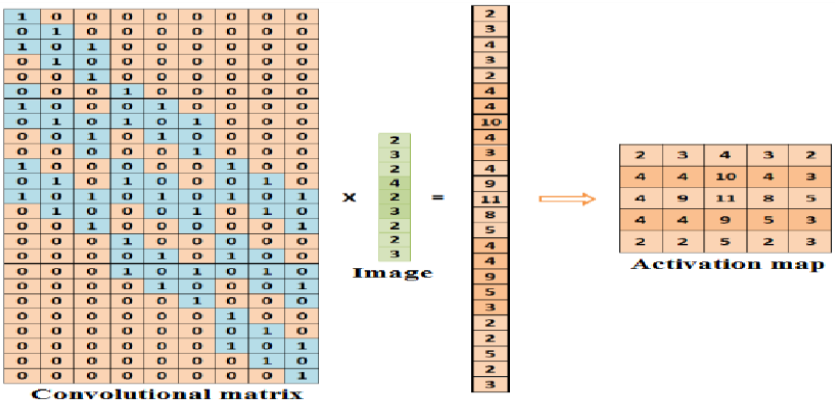
Method Used:

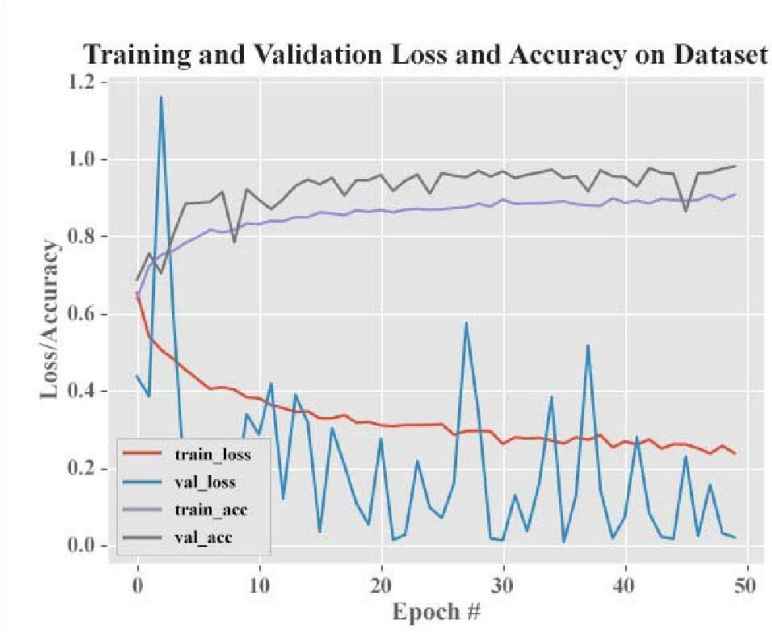
The methodology section provides a comprehensive overview of the research approach. It emphasizes the alignment with global trends in employing advanced soft computing methods, particularly machine and deep-learning techniques. Specific attention is given to the use of CNNs for image processing and classification. The section details the operations involved, including convolution, pooling, ReLU, and multilayer perceptron (MLP), in processing images and categorizing the driver's emotional status. The hardware, software environment, and dataset details are also meticulously outlined.



Results and Accuracy:

The results section showcases the success of the developed model in detecting driver drowsiness based on facial expressions captured by the autocamera. The dataset, comprising 20 subjects with 8 distinct behavioral patterns, is presented, and the accurate classification of "Aware" and "Sleepy" states is highlighted. Specific metrics or percentages demonstrating the accuracy of the model are expected in this section, offering a quantitative assessment of the CNN's performance.





12.) Driver Drowsiness Detection using Deep Learning:-

Abstract:

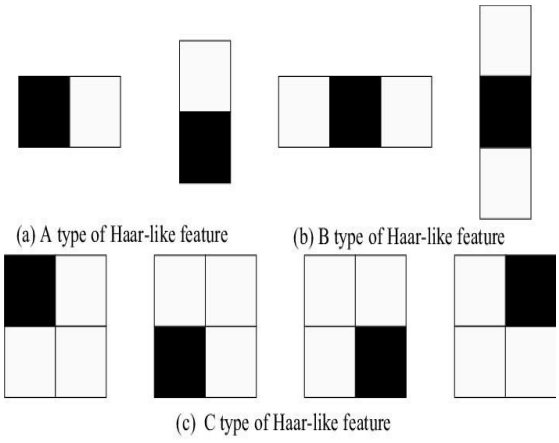
The research paper titled "Driver Drowsiness Detection using Deep Learning," authored by Dr. Yeresime Suresh, Rashi Khandelwal, Matam Nikitha, Mohammed Fayaz, and Vinaya Soudhri, addresses the critical issue of preventing road accidents by developing a system for detecting driver drowsiness. The proposed system employs deep learning, specifically a Convolutional Neural Network (CNN), to classify the driver's eye condition as open or closed, triggering an alarm upon detecting drowsiness. The study evaluates its approach on a substantial portion of the MRL eye dataset, comprising 48,000 images, achieving an accuracy of 86.05% using the CNN model.

