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# A Real Time Driver's Eye Tracking Design Proposal for Detection of Fatigue Drowsiness

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**ABSTRACT**: It is a known fact that many accidents occur due to driver's fatigue and sometimes due to inattention factor. Driver's Fatigue and drowsiness problems are one of the important reasons that create many road accidents across the world. Many different types of methods have been carried out to avoid road accidents, however in this paper, a real time vision-based method is proposed to monitor driver fatigue. This paper approach adopts the Viola-Jones classifier to detect the driver's facial features. One of the mostly used method is the color space model for face detection and thus by cropping of face area the eye localization is been done. The first common drawback of color space model is that the non-face area is also detected as face. The second drawback is lacking in modesty of eyes localization by cropping face area of tilted faces in real time. In reality the face can be tilted in any direction due to road condition. So to overcome this problem a new design system is proposed. This papers deals with some proposed methods available for drowsiness and fatigue detection along with their drawbacks and propose a new design to get a better accuracy.

**KEYWORDS**: ROSAP, Face Detection, Fatigue Warning, Eye Detection, Driver drowsiness, Advanced Vehicle Safety, Haar Classifier.

## I. INTRODUCTION

According to the report of ROYAL SOCIETY FOR THE PREVENTION OF ACCIDENTS (ROSAP) the Driver fatigue is a one of the serious problem which results in thousands of road accidents every year. The data from ROSAP shows that driver fatigue is one of the important factor of road accidents all around the world that is about 20% [1]. These types of crashes are lead to about 50% more likely to death or serious injury as they are in a high speed and driver who has falls asleep cannot brake easily to avoid or reduce the impact. Drowsiness reduces reaction time of humans. It also reduces alertness and concentration of the driver which results in low attention-based activities is impaired. Thus quality of decision-making is affected [1].

The work for detection for Eye has done from quite a long time and from the last decade various methods had been developed to Tracking/monitor the drive's fatigue detection system. The methods can be divided into three main types based on its applications. The first category deals with the use different method of biometric signals such as EEG, EMG and ECG signals [2] [3]. To do analysis of biometric signals electrodes are attached to the body which is not practically possible always. This method is highly accurate for driver drowsiness detection, but is very inconvenient detection.

The second contain different methods of driving behavior such as steering wheel movement, driving speed, driver grip on steering wheel etc.[4], it is inconvenient because of its mechanical wear and tear. The third category is based on the real-time facial image processing.

The last method uses image processing for tracking/detecting drivers physical changes during drowsy. Thus we can observe these physical changes of driver in facial features. Behaviors like open or closed eyes, eyelid movement, yawing, nodding and gazing. The researchers have already showed that the last method is better than the other methods. In the last one we focus on detecting fatigue driver based on eye states. Thus it shows that change in regularity of eye has a high relativity with the driver's mental states [5].

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## II. RELATED WORK

There has been many method proposed for the tracking of eye depending on the different techniques and algorithm use in it. The ratio of eye closing during a period of time was calculated by the Zheng pei. This ratio can reflect the level of activeness of driver and Wenhui Dong proposed a method to detect the distance of eyelid, then judged the driver's status by this kind of information [5]. One of the drowsiness detection method was proposed by Liu et al based on eyelid movement based on the eyelid changes from a temporal differences image, the fatigue situation will be analyzed [6]. R. Rabenstein and S. Spors proposed the system in which face detection is performed using the statistical properties of human skin color [7]. Nikolaos and S Sarbjit and proposed the system that deals with skin-color information to extract the face region then eyes are located and then for tracking eye they use gray color model [8].

A recently proposed method by S. Fazli [9] uses color space for face detection and eye area is obtained by simply cropping the two fifth of face area. Then canny operator of edge detection is used to extract the coordinates of eye region. The figure.1 shows the proposed method.

