REAL – TIME ALERT INDICATION FOR DRIVER DROWSINESS USING FEATURE – LEVEL FUSION

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ABSTRACT

A wide range of road casualties occur basically due to drowsiness of driver. Drowsiness is the state when driver has not slept for more time and is constantly driving. Lack of alertness can cause to loss of lives due to drowsiness. Driver drowsiness detection is the most prominent topics in the recent times and many approaches are being studied so far. This paper provides an overview of different parameter, methods and approaches used to detect the driver fatigue.

Keyword: *- Drowsiness Detection, Face Recognition, PCA, AdaBoost, Viola Jones, Fuzzy Logic*

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1. INTRODUCTION

Driver Drowsiness and fatigue are among the most significant factor in large numbers of road accidents [1]. The recent statistics states that the rates of accidents occurring due to driver drowsiness are quite more than the accidents occurring due to drunken driver. According to the survey by American National Highway Traffic Safety Administration (NHTSA) [2] most of the accidents occur due to drowsiness of the driver which may result into fatal accidents. Approximately 100,000 accidents per year occur due to drowsiness of driver. And because prevention measures are not taken the number is increasing every year. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Because of the hazard that drowsiness presents on the road, methods need to be developed for avoiding its affects. Driver inattention might be the result of a lack of alertness when driving due to driver drowsiness and distraction.

Various researchers have been done in order to prevent the accidents. Many algorithm and methods are proposed to detect the driver drowsiness and to warn the driver in order to prevent the cause of accidents.

This paper discuss about the various approach to detect and prevent the occurrence of accidents due to driver drowsiness using various feature level fusion.

2. RELATED WORK

The work in [3] proposed the method by merging eye closure and yawn detection in which eye region is extracted using SSIM which is used to calculate the similarity between two images and this works in YCrCb color space. In [4] it uses EEG and ECG as parameters to detect the level of fatigue of driver as it can give predictable result but still it can be precise upto 87.5%. In [5] they have used an infrared camera to detect the eyes region of the driver.

SVM technique which is used to detect the fatigue based on psychological feature like EEG and ECG.

There are various methods for detection of drowsiness and are divided into 3 sections: **Physiological Based**, **Vehicle** and **Behavioural Based**. Various parameters used for measuring driver drowsiness include Percentage of Eye Closure (PERCLOS)[1][2][11], Eye Closure Duration (ECD)[9] & Frequency of Eye Closure (FEC)[9], combined with several facial clues such as yawning[12], blinking, eyebrow rising, head tilt position[3], voice recognition[3], biometric[3] etc.

Physiological based measures*:* The correlation between physiological signals ECG (Electrocardiogram) and EOG (Electrooculogram). Drowsiness is detected through pulse rate, heart beat and brain information.
Vehicle based measures*:* A number of metrics, including deviations from lane position, movement of the steering wheel[11], pressure on the acceleration pedal, etc., are constantly monitored and any change in these that crosses a specified threshold indicates a significantly increased probability that the driver is drowsy.
Behavioral based measures*:* The behavior of the driver, including yawning, eye closure, eye blinking, head pose, etc. is monitored through a camera and the driver is alerted if any of these drowsiness symptoms are detected

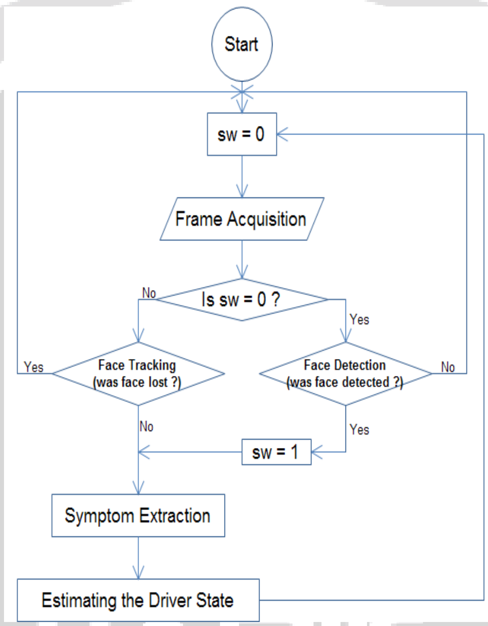

Fig: 1 Drowsiness Detection Flowchart

3. GENERIC FACE RECOGNITION PROCESS

3.1 Acquisition of the image

In this step, the system may capture the image of the subject and quality of the image acquired. If the quality of the image acquired is not good, then the image is re-acquired in order to obtain better quality image. This step is important, as the accuracy of the face recognition depends on the quality of the image acquired.