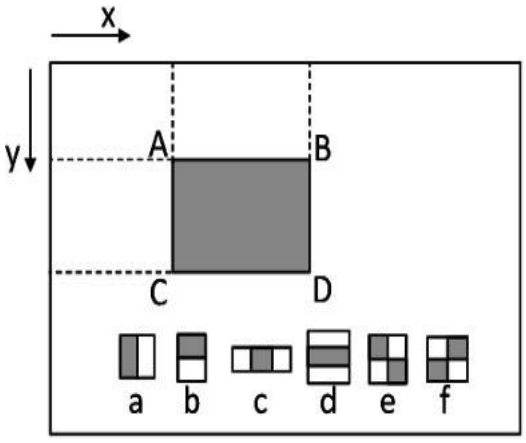
Introduction:

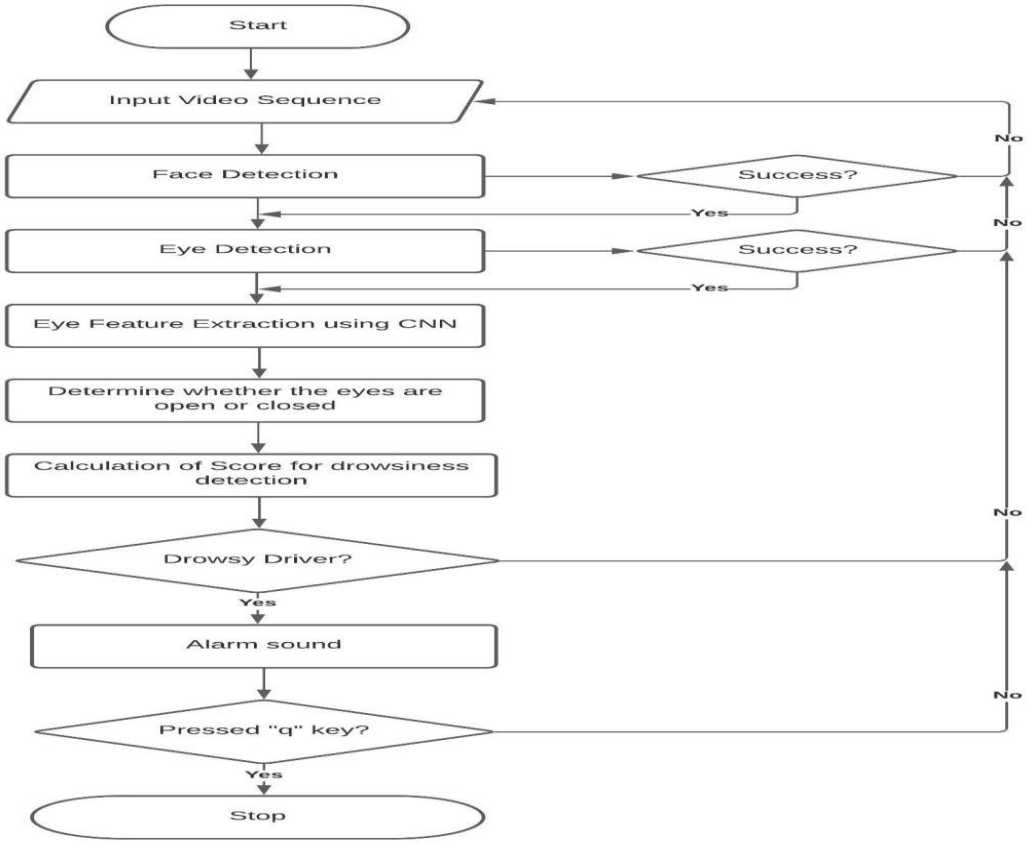
The introduction establishes the research goal: creating a drowsiness detection system to enhance road safety. It outlines the significance of leveraging deep learning, particularly CNNs, for real-time classification of the driver's eye condition. The introduction sets the stage for the detailed exploration of the proposed methodology and its evaluation.

Method Used:

The methodology section delineates the research approach, providing a four-stage overview: pre-processing, face and eye detection, feature extraction, and final output classification. Specific techniques, such as the Haar Cascade algorithm for face and eye detection and CNNs for feature extraction, are highlighted. The section elucidates the use of integral images, Adaboost training, and cascading classifiers in the CNN model implementation. The proposed system's focus on automatically detecting driver drowsiness and triggering an alarm is clearly presented.







Results and Accuracy:

This section emphasizes the outcomes of the study, indicating that the proposed system achieved an accuracy of 86.05% in detecting driver drowsiness using the CNN model. The evaluation, conducted on a substantial dataset of 48,000 images, underscores the successful classification of the driver's eye condition as open or closed, validating the efficacy of the deep learning approach for drowsiness detection.

```
In [15]: runfile('C:/Users/Rashi/Desktop/driver drowsiness/model.py', wdir='C:/
Desktop/driver drowsiness')
Found 9600 images belonging to 2 classes.
Confusion matrix
[[3681 1119]
 [ 260 4540]]
              precision    recall  f1-score   support

      closed       0.93      0.77      0.84      4800
        open       0.80      0.95      0.87      4800

    accuracy                           0.86      9600
   macro avg       0.87      0.86      0.86      9600
weighted avg       0.87      0.86      0.86      9600
```

13.) Drowsiness Detection System Using Deep Learning:-

Abstract:

The research paper titled "Drowsiness Detection System Using Deep Learning," authored by Avigyan Sinha, Aneesh R P, and Sarada K Gopal, confronts the critical issue of driver drowsiness, a prominent cause of road accidents, by proposing a drowsiness detection system leveraging deep learning techniques. The study centers on drowsiness detection through facial expression analysis, underscoring the significance of face and expression detection. The authors acknowledge the challenges faced by existing algorithms, particularly due to extrinsic environmental factors like light and camera position. The paper introduces novel detection methods utilizing different architectures for face and drowsiness detection, employing Viola Jones, DLib, and Yolo V3 algorithms for face detection, and a modified LeNet architecture for drowsiness detection.

Introduction:

The introduction establishes the pivotal problem of driver drowsiness and its association with road accidents. It emphasizes the need for an effective drowsiness detection system, highlighting the focus on facial expression analysis. The authors articulate the challenges posed by environmental parameters and provide a roadmap for their proposed deep learning-based solution.

