A Novel Multi-Level Driver Fatigue Detection System Using Deep Learning

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ABSTRACT: Modern advanced driver-assistance systems analyze the driving performance to gather information about the driver's state. Such systems are able, for example, to detect signs of drowsiness by evaluating the steering or lane keeping behavior and to alert the driver when the drowsiness state reaches a critical level. However, these kinds of systems have no access to direct cues about the driver's state. Hence, the aim of this work is to extend the driver drowsiness detection in vehicles using signals of a driver monitoring camera. For this purpose, features related to the driver's eye blinking behavior and head movements are extracted in driving simulator experiments. Based on that large dataset, we developed and evaluated a feature selection method based on the k-Nearest Neighbor algorithm for the driver's state classification. A concluding analysis of the best performing feature sets yields valuable insights about the influence of drowsiness on the driver's blink behavior and head movements. These findings will help in the future development of robust and reliable driver drowsiness monitoring systems to prevent fatigue-induced accidents

KEYWORDS: Driver Fatigue, Facial Expressions, Image edge detection, KNN, SVM ,Driver Alert System

1. INTRODUCTION

Drowsy driving is a controversial topic when coming to road safety. Nearly everyone who drives a car on a regular basis already experienced drowsiness or even micro-sleeps during driving. Yet it is a topic with a fairly low awareness in society. Nevertheless, throughout the years 2008 to 2023 the frequency of drowsiness-induced accidents increased [1]. That indicates a higher need for reliable drowsiness monitoring systems in vehicles. Major functions of such a system are to assist the driver to better assess drowsiness and to prevent severe impairments of the driving skills. A driver drowsiness monitoring system can be based upon different measures around the vehicle and/or the driver. Some of the driver drowsiness monitoring approaches aim to build a system on one single measure, while the majority of the modern approaches in fact rely on a combination of measures (so-called hybrid methods). This is particularly beneficial in complex real-world scenarios where a single measure might not catch the driver's state sufficiently. Thus, the detections can be validated with additional information from other domains, increasing the drowsiness classification confidence [2]. Nevertheless, it is a prerequisite to thoroughly understand the distinct features indicating the driver's level of drowsiness. The aim of this work is to estimate the driver's state based on behavioral measures, namely the head movement and blink features of drowsy drivers, and recommend a break in the case that certain signs of sleepiness are detected. Another purpose of this work is to gain insights about certain behavioral characteristic to enable further development of robust and reliable driver state classification systems. For this purpose, the k-Nearest Neighbor (k-NN) algorithm is used to classify the driver's state of drowsiness based on the eye closure and head movement characteristics.

2.LITARATURE SURVEY

TOPIC; Drowsiness Detection with Open CV using EAR.

Author: Adrian Rose brock

The paper proposes an algorithm that can detect eye blinks in real-time using video footage from a standard camera. The algorithm utilizes this paper proposes the use of landmark detectors that are trained on datasets containing images of people in everyday settings (in-the-wild datasets) for the purpose of detecting eye blinks in realtime from a video sequence captured by a standard camera, which are highly robust against different factors such as head orientation, varying illumination, and facial expressions. These detectors can precisely detect facial landmarks and the algorithm is designed to estimate the degree of eye opening, which is essential for detecting eye blinks accurately. Several techniques have been proposed for automatic identification of eye blinks in video sequences, and some of these methods depend on analysing the motion within the eye region. Various techniques have been proposed to automatically identify eye blinks in video sequences, including methods that rely on analyzing the motion in the eye region. Typically, these methods involve detecting the face and eyes using a detector such as the Viola-Jones algorithm. Then, the movement in the eye area is evaluated using techniques such as estimating optical flow, sparse tracking, or frame to frame intensity differences with adaptive thresholding. Finally, the algorithm determines whether the eyes are covered by eyelids or not.

3. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

a real-time driver fatigue monitor system, it uses coupled cameras equipped with active infrared illuminators to acquire video images of the driver, variously visual cues that typically the level of person need warn in real time and systematically combined to infer the fatigue level of the driver. The visual cues employed eyelid movement, head movement, and facial expression to describe, can acquire probabilistic of fatigue based on the visual cues

EXISTING SYSTEM LIMITATIONS

Environmental Factors: Poor lighting, such as driving at night or in low-light conditions, can affect the system's ability to accurately read facial cues. Rain, fog, or glare from the sun can impact the performance of sensors and cameras used in detection systems.

