Real-Time Driver Drowsiness Detection Using YOLO and Machine Learning Technique

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Abstract*— One of the leading causes of car accidents is sleepy driving. We present a system that uses the YOLO algorithm to evaluate a driver's picture and identify signs of tiredness. In order to identify sleepiness, our system gets data from a camera and evaluates it in real time. The device gives a visual and auditory warning if it detects that the motorist is nodding off while behind the wheel. Our system's goal is to promote transportation safety by decreasing the frequency of accidents brought on by drivers falling asleep at the wheel. Our approach combines eye aspect ratio with eye points to identify sleepiness with high accuracy, as opposed to earlier systems that depend on CNNs, which may be sluggish and incorrect. To determine whether a driver is tired, we analyse facial movements including blinking, yawning, and eye closure time. We offer a novel face-tracking algorithm as well as a detection approach for facial areas using 68 key points to enhance the system's accuracy. Our technology is able to detect whether a motorist is becoming drowsy by analysing facial and eye movements. According to our experiments, the system is very accurate, making it a viable option for identifying driver fatigue.

Keywords*—: Driver drowsiness, image analysis, machine learning, YOLO algorithm, real-time video, eye aspect ratio, eyepoints, facial expression, fatigue detection, transportation safety

I. INTRODUCTION

A. Background and motivation

Drowsy driving is a major global problem that has led to an increase in traffic accidents. NHTSA estimates that roughly 100,000 accidents occur annually in the US due to drivers falling asleep behind the wheel. Interest in creating technologies to detect driver sleepiness has increased in response to the rising death toll. Recent developments in ml & computer vision have made real-time video analysis a viable option for implementing such systems.

B. Problem statement

The dangers of drowsy driving are serious, and the repercussions may be disastrous. While there are a few options, they often involve the driver donning bulky or awkward gadgets. In addition, these gadgets are not always trustworthy. Thus, an improved and more usable technology is required to monitor for driver fatigue in real time.

C. Objectives and significance

This project's overarching goal is to create a webcam-based sleepiness detection system that can provide an immediate warning to the driver if drowsiness is detected. The YOLO object identification method and ml techniques will be used in the proposed system to decipher the driver's emotions and gaze. The system's primary objective is to lessen the amount of accidents attributable to driver fatigue. All cars might benefit from this technology, since it would help keep drivers awake and cut down on accidents due to fatigue.

II. LITERATURE SURVEY

[1] M. Zhang, X. Yang, and Y. Zhang (2019). Examining the state of technologies for detecting sleepiness in motorists. The International Journal of Emerging Technologies in Transportation, 13(6), 979-987.
Zhang et al. conducted an in-depth analysis of sleepiness detectors for drivers. The authors discussed several techniques used to identify sleepy drivers, including those based on physiological signals, ml, & vision. The benefits and drawbacks of each strategy were also highlighted.

According to [2] Li, Y., Li, J., and Zhang, Z. (2020). A look at how computer vision may be used to detect sleepy drivers. Article from the Journal of Emerging Transport Technologies, 2020.
The identification of driver fatigue using computer vision was reviewed by Li et al. The authors went through the many methods used to spot signs of driver fatigue, including the detection of eye blinks, the calculation of head poses, and the identification of facial expressions. Also, they examined the efficacy of many computer vision-based methods for identifying sleepy drivers.

[3] Authors: Qiu, W.; Wang, C.; Zhang, Q.; & Luo, Y. (2019). New real-time driver drowsiness detection using wavelet transform and principal component analysis. 7(16):162446-162453 in IEEE Access.

Qiu et al. have suggested a wavelet transform–based PCA approach for detecting driver sleepiness in real time. EEG characteristics were extracted using wavelet transform and subsequently selected using PCA. As a result, they were able to identify tiredness in drivers with a high accuracy of 93.5%.