Method Used:

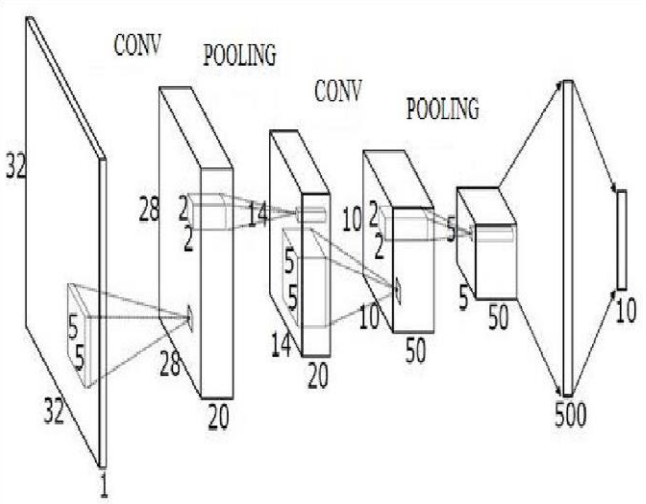
The methodology section details the research approach, encompassing deep learning techniques, particularly the application of Convolutional Neural Network (CNN) architecture with a modified LeNet model for drowsiness detection. Viola Jones, DLib, and Yolo V3 algorithms are employed for face detection. The section emphasizes a non-contact method, aiming to overcome drawbacks associated with contact methods and providing a cost-effective solution. The emphasis on avoiding manual feature extraction and concentrating on facial regions for drowsiness detection is highlighted.

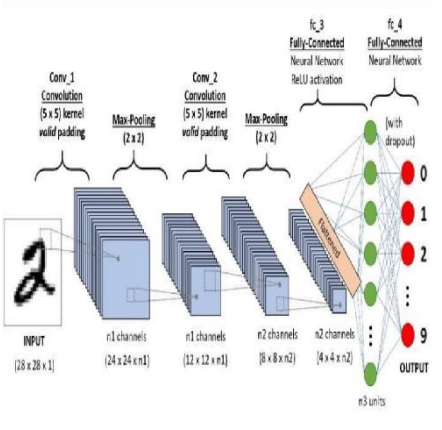
Results and Accuracy:

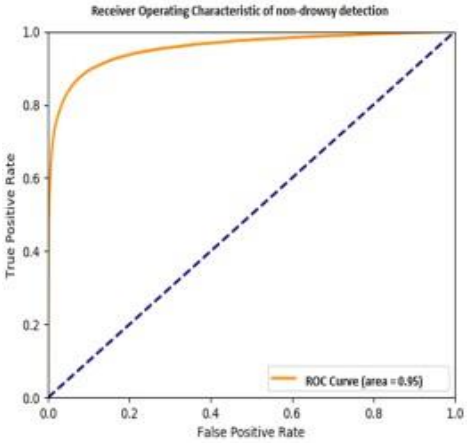
The paper does not explicitly present specific results and accuracy metrics achieved by the proposed system. However, it discusses the exploration of different architectures for face and drowsiness detection, indicating a focus on analyzing the performance of these components.

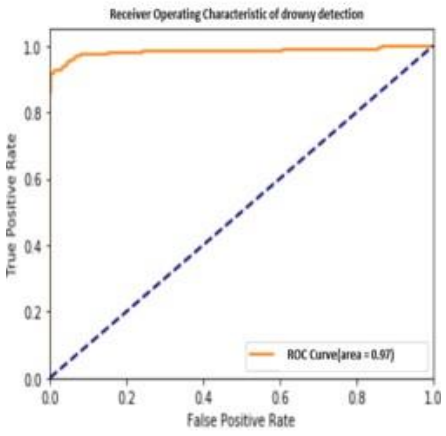
While the abstract lacks explicit accuracy figures, the study aims to estimate the driver's state, with a particular emphasis on detecting drowsiness through deep learning techniques.

	Type	Filters	Size	Output
	Convolutional	32	3 × 3	256 × 256
	Convolutional	64	3 × 3 / 2	128 × 128
1×	Convolutional	32	1 × 1	
	Convolutional	64	3 × 3	
	Residual			128 × 128
	Convolutional	128	3 × 3 / 2	64 × 64
2×	Convolutional	64	1 × 1	
	Convolutional	128	3 × 3	
	Residual			64 × 64
	Convolutional	256	3 × 3 / 2	32 × 32
8×	Convolutional	128	1 × 1	
	Convolutional	256	3 × 3	
	Residual			32 × 32
	Convolutional	512	3 × 3 / 2	16 × 16
8×	Convolutional	256	1 × 1	
	Convolutional	512	3 × 3	
	Residual			16 × 16
	Convolutional	1024	3 × 3 / 2	8 × 8
4×	Convolutional	512	1 × 1	
	Convolutional	1024	3 × 3	
	Residual			8 × 8
	Avgpool		Global	
	Connected		1000	
	Softmax			









14.) Early Identification and Detection of Driver Drowsiness by Hybrid Machine Learning:-

Abstract:

The research paper titled "Early Identification and Detection of Driver Drowsiness by Hybrid Machine Learning," authored by Ayman Altameem, Ankit Kumar, Ramesh Chandra Poonia, Sandeep Kumar, and Abdul Khader Jilani Saudagar, proposes a real-time system for detecting driver drowsiness using hybrid machine learning methodologies. The system leverages facial expressions to discern changes in the driver's state of expression presentation, determining their adherence to safe driving practices. Testing conducted under variable luminance conditions yielded promising results, with the proposed system achieving an accuracy of 83.25% in detecting facial expression changes. The paper explores diverse methods for drowsiness detection, encompassing physiological signals, behavioral measures, and vehiclebased measures. The authors advocate for a hybrid approach, combining physiological measurements with vehicular or behavioral measures to enhance the accuracy of drowsiness detection, effectively overcoming the limitations of individual techniques.

