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Drowsiness Detection Using Haar and CNN Algorithm

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Abstract

The objective of this project is to create a drowsiness detection system that can recognize when someone's eyes are closed for a brief period of time. When sleepiness is detected, this system will give the user a warning. When someone is falling asleep, an alarm buzzes to wake them up. Making the model platform independent, computationally efficient, and affordable for the low-end spec platform is the main goal of this project. Furthermore, to boost the detection's face-sensing accuracy, a mixture of two improved algorithms is applied. The existing system occasionally generates false positive results, which results in erroneous drowsiness detections. These systems might not function properly in various lighting scenarios or with different facial expressions. The proposed system is made with the intention of reducing accident rates and advancing technology in order to reduce the number of deaths and injuries brought on by traffic accidents.

Keywords: Image Processing, Feature Learning, Accuracy, Real-time Processing, Drowsiness.

Introduction

One of the most prevalent causes of accidents is driver sleepiness and weariness. Each year, the deaths of individuals in such incidents rises across the world. The intent of this research is to reduce the frequency of accidents caused by driver sleepiness and exhaustion. As a result, transportation safety will improve. Driver drowsiness detection is a technology that can help avoid accidents and save drivers' lives when they become drowsy. This research use computer vision to identify driver drowsiness. This research focuses on creating an efficient and cost-effective drowsiness detection system. The approach required in the current circumstance identifies tiredness using geometric aspects of the eyes and lips. This research aims to accomplish the same goal by constructing a sleepiness detection system to monitor and avoid a negative consequence from tiredness neglect.

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LITERATURE SURVEY:
The following is a brief summary of the papers reviewed:

The research conducts a comparative analysis of studies on driver sleepiness detection and alarm systems. An arithmetic-based strategy is employed to give a solution to the problem of detecting tiredness. This technology detects weariness by detecting eye movement. A camera is used to detect eye movement.To determine the driving condition, the PERCLOS algorithm and Haar-based cascade classifiers are utilised. The detecting mechanism distinguishes between regular eye blinks and tiredness. The technology created is non-invasive[1].

The paper explains how to identify drowsiness by observing the eyes and lips. To detect essential characteristics on the face, shape prediction algorithms are applied. The inputs to these systems are facial landmarks collected by facial landmark detection. This module is concerned with the EAR function, which computes the distance ratio between horizontal and vertical eye landmarks[2].

Algorithm Study
A. Haar Algorithm
The Haar algorithm is a well-known image processing algorithm that is used for object detection and facial recognition. The Haar algorithm can be used in the context of drowsiness detection to identify characteristics on the face such as the eyes and mouth, which can subsequently be used to assess whether the individual is drowsy.

The Haar algorithm works by analyzing the contrast between different regions of an image. It uses a set of pre-defined Haar features that are trained to recognize certain patterns in the image. These features are typically rectangular and vary in size and orientation.

To detect sleepiness, the algorithm would first take a picture of the person's face with a camera. Then it would use the Haar algorithm to identify the eyes and mouth in the image. The algorithm would then analyze the position and movement of these features over time to determine if the person is drowsy.

For example, if the algorithm detects that the person's eyes are closed or drooping, or that the mouth is open for an extended period of time, this may indicate that the person is sleepy and needs rest.

Overall, Haar edge and line detectors can be used to detect various facial features that can be used to determine whether the driver is drowsy. By combining multiple features, it is possible to create a more accurate drowsiness detection system.

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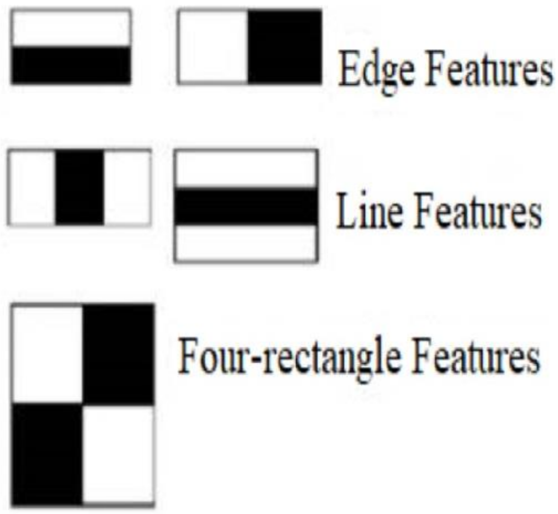

Fig.1.Haar Feature detectors

The Haar method may be used to identify the edges of the driver's eyes. It is possible to tell if the driver's eyes are closed or partially closed by measuring the aspect ratio of the observed eyes, which is an indicative of drowsiness.