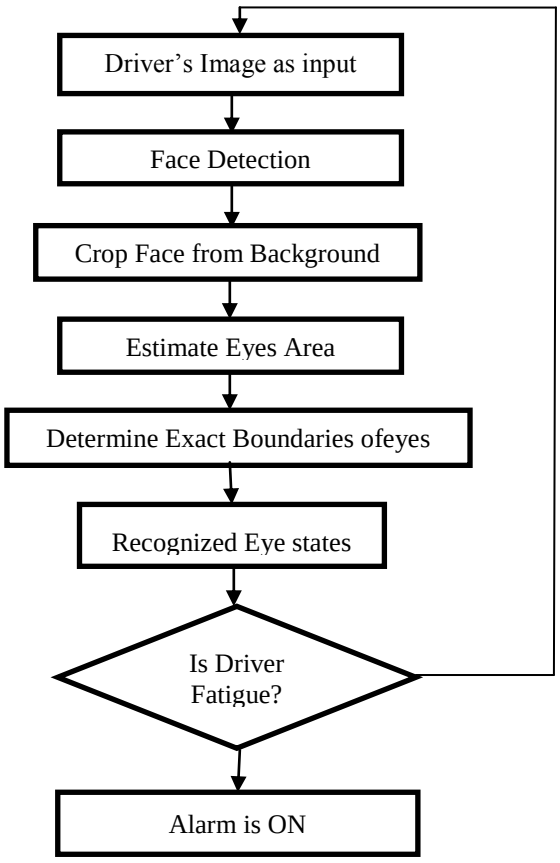


Figure: 1. Flow chart for fatigue detection system

S. Fazli divided face detection into two major categories: face features and face colors. For face features he used distance of two eyes, distance eyes and mouth, distance eyebrow and eye and some other features that are fixed in the face. For second method he had some color space like HSI space, YCbCr space, CMYK and YIQ space. He tested HIS color space and YCbCr color space and according to experimental results he got YCbCr color-space has the better results for face detection.

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Fazli takes advantage of symmetrical characteristic of the eyes in the face region for eye detection as eyes are always in the specific area of face. This method crop detected face area from two-fifth and three fifth areas in face detection picture. Again they crop it from middle that is vertically. Now in this area eyebrow and eye exist. The system uses canny operator of edge detection to extract the coordinates of eye region. Now to extract only eye portion middle axis (M) of image is found out and for M-5 to M+5 moves up and down of image and search white pixel.

For fatigue detection S. Fazli use the difference between up and down coordinate. This method calculates the threshold for open and close state of eye. When eyes are closed the difference between up and down coordinate is almost zero. If eyes are open this system convert's color image to gray image and calculate number of white pixel. If white pixel are more than threshold means eye is open otherwise close. Now for each image this system calculates the difference and recognized eye state. If eye is closed for five consecutive frames then come to conclusion that driver is sleepy [9].

## III. PROPOSED ALGORITHM

In this proposed method, first the image is acquired from the webcam. The images of the driver are then captured from the camera which is installed in front of the driver on the dashboard of car. It will be passed to preprocessing which prepares the image for further processing by the system. To eliminate noises caused by the image acquisition subsystem and image enhancement we used Histogram Equalization. Then we search and detect the face in each frame. If there is no face in the current frame then another frame is acquired. If a face is detected in frame, then region of interest is taken within the face. This region is important as it contains eyes. Defining a region of interest will definitely reduce the computational time of the system. Then the eyes are detected from the region of interest.

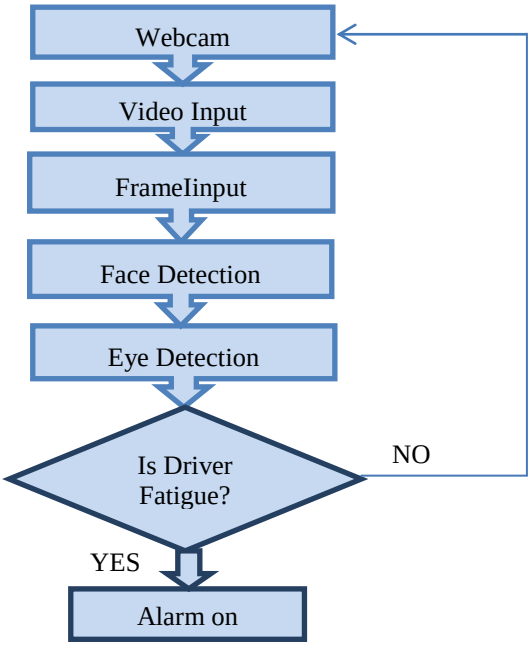


**Figure 2**: Flowchart of Driver Drowsiness Detection System

When the eyes are closed for more than 5 frames then it is conclude that the driver is feeling drowsy and thus drowsiness is detected and an alarm is sounded. Thus the whole process is repeated as long as the driver is driving the car. The overall flowchart for drowsiness detection system is shown in Figure 2

This proposed paper deals with a very popular algorithm called Viola and Jones algorithm [10][11] which use features based system on pixel intensity rather than to use pixel based system as Features-based system operates must