Introduction:

The introduction outlines the critical issue of driver drowsiness and underscores the need for an effective early identification and detection system. The authors introduce the focus on facial expressions as a key indicator of drowsiness, emphasizing the real-time nature of their proposed solution. The section previews the testing conditions and provides an overview of the methodologies used.

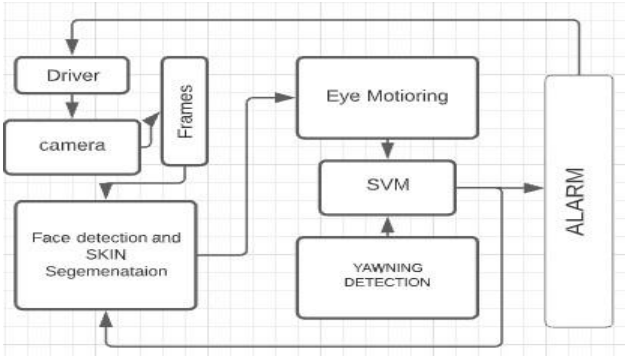
Methods Used:

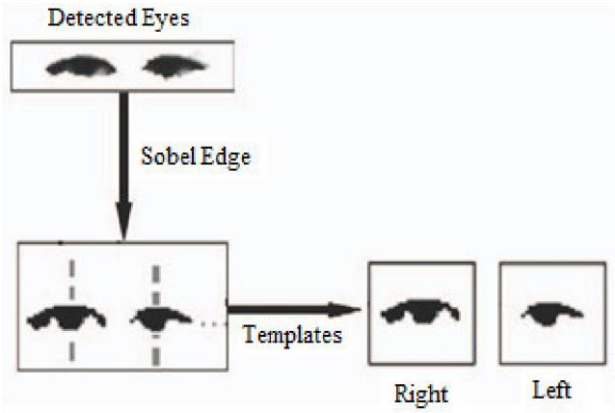
The methodology section details the proposed system's approach, emphasizing hybrid machine learning methodologies. Facial expressions serve as the primary input for detecting changes in the driver's state, and the system's performance is evaluated under varying luminance conditions. The section positions the hybrid approach as a synergistic integration of physiological measurements, behavioral measures, and vehicle-based indicators.

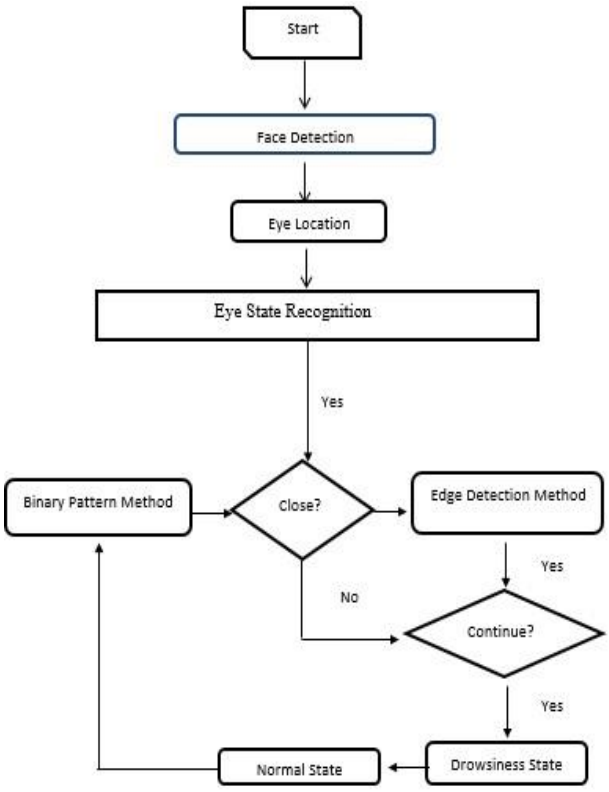
Results and Accuracy:

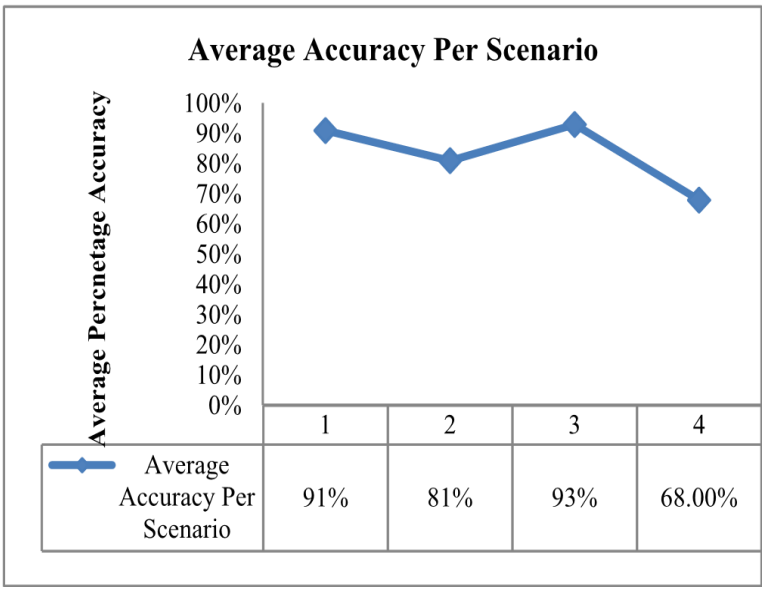
The results section highlights the system's performance under variable luminance conditions, showcasing an accuracy of 83.25% in detecting facial expression changes. While the specific

luminance conditions and corresponding accuracy figures are detailed, the section emphasizes the promising outcomes of the hybrid machine learning approach.