B. CNN Algorithm

Convolutional Neural Networks (CNNs) can be used in drowsiness detection systems to automatically extract relevant features from images or videos of a person's face or eyes.

The CNN model extracts characteristics that are critical for discriminating between these two states from a huge dataset of annotated images, where each image is classified as drowsy or non-drowsy. These characteristics might include drooping eyelids, alterations in the structure of the eyes, and the degree of eye closure.

Once trained, the CNN model may be used to categorize new images or video frames as drowsy or non-drowsy. The CNN model analyses an image or video frame through a series of convolutional layers that learn to detect patterns and characteristics in the input image. The convolutional layer output is then input into fully connected layers, which learn to map these characteristics to a final classification of drowsy or non-drowsy.

In summary, CNNs are used to detect drowsiness by automatically extracting key data from images or video frames and using them to identify the state of drowsiness. This can aid in the development of real-time systems that can inform drivers or operators if they are growing drowsy and are at risk of an accident. [6-14]

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System Implementation

The system implementation of drowsiness detection using Haar algorithm and CNN algorithm typically involves several steps, including data collection, preprocessing, feature extraction, classification, and visualization.

1. Data Collection: The first step in implementing a drowsiness detection system is to collect data. This involves capturing images or videos of individuals in different states of drowsiness, such as awake, sleepy, and falling asleep. The data should be diverse and representative of real-world scenarios.
2. Preprocessing: The next step is to preprocess the data. This involves converting the images or videos into a format that can be processed by the algorithms. It may also involve image normalization, resizing, and cropping to reduce noise and improve accuracy.
3. Feature Extraction: The Haar algorithm is used for feature extraction, which involves detecting specific facial features such as the eyes and mouth. This is accomplished using a cascade of Haar classifiers that are trained to recognize different patterns in the image data.
4. Classification: The CNN algorithm is used for classification, which involves training a deep neural network to recognize patterns in the image data and classify the images as either drowsy or not drowsy. The network is trained using a labeled dataset of images that have been preprocessed and feature extracted using the Haar algorithm.
5. Visualization: Once the system has been trained, it can be used to detect drowsiness in real-time scenarios, such as while driving. The system can generate visual alerts or sounds to warn the driver if they are exhibiting signs of drowsiness.

Overall, the system implementation of drowsiness detection using Haar algorithm and CNN algorithm involves combining the strengths of both algorithms to improve the accuracy and reliability of drowsiness detection. By detecting facial features using the Haar algorithm and classifying the images using the CNN algorithm, the system can accurately detect drowsiness in real-world scenarios.

Prerequisites

1. Labeled Dataset: A labeled dataset of images or videos is required for training the CNN algorithm. The dataset should contain a representative sample of images or videos of individuals in different states of drowsiness.
2. Haar Cascade Classifiers: The Haar algorithm requires a set of pre-trained classifiers to detect specific facial features such as eyes and mouth. These classifiers are typically available in OpenCV library or can be trained from scratch.

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3. Image Pre-processing: Pre-processing of images is necessary to reduce noise and improve the accuracy of feature detection. The pre-processing steps can include image normalization, resizing, and cropping.
4. Machine Learning Framework: A machine learning framework such as TensorFlow or Keras is required for training the CNN algorithm. These frameworks provide a convenient and efficient way to build, train and deploy machine learning models.
5. Hardware Requirements: Drowsiness detection using Haar algorithm and CNN algorithm requires significant computational resources. This includes a powerful CPU or GPU, and sufficient memory to process and store large datasets.
6. Real-Time Data Input: Drowsiness detection using Haar algorithm and CNN algorithm requires real-time input data, such as from a camera or sensor. Therefore, a reliable data input system should be in place.

Overall, drowsiness detection using Haar algorithm and CNN algorithm is a complex process that requires significant expertise in computer vision, machine learning, and software engineering. It is important to carefully consider the prerequisites before beginning to develop a drowsiness detection system.

