Detection of Drowsiness of Drivers using Observer Rated Sleepiness

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Abstract*-Today, a number of accidents happen during drowsy driving on roads and are increasing day by day. It is a known fact that many accidents occur due to driver's fatigue and sometimes due to inattention factor. This research mainly focuses on maximizing the effort in identifying the drowsiness state of driver in real driving conditions. The goal of driver drowsiness detection systems is an attempt to contribute in reducing these road accidents. However, in this system, a real time vision-based method is proposed to monitor driver fatigue. This research approach adopts the Viola-Jones classifier to detect the driver's facial features. As a first step, the face is located then eye region, mouth region and head position are detected and tracked using the functions in the Matlab library with Haar Cascade algorithm and CAMshift algorithm. As a second step, the open/close state of eyes, mouth and head positions are determined by the Morphological algorithm, and then fatigue is determined based on the series state of eyes, mouth, and head. If the drowsiness is detected then an alarm is raised to alert the driver. The proposed method found to perform better then the existing methods.*

Keywords-Face Detection, Eye Detection, Yawn Detection, Head Pose Detection, Haar Cascade Classifier.

I. INTRODUCTION

The proposed system is designed to detect the level of driver's alertness using a method called Observer Rated Sleepiness which is very important in ensuring road safety. By the observation of eyes, head movements, and mouth motions, the driver fatigue can be detected early enough to prevent collisions caused by drowsiness [1]. Haar Cascade Classifier, Camshift algorithm and the Morphological operations are used to detect the face, eyes, mouth and head positions.

1.1 Haar Cascade Algorithm

The Haar Cascade algorithm is proposed by Paul Viola and Michael Jones. Haar cascade algorithm has some features called Haar features or Haar-like features [2]. Based on these features the objects are detected. It is a very simple but powerful method to reduce the computing complexity.

1.2 Camshift Algorithm

CamShift is primarily intended to perform efficient head and face tracking in a perceptual user interface. It is based on an adaptation of Mean Shift that, given a probability density image, find the mean (mode) of the distribution by iterating in the direction of maximum increase in probability density. It is more efficient for tracking different types of facial views, not only the front view. The size and angle of the face location are adjusted each time when it shifts. The scale and orientation, which are best fit to the face probability pixels inside the new location, are selected [3].

1.3 Morphological Operations

Morphology is a vast extent of image processing operations that modifies the images based on shapes. The basic morphological operations are dilation and erosion, which are expressed in logical AND, OR notation and described by set analysis. Dilation adds pixels while erosion removes the pixels at boundaries of the objects. This removal or addtion of pixels depends on the structuring element used for processing the image [4].

II. LITERATURE SURVEY

Preeti Bajaj and Mandalapu Saradadevi.[1] proposed a method to locate and track driver's mouth using cascade of classifiers proposed by Viola-Jones for faces. SVM is used to train the mouth and yawning images. During the fatigue detection, the mouth position is detected from face images using cascade of classifiers. Then, SVM is used to classify the mouth regions and to detect yawning.

A.N.Shewale and Pranita Chaudhari.[2] used Viola Jones method which detects objects in the images i.e. detects face and eye localization using Haar like features.

Chinnawat Devahasdin Na Ayudhya and Thitiwan.[3] used Haar Cascade Classifier and Camshift algorithms for face tracking and consequently getting facial axis information. In addition, we applied an Adaptive Haar Cascade Classifier from a cascade of boosted classifiers based on Haar-like features using the relationship between the eyes and the facial axis for positioning the eyes.They proposed a new algorithm and a new measurement for eye blinking detection called "the eyelid's state detecting (ESD) value." The ESD value can then be used for examining the open and close states of eyelids.

Vijayalaxmi and Elizabeth Rani. D.[4] developed an algorithm to estimate whether eyes are open or closed and fatigue is estimated using PERCLOS method.

Dr. Suryaprasad J and his team [5]Through this paper, they provide a real time monitoring system using image processing and face/eye detection techniques. Further, to ensure real-time computation, Haar cascade samples are used to differentiate between eye blink and drowsy/fatigue detection.

Amardeep Singh nad AmardeepSingh Virk[6] non recursive system have been designed to detect shutting of eyes of the person driving an automobile. Real time detection of driver's eyes is processed using image processing in MATLAB to detect whether the eye remains closed more than the fixed duration thus indicating condition of fatigue and raise an alarm which could prevent a collision. The driving support systems have been found lacking in detecting the influence of drug or alcohol causing great degree of risks to the commuters. This study has found that eye blink patterns are starkly different for persons under the influence of drugs and can be easily detected by the system designed by us.