3.2 Localization and alignment

Before identification and verification of the images it is necessary to make sure that the images contain all sorts of information and all the images are positioned uniformly. This step is too simple with images that are still and with frontal view of the images. But it becomes too complex with the images in motion and deformed images.

3.3 Image Enhancement

Once the image has been properly calibrated, they need to be enhanced. For instance, the effects of compression can be reduced, illumination problem can be corrected etc. In this step, face images can be arranged with proper orientation.

3.4 Extraction of features

Face recognition algorithms use many mathematical transformations to compare the images and these transformations can highlight prominent features on the face like eyebrows, eyes, head and mouth.

3.5 Comparison

A template is extracted from the modified image and then comparison function compares this template with each other for various facial expressions such as open/closed eyes, yawning, etc. so as to easily warn to prevent the casualties occurring due to loss of driver consciousness or fatigue.

4. FACE RECOGNITION ALGORITHM

4.1 Principle Component Analysis [9]

On such method was introduced by Karl Pearson [5] in 1901 called Principle Component Analysis. Principal Component Analysis is dimensionality reduction method which is used when there is a high scope of redundancy in the data available. By applying the principle component analysis reduction method to the data, the variables would be reduced to the small number of components called as principle components which will contain most of the information needed for recognition process which can also be referred to as variance. In principle component analysis the dataset of images available is simplified and arranged according to the order of variance available.
The input images which are acquired may contain a high amount of noise in terms of distractions like lighting, pose, occlusion, distortion etc thus these input images with noise are classified into signals and patterns are created where ever eyes, nose, mouth etc are detected. These are referred to as eigenfaces or principle components for the given set of input images.
However by considering only few eigenfaces an approximate image can be constructed. Thus the main idea behind PCA is to reduce the high dimensional feature space into low dimensional feature space.

4.2 Linear Discriminant Analysis [9]

The most famous example of dimensionality reduction is “principal components analysis”. This technique searches for the data that have largest variance and then project the data in it. In this way, we obtain a lower dimensional representation of the data, which removes some of the “noisy” directions.
Both Linear Discriminant Analysis (LDA) and Principal Component Analysis (PCA) are linear transformation techniques that are commonly used for dimensionality reduction. PCA can be described as an "unsupervised" algorithm, since it "ignores" class labels and its goal is to find the directions (the so-called principal components) that maximize the variance in a dataset. In contrast to PCA, LDA is "supervised" and computes the directions ("linear discriminants") that will represent the axes that maximize the separation between multiple classes.
Linear Discriminant Analysis (LDA) is a dimensionality reduction algorithm which is applied as a pre-processing step in many pattern recognition and machine learning applications for face recognition. The main aim of this algorithm is to create a dataset with a low dimensional space and good separability features in order to reduce computational costs.
The general LDA approach is very similar to a Principal Component Analysis, but in addition to finding the component axes that maximize the variance of our data (PCA), we are additionally interested in the axes that maximize the separation between multiple classes (LDA)[8].
So, in a short, the goal of an LDA is to project a feature space (a dataset n-dimensional samples) on a smaller subspace k (where $k \le n\text{-}1$) while maintaining the class-discriminatory information.

4.3 Adaboost [9]

AdaBoost, short for "Adaptive Boosting", is a machine learning meta-algorithm. It can be used in conjunction with many other types of learning algorithms to improve their performance. The output of the other learning algorithms ('weak learners') is combined into a weighted sum that represents the final output of the boosted classifier. AdaBoost is sensitive to noisy data and outliers. In some problems, however, it can be less susceptible to the over fitting problem than other learning algorithms. The individual learners can be weak, but as long as the performance of each one is slightly better than random guessing (i.e., their error rate is smaller than 0.5 for binary classification), the final model can be proven to converge to a strong learner.

AdaBoost (with decision trees as the weak learners) is often referred to as the best out-of-the-box classifier. When used with decision tree learning, information gathered at each stage of the AdaBoost algorithm about the relative 'hardness' of each training sample is fed into the tree growing algorithm such that later trees tend to focus on harder to classify examples.