15.) 4D: A Real-Time Driver Drowsiness Detector Using Deep Learning:-

Abstract:

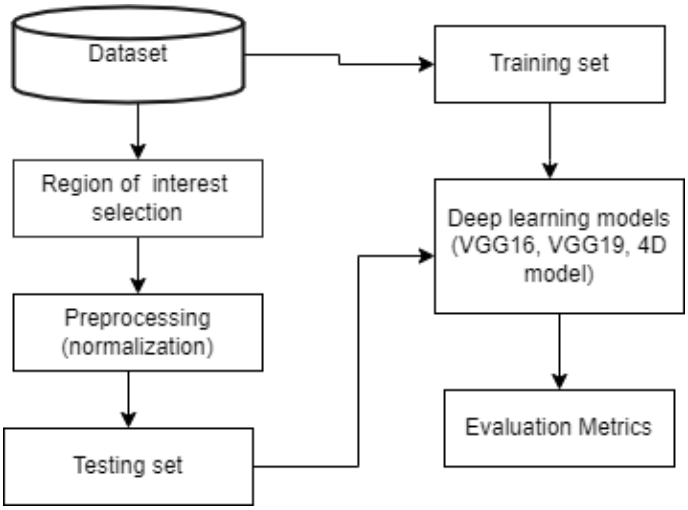
The research paper titled "4D: A Real-Time Driver Drowsiness Detector Using Deep Learning," authored by Israt Jahan, K. M. Aslam Uddin, Saydul Akbar Murad, M. Saef Ullah Miah, Tanvir Zaman Khan, Mehedi Masud, Sultan Aljahdali, and Anupam Kumar Bairagi, introduces a realtime driver drowsiness detection system employing deep learning algorithms. The system integrates convolutional neural networks (CNNs) for classifying eye states (open or closed) and a sigmoid classifier to ascertain the driver's drowsiness. Tested on the MRL Eye dataset, the proposed system achieves a remarkable 97.53% accuracy in predicting eye states, outperforming pretrained models (VGG16, VGG19). The paper conducts an extensive literature review encompassing physiological, behavioral, and vehicle-based measures for drowsiness detection, highlighting the superiority of deep learning algorithms in image classification. The authors advocate the proposed 4D model as a user-friendly solution applicable to desktops and mobile devices, envisioning its integration into future intelligent vehicles to mitigate accidents caused by driver fatigue.

Introduction:

The introduction outlines the imperative of addressing driver drowsiness in real-time to enhance road safety. The authors underscore the use of deep learning algorithms, particularly CNNs, in developing an effective drowsiness detection system. The user-friendly nature of the proposed solution and its potential impact on preventing accidents caused by driver fatigue are emphasized.

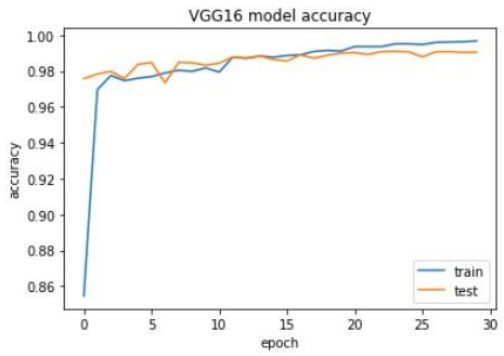
Methods Used:

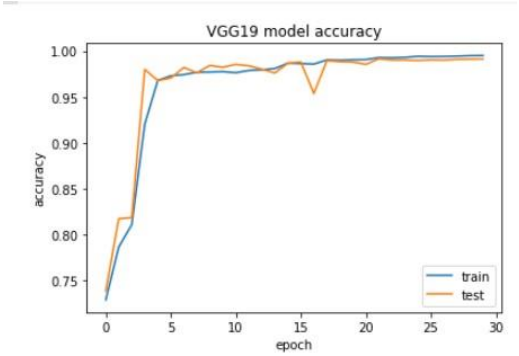
The methodology section delineates the key components of the proposed 4D model, elucidating the utilization of CNNs for eye state classification and a sigmoid classifier for drowsiness determination. The MRL Eye dataset serves as the testbed for evaluating the system's performance. Comparative analysis with pretrained models (VGG16, VGG19) underscores the superior accuracy achieved by the 4D model.

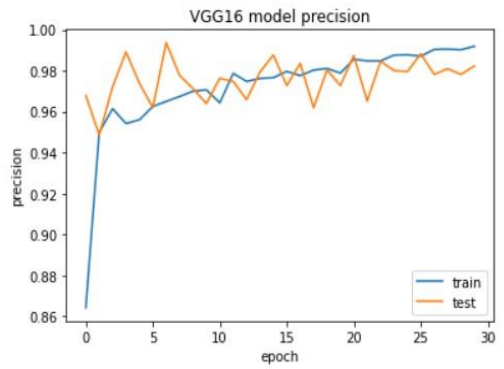


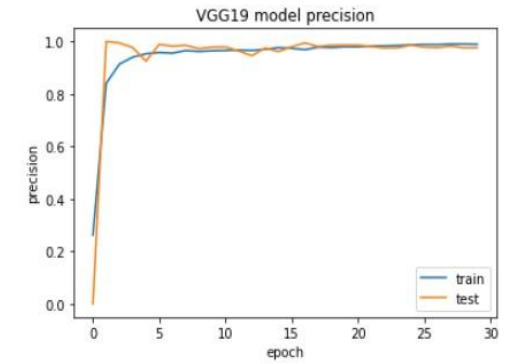
Results and Accuracy:

The results section showcases the outstanding performance of the 4D model, achieving approximately 97.53% accuracy in predicting eye states. Comparative assessments with VGG16 and VGG19 models further affirm the superior accuracy of the proposed system.