III. PROPOSED WORK

The proposed driver drowsiness detection system is designed to perform the following process,

- To detect the face, eyes, and mouth using Haar Cascade Algorithm.
- To detect eye open and close states, mouth open and closed states, using Morphological Operations .
- To detect the driver head postures, usimg Camshift algorithm.

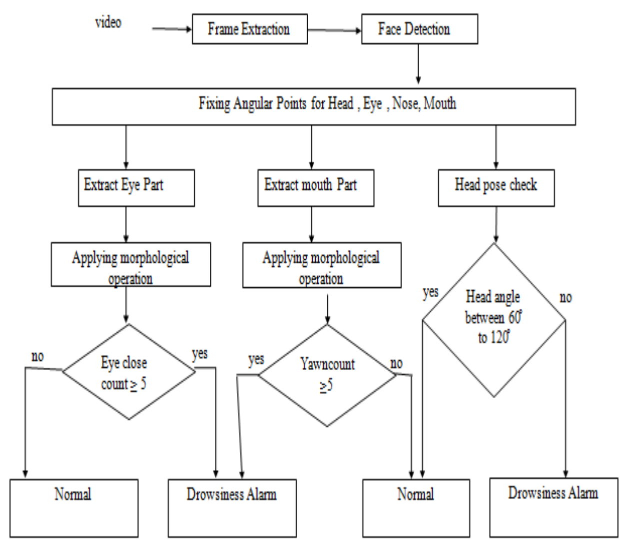

Fig 3.1 Block Diagram of the Proposed System

3.1 Face Detection

Face detection is achieved by the Haar Cascade Algorithm. For the detection of the face, haar features are the main part of the haar cascade classifier. Haar features are used to detect the presence of feature in given image. Haar cascade files contains a number of features of the face, such as height, width and thresholds[5].The System is capable of detecting the faces from the captured image from video for the purpose of analyzing and detecting the face. This video is converted into a number of frames. When the Haar-classifier is loaded. Each frame is compared with the pre-defined features of the Haar-classifiers. When the features are matched the face is detected and a rectangle is drawn around the face [6]. A face is located and it is being done by scanning the different image scales and extracting the exact patterns to detect the face.

3.2 Eye Detection

After detecting the face, the next step is to divide the face into four regions like fore head, eyes, nose and mouth by using Camshift algorithm. From these four regions the eye region is detected. This can be achieved by making use of the same technique used for face detection. However, to reduce the amount of processing, we mark the region of interest before trying to detect eyes [7]. The region of interest is set by taking into account the following:

- The eyes are present only in the upper part of the face detected.
- The eyes are present a few pixels lower from the top edge of the face.

Once the region of interest is marked, the haar cascade algorithm is applied only on the region of interest, thus reducing the amount of processing significantly. Now, the same technique is used for face detecting the eyes. After detection of eyes the morphological operations are applied to detect the open and closed state of eyes.

3.3 Mouth Detection

The mouth region was localized based on the position of nose. Therefore, first the location of the nose was approximated, then, the lower area of the nose was detected as the mouth region [8]. These are performed by the Haar cascade algorithm.

3.4 Yawn Detection

Yawning is one of the hypo vigilance symptoms related to the mouth region [9]. This symptom was extracted by detecting the open mouth position. The morphological operations are applied to detect the open and closed state of mouth. The opened mouth corners touch the region edges which denotes as the driver is yawning. The number of connecting components is used to decide the open/close state of the mouth. If the number of connecting components is <=3 then it closed state else if the number is >3, then it is the opened state of the mouth as shown in Fig 3.2.and Fig 3.3 respectively.

Fig 3.2 Mouth Closed State

Fig 3.3 Mouth Opened State

3.5 Head Pose Detection

Some fatigue and distraction symptoms are related to head [10]. These symptoms include head nodding and head orientation. Head nodding can be used for fatigue detection, and head orientation can be used for both fatigue and distraction detection. Driver nodding and lack of driver attention to the road can be detected by estimating the head position.

The head position is detected by using Camshift algorithm. Head pose estimation is a good index that directly shows the current state of the driver. When drowsy, most of time the person's head is leaned forward or otherwise move left or right [11]. At the time the head is crosses the region edges, so that the eyes and mouth could not be detected. This indicates the drowsiness of drivers. The various angles of head poses are shown in Fig 3.4.