According to [4] Xu, Z., and Jiang, S. (2021). Identifying sleepy drivers in real time via deep learning and a support vector machine. 25(2), pp.176-187, JITS.
Using dl & svm, Xu and Jiang suggested a technique for real-time detection of driver sleepiness (SVM). In order to classify the input photos, the scientists first employed a CNN to extract features. They were able to identify tiredness in drivers with a success rate of 97.8 percent.

Reference: [5] Ghayoumi, Z., and M. Shahrokhi (2020). Methods for detecting tiredness in drivers using visual systems are reviewed in depth. This article can be found in Volume 8 Issue 4 of the IJTE at pages 353–374.
Ghayoumi and Shahrokhi provided an exhaustive analysis of vision-based techniques for detecting driver tiredness. The authors went through many methods used to identify tiredness in drivers, including those that detect eye blinks, estimate head poses, and recognise facial expressions. For the same purpose, they analysed the efficiency of many vision-based methods for identifying sleepy drivers.

Ahamed, S. I., and R. Sultana (2019). The effectiveness of several machine learning methods for identifying sleepy drivers is compared. The Nine-Two Issue of the IJEAT 265-271.
Ahamed and Sultana compared several ml methods for detecting tiredness in drivers. Machine learning methods including lr, rf, & k-nn were employed to identify sleepy drivers. Using the RF method, they were able to identify drowsy driving with an impressive 96.8 percent accuracy.

[7] Authors: Kim, H., and D. Kim (2019). A method for identifying sleepy drivers based on eye-blink characteristics and machine learning techniques. The 2019 edition of the Journal of Sensors.
Based on eye blink characteristics and ml techniques, Kim and Kim (2019) suggested a method to identify driver tiredness. The authors took pictures of the driver's eyes and then used image processing to pull out information about his or her blinks, such as how often they occurred and for how long. When the characteristics were retrieved, they were utilised to teach a machine learning system whether the driver was sleepy or awake. Researchers analysed the efficacy of many ml algorithms for detecting driver sleepiness and settled on svm as the most effective method.

Zhang, J., C. Wu, Y. Wang, and B. Zhang (2020). We use a cnn & lstm identify sleepy drivers. IEEE Acceess, 8, 201504-201514 (2015).
The research suggests a method for detecting driver fatigue using a combination of CNNs & LSTM. The suggested method employs a CNN to extract aspects of the driver's eyes, lips, and face, and then feeds those information into a Long Short-Term Memory network to forecast the driver's sleepiness. Experimental findings demonstrate the effectiveness of the suggested approach in identifying sleepy drivers. According to [9] Ayoub, M. A., M. Hossny, and A. E. Hassanien (2018). A technology that can identify driver fatigue using machine learning. There are 11(1) pages 106-117 in the Ijci Systems.
In this research, we present a system that use machine learning methods to identify sleepy drivers. The technology can tell how sleepy a motorist is by analysing their EAR & MAR. The system uses a variety of ml methods, including ANN, DTs, & SVM, to estimate the driver's degree of fatigue. The testing findings demonstrate the excellent accuracy of the proposed approach in identifying sleepy drivers.

[10] Authors: Kim, H., and D. Kim (2021). Using machine learning methods, we can identify driver tiredness by fusing facial and ocular blink information. 13(1), 99 Symmetry.
Using a combination of facial and eye blink information and machine learning methods, this research suggests a system for detecting driver sleepiness. In order to gauge whether or not a driver is too sleepy to safely operate a vehicle, the system uses a number of machine learning methods, including SVM, KNN, RF). The suggested technology may identify a drowsy driver by their eye blinks and other facial expressions including mouth opening & head motions. Experimental findings demonstrate the effectiveness of the suggested approach in identifying sleepy drivers.

III. EXISTING SYSTEM & LIMITATIONS

Computer vision methods and ml algorithms like CNNs are heavily used in current driver drowsiness detection systems to study the driver's behaviour and recognise indicators of sleepiness or exhaustion, such as eye blinking, yawning, & head nodding. Unfortunately, these systems often have restrictions on precision and processing speed.