4.4 Viola Jones [6]

The **Viola–Jones object detection framework** is the first object detection framework to provide competitive object detection rates in real-time proposed in 2001 by Paul Viola and Michael Jones. Although it can be trained to detect a variety of object classes, it was motivated primarily by the problem of face detection. This algorithm is implemented in Open CV as cv Haar Detect Objects(). The various characteristics of this algorithm make it a good detection algorithm.

4.5 Haar – like Feature

Haar – like features are digital image features used in object recognition. They owe their name to their intuitive similarity with Haar wavelets and were used in the first real-time face detector.
Viola and Jones adapted the idea of using Haar wavelets and developed the so-called Haar-like features. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums. This difference is then used to categorize subsections of an image.
In the detection phase of the Viola–Jones object detection framework, a window of the target size is moved over the input image, and for each subsection of the image the Haar-like feature is calculated.
This difference is then compared to a learned threshold that separates non-objects from objects. Because such a Haar-like feature is only a weak learner or classifier (its detection quality is slightly better than random guessing) a large number of Haar-like features are necessary to describe an object with sufficient accuracy.

4.6 Sum of Absolute Difference (SAD) [1]

In digital image processing, the **sum of absolute differences** (**SAD**) is a measure of the similarity between image blocks. It is calculated by taking the absolute difference between each pixel in the original block and the corresponding pixel in the block being used for comparison. These differences are summed to create a simple metric of block similarity, the L^1 norm of the difference image or Manhattan distance between two image blocks.
The sum of absolute differences may be used for a variety of purposes, such as object recognition, the generation of disparity maps for stereo images, and motion estimation for video compression.

4.7 Hough Transform [10]

The **Hough transform** is a feature extraction technique used in image analysis, computer vision, and digital image processing. The purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure.
The classical Hough transform deals with the identification of lines in the image, but later the Hough transform has been extended to identifying positions of arbitrary shapes, most commonly circles or ellipses. The Hough transform as it is universally used today was invented by Richard Duda and Peter Hart in 1972, who called it a "generalized Hough transform" after the related 1962 patent of Paul Hough.
The Hough transform can be used to determine the parameters of a circle when a number of points that fall on the perimeter are known. A circle with radius R and center (a,b) can be described with the parametric equations

$$x=a+R\cos(\theta)$$
$$y=b+R\sin(\theta)$$

When the angle θ sweeps through the full 360 degree range the points (x,y) trace the perimeter of a circle.

4.8 Fuzzy Logic

Fuzzy logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1, considered to be "fuzzy". By contrast, in Boolean logic, the truth values of variables may only be 0 or 1, often called "crisp" values. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false. Furthermore, when linguistic variables are used, these degrees may be managed by specific (membership) functions.
Fuzzy logic and probability address different forms of uncertainty. While both fuzzy logic and probability theory can represent degrees of certain kinds of subjective belief, fuzzy set theory uses the concept of fuzzy set

membership, i.e., *how much* a variable is in a set (there is not necessarily any uncertainty about this degree), and probability theory uses the concept of subjective probability, i.e., *how probable* is it that a variable is in a set (it either entirely is or entirely is not in the set in reality, but there is uncertainty around whether it is or is not).

