ENHANCED TRANSPORTATION SYSTEM TO DETECT SLUGGISH DRIVERS

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ABSTRACT*: The main cause of traffic accidents is due to drowsiness of drivers during prolonged driving. In this paper, we propose a method for the analysis of eye state to detect the driver's fatigue. The method has modules of face detection, eye pair detection and pupil detection. The driver's state is continuously monitored by the camera and it captures a video segments. The algorithms used are: 1) Viola Jones algorithm- an approach for face detection; 2) Golden Ratio- a method for the detection of eye pair; and 3) Hough Transform- a technology for extraction of image feature (especially to find the equivalent circular area of pupil). The driver is alerted if the drowsiness is detected. The vision-based systems on behavioural analysis are more attractive to automobile industries as it more comfortable to the drivers.*

Index terms: Video analytics, Viola Jones, Golden Ratio, Hough Transform, Behavioural approach.

I. INTRODUCTION

Many traffic accidents occur due to sleepiness of the driver. In India, the statistics report shows that about 1500 people are killing around due to the sluggishness of the drivers. There are three main approaches to detect sluggish face: 1) Behavior based approach, 2) vehicle based approach and 3) physiological signal based approach. In vehicle based approach, driver's sluggishness can be analyzed by using sensors in the vehicle. The sensors sense the hand pressure of drivers on the steering, speed, acceleration and brake to predict the driver's performance. This approach takes long time for analysis and it intrudes drivers during the driving. In physiological signal based approach, the physiological signals such as Electro-cardiogram (ECG), Electro-oculogram (EOG) are used to identify the sluggish drivers. In behavior based approach, the sleepy drivers are analyzed based on the eye state of drivers. This approach is non-intrusive to the drivers and it is more preferable in many automobiles.

II. RELATED WORK

Many eye tracking methods for detecting the driver's fatigue are introduced. The driver's sluggishness are analyzed by the following process, such as face detection, eye detection, eye openness estimation, fusion, drowsiness measure by using Percentage of Eyelid Closure (PERCLOS) algorithm. Initially, the driver's face is detected by using Histogram of Oriented Gradient (HOG) estimation. The Support Vector Machine (SVM) classifier classifies the eye state whether the eye is open or closed. The continuous level of eye openness can be estimated by using spectral regression. The eye state of the driver can be detected by using the fusion algorithm. According to PERCLOS estimation, the driver's fatigue is confirmed once the eyelid closure percentage reaches more than 80 percent.

III.PROPOSED SYSTEM

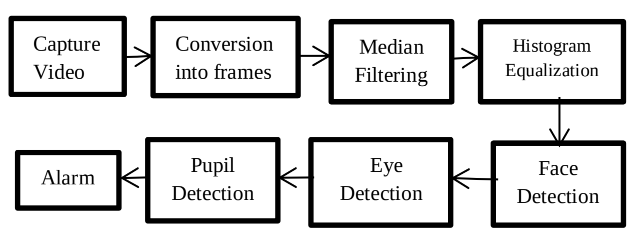


Fig 1. Block diagram of proposed system

A. MEDIAN FILTERING:

The process of linearizing the non-linear signals is called as median filtering and it can be done using median filters. It is best known for reducing the salt and pepper noise. The median value of the mask is determined and the noisy value of the digital image is replaced with the median value. The median filter is the smoothening technique and it preserves the edges in the image.

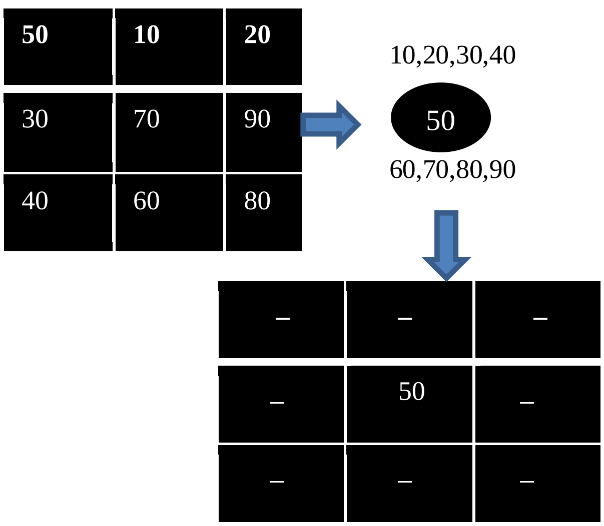


Fig 2. example for median filtering process

B. Histogram:

The pictorial representation of tonal distribution in a digital image is referred as histogram.