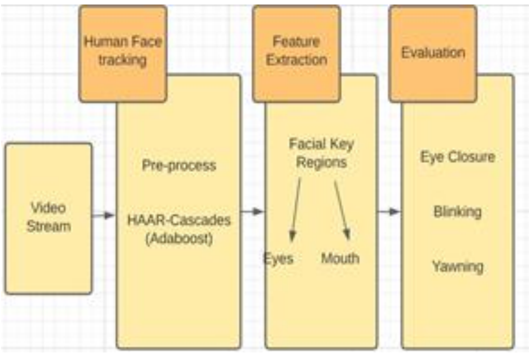

Fig.2.Process Flow

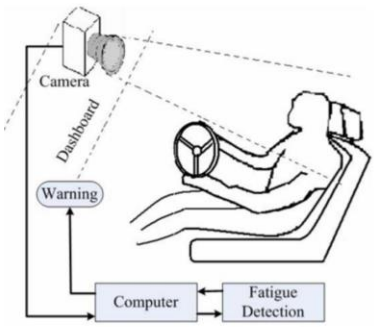

Fig.3. Real time view

The steps involved in drowsiness detection using Haar algorithm and CNN algorithm are as follows:

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Role of Haar Algorithm:

1. Collect Data: Collect a dataset of images or videos of individuals in different states of drowsiness.
2. Preprocess Data: Pre-process the data by converting the images or videos into a format that can be processed by the Haar algorithm. This may involve normalization, resizing, and cropping.
3. Face Detection: Apply the Haar algorithm to detect the faces in the images or videos.
4. Feature Detection: Apply a cascade of Haar classifiers to detect specific facial features such as eyes and mouth.
5. Feature Tracking: Track the movement of the detected features over time to identify changes that may indicate drowsiness.
6. Decision Making: Use the tracked features to determine if an individual is exhibiting signs of drowsiness.

Haar-like features formula: The Haar-like features are used to detect specific features such as the eyes and mouth of a driver. The formula for Haar-like features is:

$f(x) = \Sigma w(i) * p(i)$

where f(x) is the value of the Haar-like feature at location x, w(i) is the weight of the ith rectangle, and p(i) is the sum of pixel intensities within the ith rectangle.

Role of CNN Algorithm:

1.Collect Data: Collect a dataset of labeled images that have been preprocessed and feature extracted using the Haar algorithm.
2.Split Data: Split the dataset into training and validation sets.
3.Build Model: Build a deep neural network using a machine learning framework such as TensorFlow or Keras.
4.Train Model: Use the training dataset to train the model and the validation dataset to validate it.
5.Model Evaluation: Evaluate the trained model's performance using measures like as accuracy, precision, and recall.
6.Use Model: Use the trained model to classify new images as either drowsy or not drowsy in real-time scenarios.

CNN is a deep learning algorithm that is commonly used for drowsiness detection. The formula for CNN is:

$y = f(W * x + b)$

where y is the output of the CNN, W is the weight matrix, x is the input vector, b is the bias vector, and f is the activation function such as ReLU, sigmoid, or softmax.

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CNN Architecture:

We created the model using Keras and Convolutional Neural Networks (CNN). A convolutional neural network is a sort of deep neural network that works very well for image categorization. A CNN is made up of three layers: an input layer, an output layer, and a hidden layer with numerous layers. Convolution is conducted on these layers with the help of a filter that conducts 2D matrix multiplication on the layer and filter.

The CNN architecture is trained using a dataset of tagged video frames, with each frame categorised as sleepy or not. The model is taught to recognise drowsiness-related patterns and characteristics in video frames, such as drooping eyelids and sluggish head motions.

Once trained, the model may be used to identify further video frames in real-time, enabling for the early identification of driver sleepiness and the provision of alerts or actions to avert accidents.

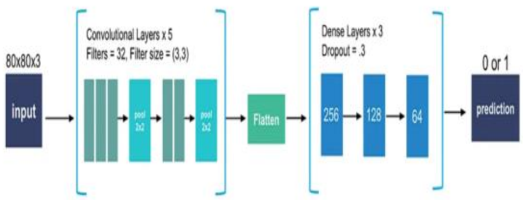

Fig.4.CNN Architecture

Implementation of Drowsiness Detection :

Let's take a step-by-step look at how our algorithm works.