16.) Enhanced Drowsiness Detection Using Deep Learning: An fNIRS Study:-

Abstract:

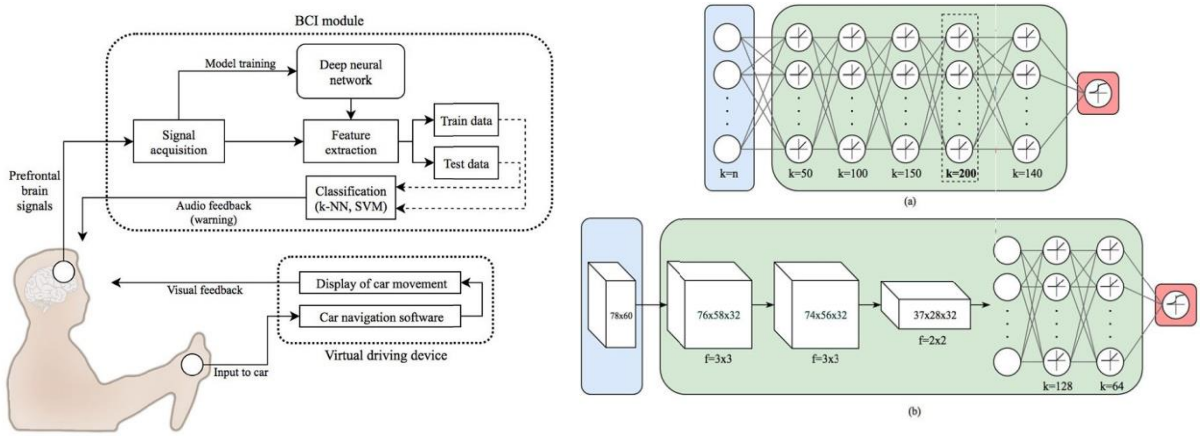
The research paper, "Enhanced Drowsiness Detection Using Deep Learning: An fNIRS Study," authored by M. Asjid Tanveer, M. Jawad Khan, M. Jahangir Qureshi, Noman Naseer, and KeumShik Hong, proposes an advanced system for detecting driver drowsiness by leveraging functional near-infrared spectroscopy (fNIRS) in combination with deep neural networks (DNN) and convolutional neural networks (CNN). The study involves passive monitoring of brain signals associated with drowsiness from 13 subjects driving a car simulator. The fNIRS system focuses on measuring brain activities in the prefrontal and dorsolateral prefrontal cortices.

Introduction:

Driver drowsiness is a critical concern for road safety, necessitating effective detection systems. The paper introduces a novel approach employing fNIRS and deep learning, emphasizing the significance of accurate and timely drowsiness detection. The context is established through a thorough literature review, examining existing methods and highlighting the limitations addressed by the proposed system.

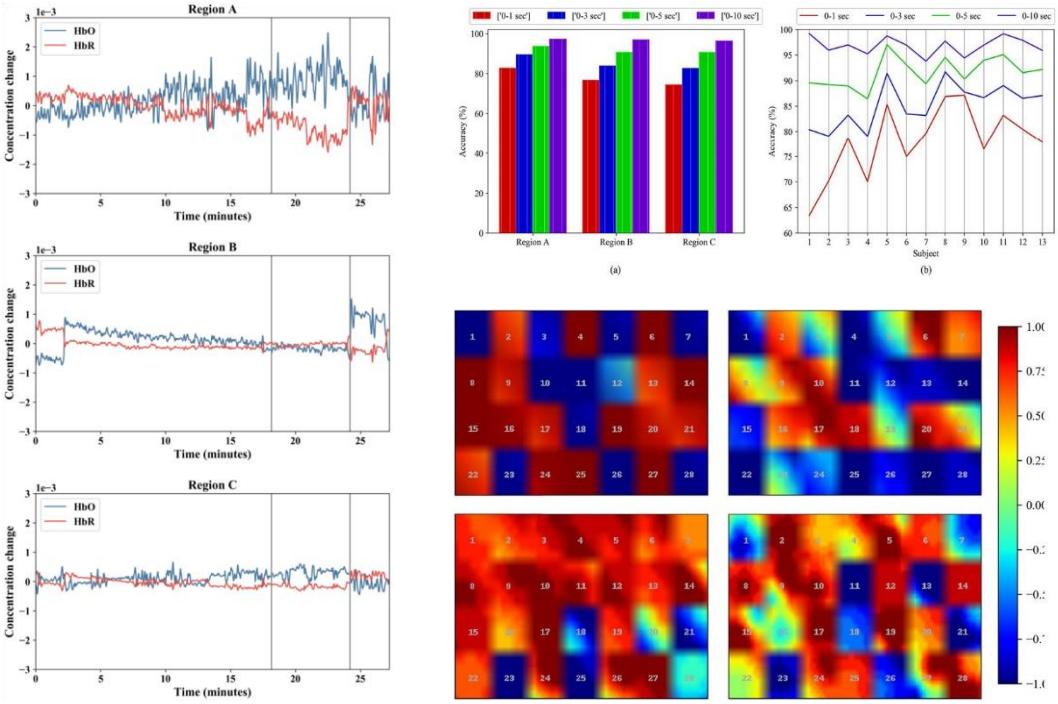
Methods Used/Methodology:

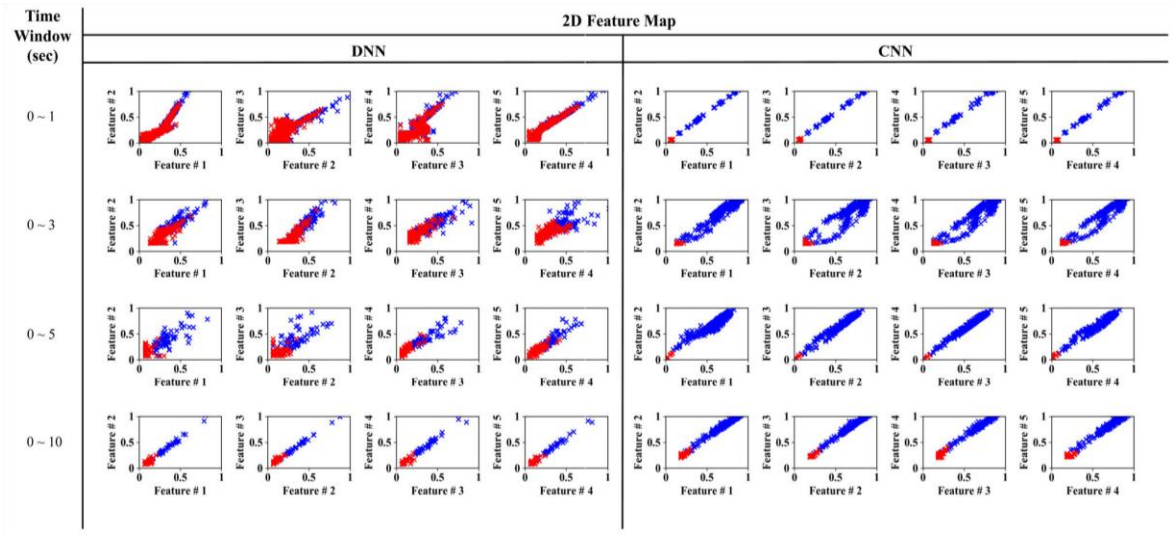
The methodology incorporates continuous-wave fNIRS to capture passive brain signals during simulated driving. The focus on specific brain regions, such as the prefrontal and dorsolateral prefrontal cortices, contributes to the system's efficacy. Deep neural networks (DNNs) and convolutional neural networks (CNNs) are employed for processing and classifying the acquired data. The study outlines the experimental setup, data collection procedures, and the architectural details of DNNs and CNNs.



Results and Accuracy:

The proposed system demonstrated notable accuracy in different time windows, with DNNs achieving accuracies of 82.7%, 89.4%, 93.7%, and 97.2% in the 0~1, 0~3, 0~5, and 0~10 sec intervals, respectively, using data from the right dorsolateral prefrontal cortex. The CNN architecture excelled with an impressive average accuracy of 99.3%, showcasing its capability to discern images related to drowsy and non-drowsy states. The results validate the effectiveness of the proposed system in providing reliable and timely detection of driver drowsiness, thereby contributing to road safety.





17.) A Deep Learning Approach To Detect Driver Drowsiness:-

Abstract:

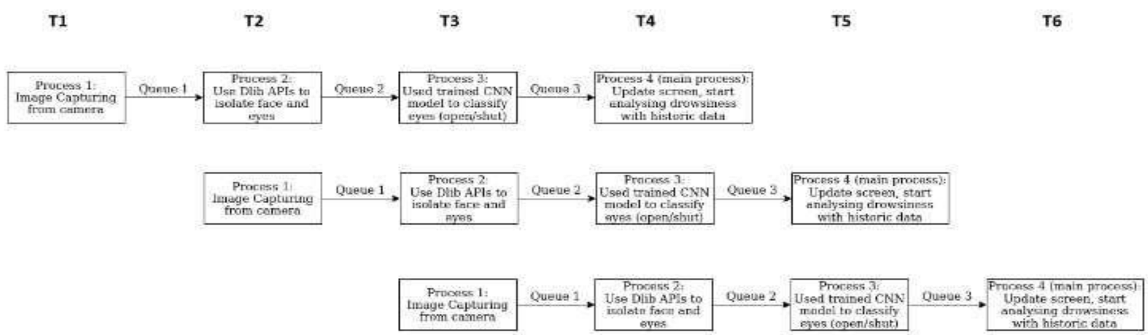
The research paper titled "A Deep Learning Approach To Detect Driver Drowsiness" addresses the crucial issue of driver drowsiness by proposing a comprehensive drowsiness detection system. The primary focus is on analyzing the state of the driver's eyes to preemptively identify drowsiness and issue alerts, thereby enhancing road safety. The paper introduces a novel deep learning-based model for classifying eye states (open/close) and seamlessly integrates it into the broader driver drowsiness detection framework. A detailed literature survey is conducted, and the proposed approach is benchmarked against existing methods.

Introduction:

Driver drowsiness poses a significant threat to road safety, necessitating effective detection systems. The paper introduces a novel approach grounded in deep learning to address this concern. The emphasis is on leveraging a sophisticated model for the classification of eye states, contributing to the early identification of drowsiness. A comparative analysis with existing methods provides context and highlights the innovative aspects of the proposed approach.

Methods Used/Methodology:

The methodology involves the development and integration of a deep learning-based model designed for the classification of eye states. The model forms a critical component of the broader driver drowsiness detection system. The paper provides insights into the architecture of the deep learning model, data preprocessing steps, and the training process. A comprehensive literature survey is conducted to contextualize the proposed method within the existing landscape of drowsiness detection techniques.