Fig 3.4 Head Positions

3.6 Drowsiness Detection

In the proposed system, the drowsiness is detected and an alarm is triggered in the following conditions,

- If the eyes are closed in more than five frames [12], then alarm is raised.
- If yawn happens more than five frames [12], then alarm is raised.
- When the angle of the head position is from 60^0 to 120^0, then normal else if $<60^0$ and $>120^0$, then drowsy. In such cases, an alarm is raised.

IV. EXPERIMENTAL RESULTS

Sample frames from the driving dataset are shown in Fig 4.1. The video resolution is 640×360.

Fig 4.1. Sample Frames for driving data

Table 1: Input Data Description

DATASET	NAME	FRAMES
1	Video 1	115
2	Video 2	96
3	Video 3	69
4	Video 4	72

Performance Analysis

In this section performance analysis for moving object detection using the proposed approach is carried out using the metrics as described below. The performance metrics [2] used for performance analysis are,

TP – True Positive - No of frames that are correctly detected as eye blinks.
TN – True Negative - No of frames that are correctly reported as no blinks.
FP – False Positive - No of frames that are reported as eye blinks but they are not.
FN – False Negative - No of frames that show eye blinks but they are not detected.

The evaluation of True Positive Rate (TPR) and False Positive Rate (FPR) are defined as,

True Positive Rate $= \frac{TP}{TP+FN} \times 100$ (1)

False Positive Rate $= \frac{FP}{FP+TN} \times 100$ (2)

Precision (P) $= \frac{TP}{TP+FP}$ (3)

Recall (R) $= \frac{TP}{TP+FN}$ (4)

F-measure $= \frac{2PR}{P+R}$ (5)

Where, P and R are Precision and Recall.

Accuracy value is calculated as below:

Accuracy(ACC) $= \frac{TP+TN}{TP+TN+FP+FN}$ (6)

TABLE 2: Precision, Recall, F-measure and Accuracy Values

DATA SET NAME	FRAMES	PRECISION (%)	RECALL (%)	F-MEASURE(%)	ACCURACY (%)
Video1	115	82.6	73.8	76.3	94.7
Video2	96	81.2	87.2	84.0	95.4
Video3	69	86.9	91.7	89.2	91.7
Video4	72	81.2	75.9	78.3	93.6

Accuracy values for different videos are shown in Fig 4.2.

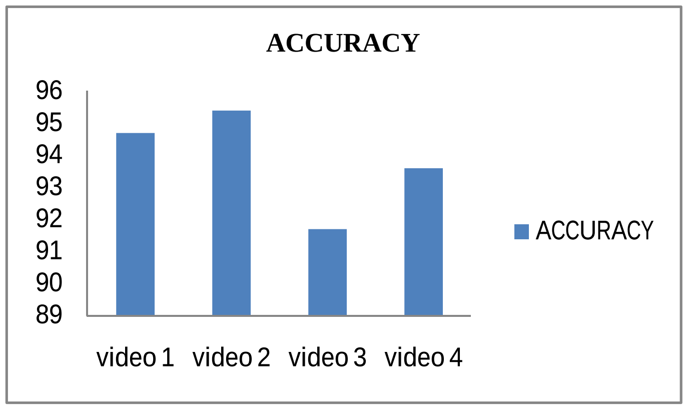

Fig 4.2 Accuracy values

V. CONCLUSION

The proposed system provides accurate detection of drowsiness of drivers. The analysis and design of driver drowsiness detection system is presented. The proposed system is used to avoid various road accidents caused by drowsy driving and it can also help drivers to stay awake when driving by giving a warning when the driver is sleepy. The system is also used for security purpose of a driver. During the monitoring, the system is able to decide if the eyes are opened or closed. When the eyes have been closed for too long, a warning signal is issued. Image processing achieves highly accurate and reliable detection of drowsiness. This was achieved by interfacing a webcam to a PC and recording test videos and frame database under different lighting conditions.

FUTURE ENHANCEMENT

In future the proposed system can be implemented by using the smart phone camera instead of the separate camera which is very hard to be fixed in a car and use all advantages of smart phone like camera and light weight. The proposed system will solve this problem by using a mobile phone camera where the phone will be put on a stand in the car to make the driver feel comfortable. The proposed system has hardware and software components such as mobile camera and Android. Both components are integrated together to record real video for the driver, and then processing it for real time object tracking. Also the proposed work can be extended to include the detection of breathing rate and Heart beat count for the drowsiness detection.

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