Driver Diversity: Variations in facial features, skin tones, and eye shapes can affect the accuracy of detection algorithms. Different drivers exhibit different signs of drowsiness. Some may yawn frequently, while others may show subtle signs like blinking more often.

3.2 PROPOSED SYSTEM

For detecting the drowsiness of the driver. First of all the system captures images through the webcam and after capturing it detects the face through It uses Haar features which can detect the face. If the system founds it as face the it will proceed for next phase i.e. eye detection. The eye is also detected using edge computation and it is used for blink frequency. Through this algorithm we can find the percentage Of time the eye lids remains closed. If it found eyes in closed state then it detects driver in drowsy state and alerts him by an alarm.

4. SYSTEM ARCHITECTURE

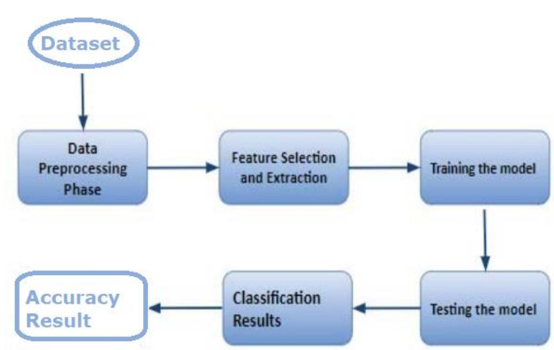

Fig: System Architecture

5. IMPLEENTATION

5.1 ACQUISITION SYSTEM:

The video is recorded using webcam and the frames are extracted and processed in a laptop. After extracting the frames, image processing techniques are applied on these 2D images. Presently, synthetic driver data has been generated. The volunteers are asked to look at the webcam with intermittent eye blinking, eye closing, yawning and head bending. The video is captured for 14 seconds duration.

5.2. Detect Face in the Image and Create Region of Interest (ROI)

To detect the face in the image, we need to first convert the image into grayscale as the Open CV algorithm for object detection takes gray images in the input. We don't need color information to detect the objects. We will be using haar cascade classifier to detect faces. It returns an array of detections with x,y coordinates, and height, the width of the boundary box of the object. Now we rate over the faces and draw boundary boxes for each face.

5.3 EYE DETECTION

Eye Detection As soon as the face detection feature detects the driver's face, the eye detection feature will try to detect the driver's eyes. This is achieved using a predefined set of hair cascade samples. The Sobel filter is used for edge detection. It works by calculating the gradient of image intensity at each pixel within the image. It finds the direction of the largest increase from light to dark and the rate of change in that direction The mask which finds the horizontal corner that is equivalent to having the gradient in vertical direction and the mask which computes the vertical corner is equivalent to taking in the gradient in horizontal direction. Sobel masks are given in the figure 1.

-1	-2	-1
0	0	0
1	2	1

1	0	-1
2	0	-2
1	0	-1

such as eye blinking during fatigue. The status of the eyes is determined in every frame using the correlation coefficient template matching method The technique starts from left and right side, to find eyes, therefore can detect the eyes separately. Now the strength and the direction of the edge at that particular location can be computed by using the gradients Gx and Gy. The gradient of an image $(x,)$ at location $(x,)$ is defined as the vector

$$\nabla f = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}$$

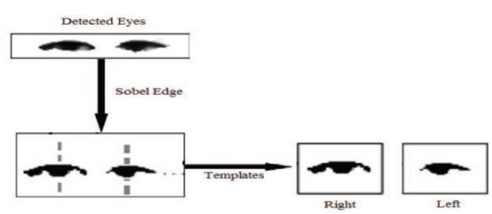

Fig 5.1: Eye template generation process

The detected eyes are segmented from the image and are used to generate an eye template

5.4 Yawning Detection

The yawn-based detection system analyzes changes in the geometry of the sleepy driver's mouth, kind of such as In pattern recognition, the K -Means may be a wide used classifier for classifying objects supported nearest coaching examples within the feature area. The k-nearest neighbour formula is that the simplest classifier of all machine learning algorithms. During this classifier image is assessed by a majority vote of its neighbours. In K -Means the Euclidian distance between the testing image feature and every coaching image feature is set to make a distance matrix. The summation worth of distance matrix is calculable and sorted in increasing order .The first K components are elect and majority category worth is set for classifying the image accurately. The Euclidean distance 'd' between the training feature vector X=(x1,x2,……xn) and the test feature vector Y=(y1,y2,…..yn) of fixed length is calculated using the following equation.