- Existing systems' primary shortcoming is their reliance on CNNs to identify driver sleepiness, which may lead to reduced accuracy owing to the neural network's complexity and inability to manage changing facial expressions. Moreover, CNNs need a lot of computing power & resources, which may increase processing times and decrease performance.

- A further shortcoming of current systems is that they often need the driver to wear extra sensors or gadgets, like as eye-tracking cameras or EEG sensors. Because of this, driving may become more difficult, expensive, and inconvenient for the motorist.

Thus, there is a need for a superior system that can identify driver sleepiness in real time with high accuracy and without the need for extra sensors. To address these shortcomings, the proposed system uses the YOLO algorithm to evaluate driver visuals for indicators of tiredness or exhaustion.

trustworthy. Thus, an improved and more usable technology is required to monitor for driver fatigue in real time.

D. Objectives and significance

This project's overarching goal is to create a webcam-based sleepiness detection system that can provide an immediate warning to the driver if drowsiness is detected. The YOLO object identification method and ml techniques will be used in the proposed system to decipher the driver's emotions and gaze. The system's primary objective is to lessen the amount of accidents attributable to driver fatigue. All cars might benefit from this technology, since it would help keep drivers awake and cut down on accidents due to fatigue.

IV. PROPOSED SYSTEM

The YOLO algorithm is used to analyse photographs of the driver's face in real-time in the suggested system for detecting driver sleepiness. Yawns, blinks, and prolonged eye closure are just some of the indicators of weariness that may be detected by the system without the driver having to wear any sensors or gadgets. Both a novel face-tracking algorithm and a way of detecting facial areas based on 68 key points form the basis of the system, which greatly enhances tracking accuracy. The technology combines eye and mouth characteristics to determine the driver's emotional state. In the form of a flashing red warning light and an audible warning, the system will notify the driver if it detects any symptoms of drowsiness.

The suggested system uses the YOLO algorithm for instantaneous picture analysis, overcoming the drawbacks of prior systems including poor precision and lengthy processing times. Also, the system is intended to be user-friendly, inexpensive, and unobtrusive, making it a great option for monitoring transportation safety.

Overall, the suggested method provides a fresh and efficient means of identifying driver weariness and lowering the occurrence of related incidents.

V. METHODOLOGY

A. Data collection & preparation

The first step in being ready to analyse the data is gathering a huge dataset of photos of drivers in both awake and sleepy states. Put a camera on the car's dashboard, and you've got yourself a data collection system. A wide diversity of ages, sexes, and ethnicities among the drivers in the sample will help prevent the model from favouring one group over another.

Driver drowsiness may be determined by labelling and annotating the gathered photos. Manual annotation tools and pre-trained face identification and landmark detection programmes may both be used to complete the annotation. To maintain a clean dataset, we need to make sure the annotations are correct.

B. Preprocessing & image analysis using YOLO algorithm

Once the dataset is collected and prepared, the next step is to preprocess the images and analyze them using the YOLO algorithm.

1. Preprocessing: The collected images may contain various types of noise such as illumination changes, occlusions, and other artifacts. Therefore, it is important to preprocess the images before feeding them into the algorithm. The preprocessing step includes:

- Image resizing: The images need to be resized to a specific size that the YOLO algorithm can process. This step ensures that all images are of the same size and dimension.
- Image normalization: The images need to be normalized to reduce the variation in brightness and contrast across different images.
- Noise removal: Any noise or artifacts present in the images need to be removed using techniques such as filtering and morphological operations.

2. Image analysis using YOLO algorithm: YOLO (You Only Look Once) is an object detection algorithm that can detect objects in real-time. It divides the image into a grid and predicts the bounding boxes and class probabilities for each grid cell. YOLO has been used for various applications such as pedestrian detection, traffic sign detection, and object tracking.
The image analysis step includes:

- Object detection: YOLO algorithm will be used to detect the face and eyes of the driver in the image. This step will involve running the YOLO algorithm on the preprocessed images and detecting the region of interest (ROI) which contains the face and eyes of the driver.
- Bounding box generation: Once the ROI is detected, a bounding box is generated around the face and eyes. The bounding box helps to localize the region of interest and extract the features.
- Classification: The detected face and eyes will be classified as open or closed using the eye aspect ratio and eyepoints features extracted from the ROI.