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faster than a pixel-based system. Viola Jones algorithm has mainly four stages,

1. Haar Features Selection
2. Creating Integral Image
3. Adaboost Training algorithm
4. Cascaded Classifiers

**[A] HAAR FEATURES SELECTION**

The Viola-Jones face detector analyzes a given sub-window using features consisting of two or more rectangles The simple features used are reminis cent of Haarb asis functions which have been used by Papageorgiouetal[12][13]. The proposed system used three kinds of features that is two,threeandfourrectanglefeature of Viola-Jones.Two-rectanglefeature simply means that differencebetweenthesumsofthepixelswithintwoadjacentregions and
similarlythreerectanglefeatureisthevalueobtainedbysubtractingthesumofpixelsofouterrectanglesfromthecenterrectangle. Thus four rectangle features is the difference between the diagonal pairs of rectangles. Basic set of Haar feature isshownin Figure 3.

Type1 Type2 Type3 Type4

**Figure 3**-Thedifferenttypesof Haar features.

**[B] INTEGRAL IMAGE**

The next step of the Viola-Jones face detection algorithm is to turn the input image into an integral image which is done by making each pixel equal to the entire sum of all pixels above and to the left of the concerned pixel. This is demonstrated in Figure4. This allows for the calculation of the sum of all pixels inside any given rectangle using only four values. Thus these values are the pixels in the integral image that coincide with the cornersof the Rectangle in the input image.

| | | |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 1 | 1 |
| 1 | 1 | 1 |

(a) Inputimage

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 2 | 4 | 6 |
| 3 | 6 | 9 |

( b ) Integralimage

**Figure 4**–Theintegralimage.

**[C] ADAPTIVE BOOSTING (Adaboost)**

Adaboost is nothing but Adaptive Boosting which is basically use with many other types of learning algorithms for

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improving the performance. Adaboost is basically machine learning algorithm. It takes a number of positive and negative images features and training sets, the machine creates a set of weak classifiers of Haar-like features. It selects a set of weak classifiers to combine and that assigns lesser weights to good features whereas larger weights to poor features. This weighted combination gives strong classifier. The boosting algorithm used for the selection of the rectangular feature and combining those to form a strong classifier.

**[D] CASCADED CLASSIFIER**

The cascade classifier consists of number of stages, where in each stage collection of weak learners is been done which is shown in figure 5. The cascade is made to reject the sub-windows because the number of non-face sub-windows are far greater than the number of face sub-window in an image. It provides the ability of training a greatly accurate classifier just by taking a weighted average of the weak learners. In order to increase the detection speed several stages of the classifiers are made which reject most of the sub-windows at the early stage to give more time on less number of sub-windows which are complex and have face like region. Each stage is trained by Adaboost algorithm. In every stage of the classifier the defined region shows the present location of window as positive or negative. If Positive then it indicates an object was found and if negative then it indicates no object found. The classification of this region is complete if the label is negative and thus the detector shifts the window to the next location. Thus if we get positive then classifier will passes interested region towards next stage. When the final stage gives positive response it means that an object is founded at the current window location only. Thus very low time processing is needed. And thus the speed of overall algorithm increases rapidly.

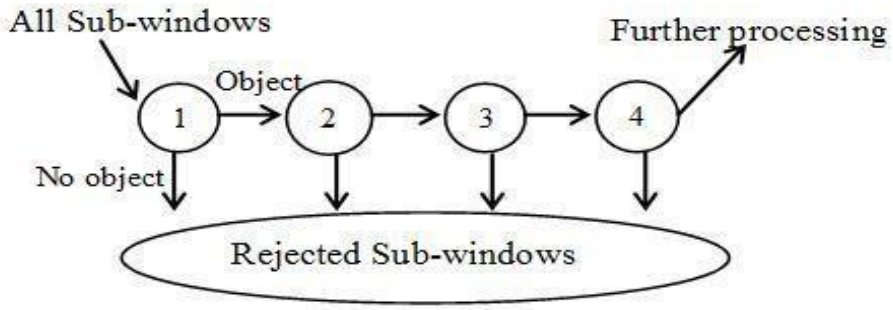


Figure5. Cascade of Classifier

**[E] EYE DETECTION**

To identify the eyes area in images proposed system uses absolutely same algorithm that is viola Jones algorithm, but only differ in training dataset. Finding eye ball is for determination of the eye states i.e. opens or closed state of eye. To find eyeballs in obtain eye area in an image proposed system uses circular Hough Transform. The Hough transform was first introduced by Paul Hough in 1962[14]. HTC The equation of a circle can be written as