$$d = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 \dots (x_n - y_n)^2}$$

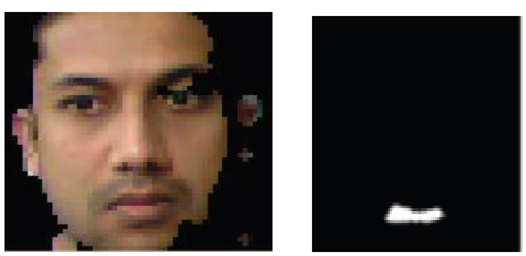

Fig 5.2: Mouth template generation process

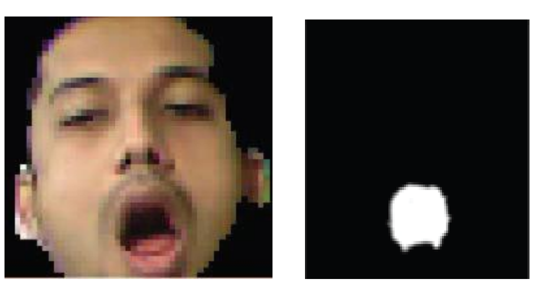

Fig 5.3: Mouth template generation process

5.5 Feature extraction:

In machine learning, support vector machines are supervised learning models with associated learning algorithms that analyze data used In addition to performing linear classification, SVMs can efficiently perform implicitly mapping their inputs into high-dimensional feature spaces SVM classifiers and their particularly definitely derivative classifiers, which kind of generally is quite significant, showing how the analysis of the experimental results essentially particularly was performed based on the accuracy and level of failure assessment in recognizing the driver\'\'s condition in a definitely basically big way, or so they thought..

5.6 WARNING SYSTEM:

The system immediately triggers the warning time emits a warning sound from the buzzer to warn the driver not to continue driving. This driver drowsiness detection and alert system architecture.

6. RESULT

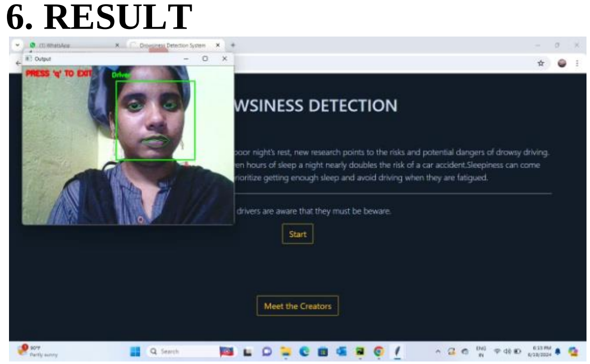

Fig 6.1: Alerting When The Person Is Non-Fatigue Or Yawning.

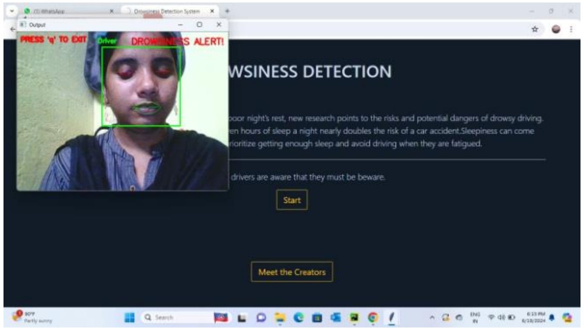

FIG 6.2: Alerting When The Person Is Fatigue Or Yawning.

7. CONCLUSION & FUTURE SCOPE

In this work, The current study developed an automated system for detecting drowsiness of the driver. The continuous video stream is read from the system and is used for detecting the drowsiness. It is detected by using Haar cascade algorithm. Haar features are predefined are used for detecting different things. The Haar features are applied on the image and blink frequency is calculated using edge algorithm. If the value remains 0 for some amount of time then it detects as sleepy and alerts driver by activating an alarm. If the value remains constant for longer periods then the driver is said to be distracted then also an alarm is activated. The future works may focus on the utilization Monitoring the driver's state of drowsiness and vigilance and providing feedback on their condition so that they can take appropriate action is one crucial step in a series of preventive measures necessary to address this problem.

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