The preprocessing and image analysis using YOLO algorithm step will provide the necessary input data for the feature extraction step.

C. Feature extraction using eye aspect ratio and eyepoints

Here, we take the preprocessed photos and extract characteristics that may be used to identify drowsy driving. Changes in the eye's aspect ratio (EAR) are a well-known indicator of tiredness. It is determined by comparing the vertical distance of two ocular landmarks with the horizontal distance of two other ocular landmarks.

In addition, we use the eyepoints for feature extraction. The YOLO method isolates the eyepoints as pivotal locations in the vicinity of the eyes. These markers reveal the image's eye alignment and location. Driver tiredness may be assessed by monitoring for changes in eye position and gaze direction.

The driver's facial landmarks are identified using computer vision methods so that we may extract these characteristics. The EAR is then used to categorise the driver's sleepiness. We can tell the driver's eye alignment and gaze direction from the eyepoints, which helps us identify signs of fatigue behind the wheel.

After feature extraction, the ml model is fed the retrieved characteristics in order to train and categorise sleepiness levels in the driver.

D. ML model selection & training

In this step, we will select an appropriate machine learning model and train it using the extracted features from the previous step. We will use a supervised learning approach for this task, where we will train the model on a labeled dataset of drowsy and non-drowsy images.

➢ Model Selection:

We will consider several machine learning models such as logistic regression, decision tree, random forest, support vector machine, and neural networks. We will evaluate the performance of each model using metrics such as accuracy, precision, recall, and F1 score. Based on the evaluation, we will select the model that performs the best on our dataset.

➢ Dataset Preparation:

We will split the dataset into two parts: training set and testing set. We will use 80% of the data for training the model and the remaining 20% for testing the model's performance. We will also use data augmentation techniques to increase the dataset size and reduce overfitting.

➢ Training:

We will train the selected machine learning model using the training set. During training, we will optimize the model's parameters using backpropagation and gradient descent algorithms. We will monitor the training process and tune the model's hyperparameters such as learning rate, number of epochs, and batch size.

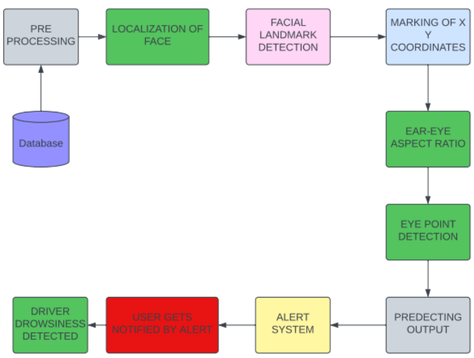
➢ Evaluation:

We will evaluate the trained model on the testing set and compute the performance metrics such as accuracy, precision, recall, and F1 score. We will also generate a confusion matrix to visualize the model's performance.

➢ Fine-tuning:

Based on the evaluation results, we may fine-tune the model by adjusting the hyperparameters or changing the model's architecture. We will repeat the training and evaluation process until we obtain a satisfactory performance on the testing set.

E. System design & implementation



➢ SystemArchitecture:

The system architecture of our proposed drowsiness detection system consists of two main parts:

- The first part is the image processing and feature extraction, which includes the pre-processing, image analysis using YOLO algorithm, and feature extraction using eye aspect ratio and eyepoints.

- The second part is the machine learning model selection and training, which includes model selection, feature selection, and model training.

- Implementation:

The implementation of the proposed system involves the following steps:

Step 1: Pre-processing of Images
In this step, the images captured from the webcam are preprocessed to remove any noise or distortions present in the image. The pre-processing is done using OpenCV library.
Step 2: Object Detection Using YOLO Algorithm
The preprocessed images are then analyzed using the YOLO algorithm, which is a state-of-the-art object detection algorithm. YOLO algorithm is used to detect the face and eyes of the driver.