Normalization of histogram:

Normalization of histogram is a process of converting a discrete distribution of intensities into a discrete distribution of probabilities. Let x be a given image which is represented as n_r by n_c matrix of integer pixel intensities ranging from 0 to L-1(maximum value of L is 256). Let r denote the normalized histogram of x and it is expressed as,

$$r_m = \frac{number\ of\ pixel\ with\ intensity\ m}{total\ number\ of\ pixels}$$ where m=0, 1… L-1

Histogram Equalization:

Histogram equalization is a method for adjusting image intensities and to enrich the contrast in an image. Its main objective is the linear arrangement of non-linear pixel intensity values. The histogram equalization is described as cumulative distributive function (cdf). The cdf is the cumulative sum of all probabilities.

$$\text{Cdf}(x) = \sum_{k=-\infty}^{x} P(k)$$

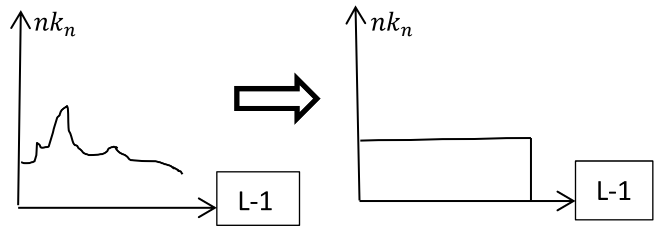


Fig 3. Histogram Equalization

The algorithms used in this process are: 1) Viola jones algorithm, 2) Golden ratio aspects and 3) Hough transfer algorithm.

C. VIOLA JONES ALGORITHM:

The Viola jones algorithm is the face detection algorithm which is very fast and accurate to detect an object. This algorithm has four stages: 1) Haar features 2) Integral image 3) Adaboost training and 4) Cascade of classifier.

Haar features selection:

Normally, all humans have similar features in their face as like eye region is darker than upper cheeks region and similarly, the nose region is brighter than the eye region. The eye region is represented as black area and the nose region is represented as white area. For an individual image, there might be maximum of 1, 60,000 features and this algorithm is used to detect the face features. Initially, the image is represented as 24 plus 24 sub windows and the values of each pixels can be calculated by measuring difference the between sum of pixels in black area and sum of pixels in white area. Each feature results in a single value by subtracting the sum of pixels under white rectangle from the sum of pixels under black rectangle. In this process, the time complexity is high and hence the integral image concept is introduced.

Some of Haar features are:

1) Line feature
2) Edge feature
3) Four rectangle feature

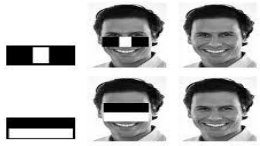
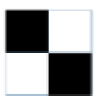


Fig 4. Haar feature selection using rectangle feature

Line feature:

Edge feature:

Four rectangle feature:



Integral image:

In the integral image stage, the image pixel value is calculated for the whole image which is in the rectangular format. The value at any point (x, y) in the summed-area table is the sum of all the pixels above and to the left of (x, y)

$$I(x, y) = \sum_{x' \le x, y' \le y} i(x', y')$$

Where i (x, y) is the value of the pixel at (x, y)

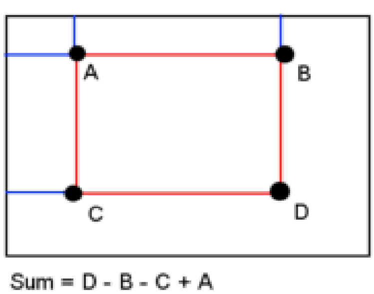


Fig 5. rectangle image for computing the sum of pixels

The sum of i(x, y) over the rectangle spanned by A, B, C and D

$$\sum_{x0<x<x1, y0<y<y} i(x, y) = I(D) + I(A) - I(B) - I(C)$$

Adaboost Training:

Adaboost process is used to discard the irrelevant features and same features in the image in order to increases the computational speed. The weak classifiers are used to find the relevant features in the image along with its weighted pixel value. The output of the weak classifier is in binary formats as 0 or 1. The output 1 represents that the pixels feature are matched with predefined features otherwise the output is 0. The sum of all linear weak classifiers are considered as a strong classifier and it is mathematically expressed as,

$$F(x) = a1f1(x) + a2f2(x) + a3f3(x) + \ldots$$

Here, F(x) is strong classifier; a1 is weighted value of pixels.