Results and Accuracy:

The paper concludes that the proposed deep learning-based approach achieves a commendable accuracy of 94% in classifying eye states. This high level of accuracy underscores the effectiveness of the method in detecting driver drowsiness. The results position the proposed approach as a robust solution for preemptive drowsiness detection, capable of providing timely alerts to mitigate potential safety risks on the road.

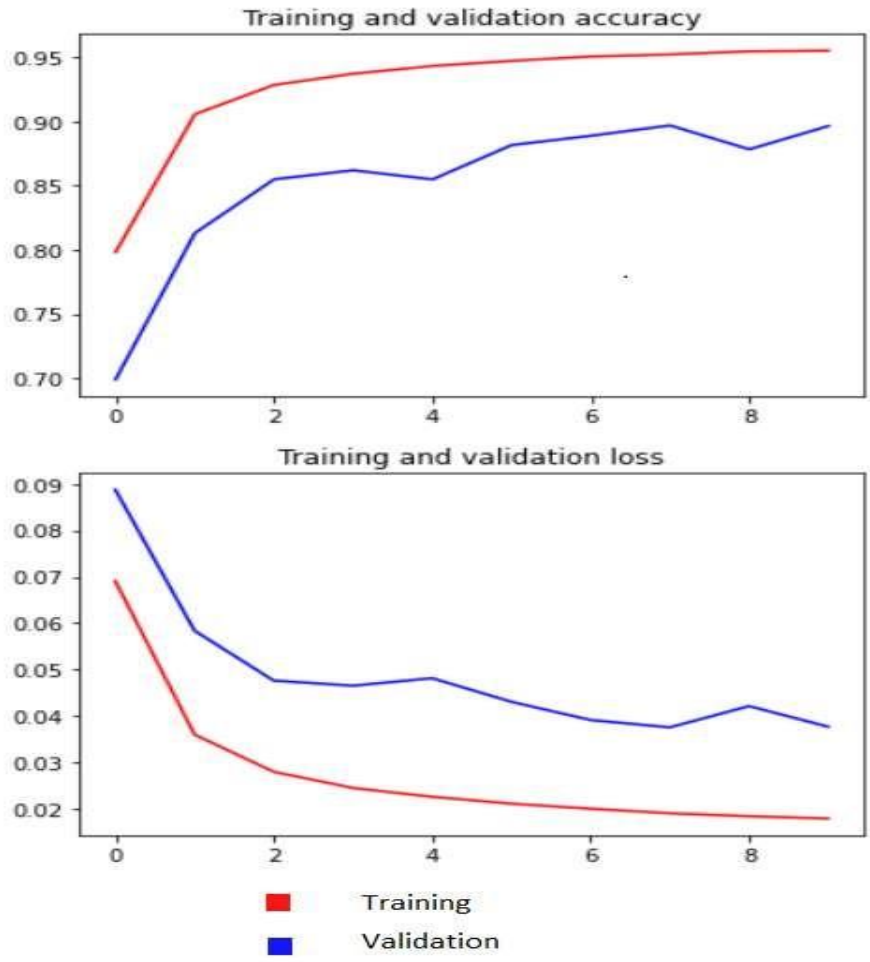


Figure 5. Training and Validation accuracy and loss

18.) Driver Drowsiness Detection Using Deep Learning:-

Abstract:-

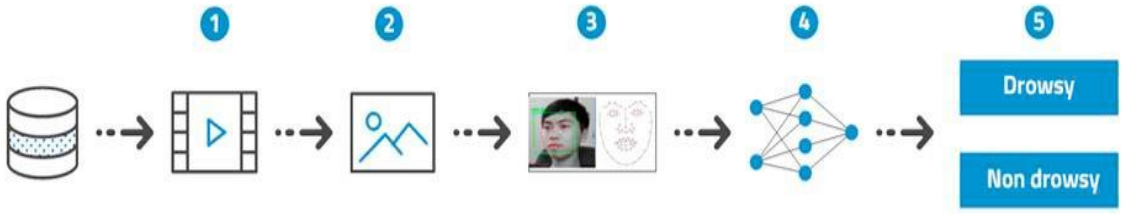
Driver drowsiness detection is a critical aspect of ensuring road safety. This literature review aims to explore the methodologies and results of driver drowsiness detection using deep learning techniques. The review focuses on recent research papers and conference proceedings to provide insights into the advancements in this field.

Introduction:-

Driver drowsiness is a major cause of road accidents, making it essential to develop effective drowsiness detection systems. Deep learning techniques have shown promise in accurately detecting driver drowsiness by analyzing facial and eye movement patterns. This literature review aims to provide an overview of the methodologies and results of recent studies in this area.

Methods Used/Methodology:-

The review includes an analysis of recent research papers and conference proceedings related to driver drowsiness detection using deep learning. The methodologies used in these studies include the application of convolutional neural networks (CNNs) and recurrent neural networks (RNNs) to analyze facial expressions, eye closure ratio, and other physiological indicators of drowsiness. The review also considers representation learning and model compression techniques used in these studies.



Results and Accuracy:-

The review reveals that recent studies have demonstrated the effectiveness of deep learning techniques in accurately detecting driver drowsiness. The application of CNNs and RNNs has shown promising results in analyzing facial and eye movement patterns to detect signs of drowsiness. Additionally, representation learning and model compression techniques have contributed to the development of real-time drowsiness detection systems.

Table 2. Accuracy per driving scenarios

Category	Accuracy
With glasses	84.848
Night Without glasses	81.40
Night With glasses	76.152
Without glasses	87.12276
With sunglasses	75.115
All	80.9274