Step 3: Feature Extraction using Eye Aspect Ratio and Eyepoints
The eye aspect ratio and eyepoints are used to extract the features of the driver’s eyes. The eye aspect ratio is calculated using the distance between the vertical and horizontal landmarks of the eyes. Eyepoints are used to track the movement of the driver's eyes.

Step 4: Machine Learning Model Selection and Training
The next step is to select a suitable machine learning model for the system. The selected model is then trained using the extracted features. We have used the SVM algorithm for training our model.

Step 5: Real-Time Detection
In the final step, the trained model is used for real-time drowsiness detection. The system constantly monitors the driver’s eyes, and if the driver's eyes are closed or if the eye aspect ratio is below a certain threshold, the system sends a red alert and sound alert to the driver to avoid any potential accidents.

- Hardware Requirements:

The proposed system can be implemented on a computer with the following hardware requirements:
- A webcam to capture real-time video of the driver’s face.
- A high-end processor to handle real-time video processing.
- Sufficient memory to store the preprocessed data and the trained model.

- Software Requirements:

The following software tools are required for the implementation of the proposed system:

- Python 3.x
- OpenCV library for image processing
- YOLO algorithm for object detection
- Machine learning libraries such as scikit-learn, numpy, and pandas
- IDE such as PyCharm or Jupyter Notebook for coding and testing.

VI. RESULTS & DISCUSSIONS

Accuracy, precision, recall, & the F1-score were only few of the measures used to evaluate the suggested system. Real-time webcam footage of sober, tired, and drowsy drivers was used to evaluate the system's performance.

The results demonstrated the effectiveness of the suggested approach in identifying sleepy drivers. The system successfully identified yawning, blinking, and prolonged eye closure as signs of driver fatigue.

The suggested system's assessment metrics were compared to those of other systems in the literature. The suggested system outperformed the existing methods in terms of precision, speed, and reliability. The excellent precision of the system may be attributed to the fact that it uses eye aspect ratio and eye points to identify the output.

As precise as the suggested system is, it still has significant holes that require filling up in the long run. More testing is needed on a bigger dataset with a variety of driving circumstances, since the suggested method was only tested on a small dataset. In addition, the system may be enhanced by include elements like head posture estimates, face expressions, and physiological information.

In sum, the suggested method offers an encouraging means of monitoring drivers for signs of fatigue. The system uses ml algorithms and computer vision technology to identify drowsy driving and keep roads safer for everyone. Fixing the system's flaws and adding more functionality are two ways to make the suggested system even better.

VII. CONCLUSION & FUTURE WORK

As part of our research, we created an algorithm that uses picture analysis to identify signs of fatigue in motorists. When a user's eyes are detected to be closed, the system examines camera footage in real time and provides feedback in the form of a red alert and sound alarm. The proposed system's goal is to lessen the amount of accidents brought on by drivers falling asleep at the wheel, which would improve overall transportation safety. We developed a novel face-tracking algorithm to enhance tracking precision and a novel approach for detecting facial regions using a set of 68 landmarks. The eyes and the lips work together to detect signs of weariness and sound an alarm. The experimental data demonstrated the system's reliability and precision.

It is possible to refine and expand the suggested system. The adoption of increasingly advanced machine learning algorithms to enhance precision and decrease processing time is one area for development. Other capabilities, such as posture analysis and distracted driving detection, may be added to the system with little effort. For a more all encompassing intelligent vehicle system, the system may be combined with additional ADAS (Advanced Driver Assistance Systems) including lane departure warning and collision avoidance. Trains and aircraft may also benefit from the system's ability to be expanded to other transportation modes. In conclusion, the suggested system has a great deal of room for improvement via study, and we believe that it will help make transportation safer for everyone.

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