D. Golden ratio concept:

After the detection of face, we should detect the eye pair. Golden ratio concept is used to detect the eye pair. Usually, all human faces have symmetrical properties that are more helpful to detect the eye pair using golden ratio. There are many facial elements like height and the width of the face. The relationship between height (h) and width (w) of the human face using golden ratio is given as,

$$\frac{h}{w} = 1.618$$

$$h = 1.618 * w$$
$$= 1.618 * 1.865 * d_{eye}$$
$$h = 3.018 * d_{eye}$$

and $\frac{d_{eye}}{m} = 1.618$

Where d_{eye} is the distance between centre of the eye and m is the width of the mouth.

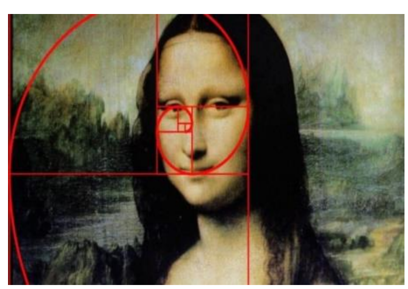


Fig 6. Golden ratio based on symmetry property

E. HOUGH TRANSFORM METHOD

Hough transform is used to find the circle even from an imperfect image. It is one of the feature extraction techniques used in digital image processing.

$$r^2 = (x-a)^2 + (y-b)^2$$

Where r is a radius of pupil, a and b are the coordinates of the pupil.

The parametric representation of the pupil is

$$x = a + r * \cos\theta$$
$$y = b + r * \sin\theta$$

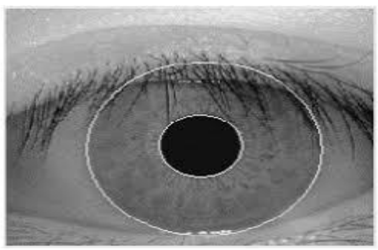


Fig 7. Real time detection of human pupil

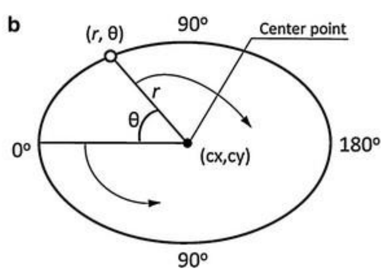


Fig 8..Hough transforms implementation in human eye

V. RESULT AND CONCLUSION

Our project is completely based on vision based system. Our approach starts detecting the face from an image by using Viola Jones algorithm. The feature extraction capability extracts the eye from an image using golden ratio. Finally, the area of the pupil is determined to estimate the driver's attention state, i.e., normal state or drowsy state. This method of application in real time is very efficient in order to provide safety driving to the society.

Our future work is the implementation of our system in heavy vehicles. The driver will be alerted whenever there is continuous closure of eyes.

The experimental results shown below explains about the detection of eye state and its graphical representation.

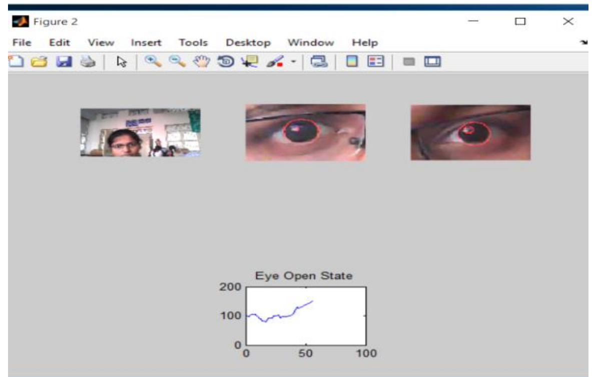


Fig 9a. Eye open state estimation

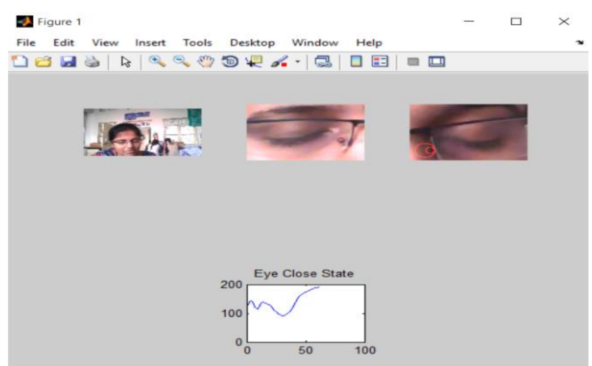


Fig 9b. Eye close state estimation

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