5. PROPOSED WORK

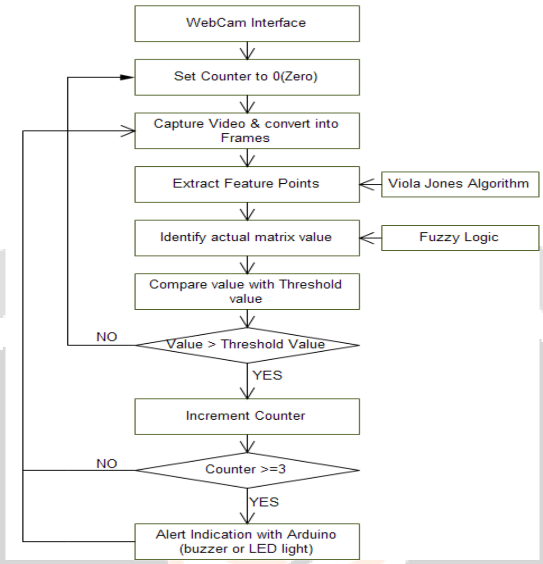

FIG: 2 PROJECT WORKFLOW

As shown in Fig. 2 the video will be captured from the camera installed on the dashboard. The captured video is then converted into frames. After it is converted into frames we will be applying Viola Jones Algorithm which is used to extract the feature. Then the adaptive boosting (Adaboost) is applied to detect the face and mouth in the first frame after which an adaptive template matching method is used to track the face effectively and with good tolerance feature extraction. After the eye and mouth is detected various parameters such as PERCLOS & ECD are used to detect the drowsiness of the driver. We will be applying bandpass filter to more normalize the data. After normalizing, the threshold (fuzzy logic) will be applied onto the detected features and the array will be generated according to the drowsiness condition extracted from it. Then the array value of matrix is then compared with the threshold value which determines the drowsy driver. If driver is found drowsy then the interface is made with ARDUINO in order to generate alert to warn the driver for preventing the further casualties.

6. IMPLEMENTATION

FIG: 3 OPEN EYES

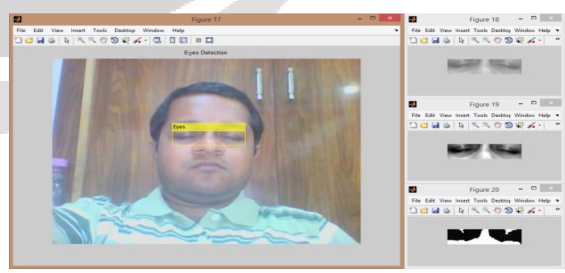

FIG: 4 CLOSED EYES

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filename =

F:\study material\_ME\Sem - 4\Final\frames\a145.png


asd =

   97.6669

eye is closed
drowsy
driver is sleeping
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FIG: 5 SOFTWARE DECISION FOR DROWSY DRIVER IF EYE CLOSED FOR 3 SECONDS

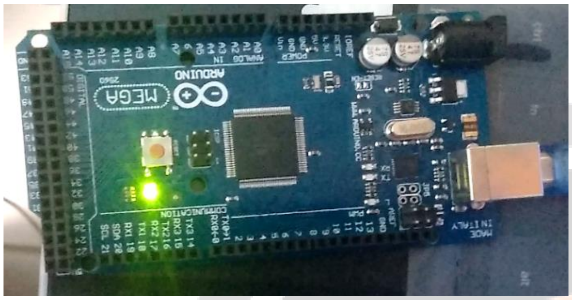

FIG: 6 ARDUINO FOR OPEN EYES

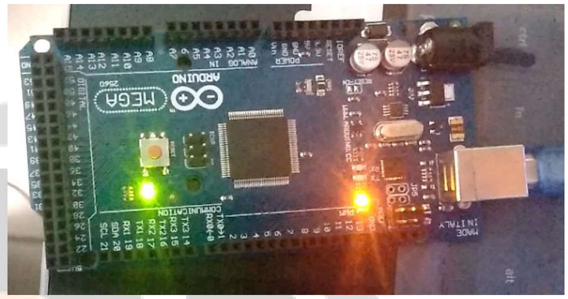

FIG: 7 ARDUINO FOR CLOSED EYES IF EYE CLOSED FOR 3 SECONDS

7. CONCLUSION

From the conducted study it is evident that there are multiple approached to detect the driver drowsiness. One of the most reliable technique for detection driver drowsiness/fatigue can be achieved by EEG [7] measurement of brain wave. This is the fact that driver fatigue can be easily detected using this method but it requires multiple electrodes attached to scalp which makes EEG-based method irritable for the driver.

The other method for driver detection is also based on visual behavior/computer-vision approach, viz. eye closure, head movement, eye blinking behavior, etc. This method has been most popular in recent years with increase in technology as it does not require any physical touch of the driver. The most noteworthy metrics used for this is PERCLOS which shows the reliable and accurate indication of driver fatigue. Other metrics such as steering angle and vehicle acceleration also gives a promising result and shall also be considered a fatigue detection candidate.

These different techniques are therefore considered in detecting the fatigue behavior of the driver. After this research it concluded that the detection through the visual behavior is quite better than physiological based as in visual based technique it has nothing physically in touch with the driver while in controversy with physiological based the driver has to wear the mindset gear on his/her forehead which is irritating to the driver while driving the vehicle.

6. REFERENCES

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