1. Using a camera, we will collect pictures as input. Thus, in order to access the webcam, we created an infinite loop that captures each frame. Each frame is read and the picture is saved in a frame variable.

2.Construct an Region of Interest based on the detection of a face in an image.

To find the face in the image, we must first convert it to grayscale because the method for object identification only accepts grayscale images as input. Colour information is not required to detect the items. To detect faces, we will employ the Haar cascade classifier. The detection is then carried out. It produces an array of detections with x,y coordinates and height, which is the width of the object's border box. We can now iterate through the faces, drawing boundary boxes for each one.

3. Using the ROI, detect the eyeballs and give them to the classifier.

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The same method that is used to detect faces is utilised to detect eyes. We first configure the cascade classifier for eyes in left eye and right eye. We must now extract only the eyes data from the entire picture. This may be accomplished by extracting the eye's border box and then using this code to extract the eye image from the frame.

Left eye just holds the eye's picture data. This information will be sent into our CNN classifier, which will predict whether the eyes are open or closed. Similarly, the right eye will be extracted into right eye.

4. The Classifier will determine if the eyes are open or closed. The CNN classifier is being used to forecast the eye state. To input our image into the model, we must first execute certain operations because the model need the proper dimensions to begin with.

To begin, we must transform the colour image to grayscale. The image is then resized. We then standardise our data to improve convergence. We prepared our model. Now we use our model to forecast each eye. If the value of prediction variable is 1, the eyes are open; if the value of prediction variable is 0, the eyes are closed.

5. Compute the score to see if the person is drowsy. We're drawing the result on the screen with a function that displays the person's current state in real time.

If the score surpasses a certain limit, it shows that the person's eyelids have been closed for a prolonged period of time. The alarm goes off at this point.

Overall, the Haar method is used to detect and track features, whilst the CNN algorithm is employed to classify images. Drowsiness detection systems can identify indicators of sleepiness in real-world circumstances by integrating the strengths of both methods.

Result:

The plot for accuracy for our model can be depicted as follows:

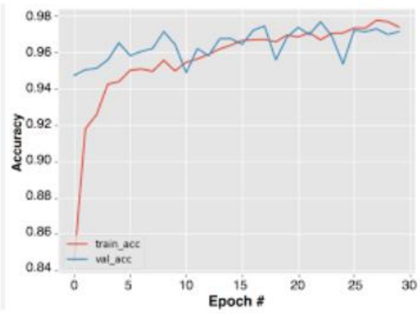

Fig.5.Scattered-plot of accuracy

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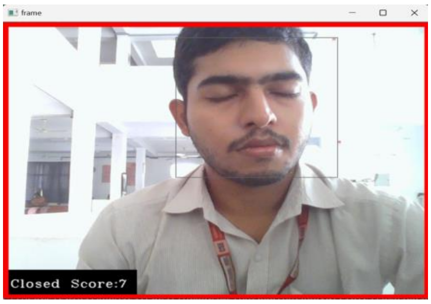

Fig.6.Captured-image with eyes closed

Fig.7.Captured-image with eyes open

Fig.8. Captured- image with eyes open

Conclusion

We implemented a drowsiness detection system in this paper using the Haar algorithm and the CNN algorithm, which is a combination of computer vision and machine learning techniques. A dataset of images and videos of people in various states of drowsiness is computed. The images or videos are transformed into a format that the algorithms can understand. Normalization, scaling, and cropping are all involved. The Haar algorithm detects certain face characteristics such as the mouth and eyes.This is performed through the use of a cascade of Haar classifiers that have been trained to detect various patterns in image data. The mobility of the identified features is monitored over time in order to detect alterations that may suggest drowsiness. The labelled dataset is created by extracting the characteristics and classifying them as sleepy or not drowsy. CNN Model Training is

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accomplished by building a deep neural network with TensorFlow and Keras. The prepared dataset is used to train the model, and a validation set is used to validate it. Metrics such as accuracy, precision, and recall are used to assess the trained model's performance.In real-time circumstances, such as when driving, the trained model is used to categorise new images as drowsy or not drowsy. If the driver shows indications of drowsiness, audio warnings are issued to warn them.

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