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

In above equation a and b are the coordinates for the center, while r is radius of the circle. The parametric equation of circle is

$$x = a + r*\text{cosine}(\theta)$$
$$y = b + r*\sin(\theta)$$

The method starts with a search for a pixel that represents an edge point; canny edge detector is applied to the detected eye area [15] [16]. After such a pixel is found that represents an edge point then in parameter space circle is drawn, such that x axis represent a-value and the y axis represent the b-value while the z axis represent the radii r. As direction of orientation and value of radius is not known, for every edge pixel for each possible value of r and θ circle is drawn. Calculate value of a and b from parametric equation. Store these values in accumulator. The accumulator will now include numbers equaling to the number of circles going through the each coordinates. Thus the highest numbers represent the circle's center in image and map this back to original.

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## IV. IMPLEMENTATION

### I. Software

The Software implementation is done by using EmguCV [17] which is an open source image processing library for C#.NET. EmguCV is a very good platform for .Net wrapper to the OpenCV IP libraries. It permit Open Computer Vision functions to be called from .NET compatibility languages such as VB, C#, C++, Iron and Python .To detect human facial feature Intel developed an Open source library used for the implementation of computer vision related programs called OpenCV. OpenCV library is used for implementation of Haar training. We have used the Haar training applications in OpenCV to detect the face and eyes. This creates a classifier given a set of positive and negative samples. OpenCV is designed for computational efficiency and with a strong focus on real-time applications. OpenCV helps to build vision applications quickly and easily. OpenCV satisfies the low processing power and high speed requirements of our application.

### II. Hardware

In Hardware we have used a Laptop with Configuration as Intel i5 2.26 GHz processor, 2GB DDR3 RAM Memory with build in Webcam VGA, Operating system was Windows 8.

## V. EXPERIMENTAL RESULTS

We have used Open CV as a platform to develop a code for real time eye detection. This code is then implemented on system installed with OpenCV and Visual Studio 2010 software. To detect human eyes, face has to be detected first. This is done by OpenCV face haar cascade classifier which is in OpenCV library. Once we get the face, the location of the eyes is estimated and eye detection is done using eye Haar-cascade classifier which is again in OpenCV library. Hence using the OpenCV, face and eyes are detected accurately and displayed on the monitor as shown in the Figure 6.The larger pink circle indicates the face while smaller blue circles indicate the eyes.

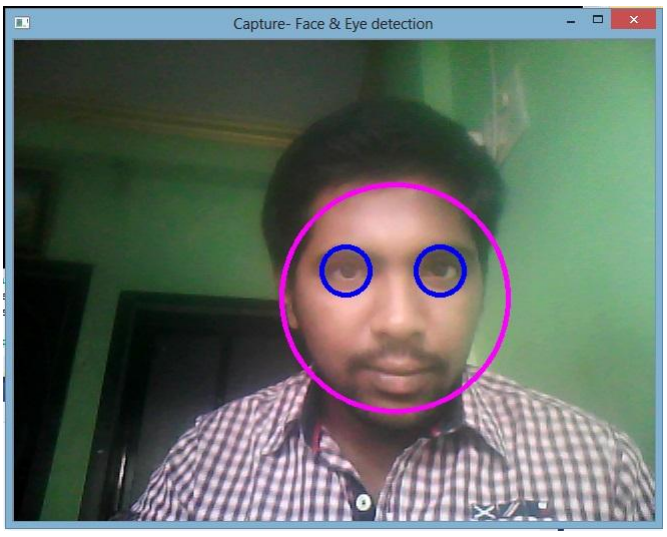


Figure6. Photography of face and eye detection

Figure 6 shows the experimental results in which human eyes and face can be detected easily from the proposed method using Viola-Jones and HTC method.

## VI. CONCLUSION

This proposed system provides accurate detection of driver fatigue. The Viola Jones algorithm is used for localization of drivers face and eye. For analysis of driver drowsiness detection system is presented. The proposed

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system can be used to avoid road accidents caused by driving drowsiness and it can also help drivers to stay awake by giving a warning when he is a sleepy. During monitoring the system can easily decide that whether the eyes are opened or closed. When the eyes have been closed for longer time the system gives a warning signal. We concluded that Image processing gives highly accurate and reliable drowsiness detection. The calcu5lation speed, accuracy and robustness will be influenced in different processors and other issues.

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