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DRIVER DROWSINESS MONITORING BASED ON EYE AND YAWN DETECTION

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ABSTRACT

Drowsiness can be dangerous when performing tasks that require constant concentration, such as driving a vehicle. When a person is sufficiently fatigued, drowsiness may be experienced. Drowsy driving is a prevalent and serious public health issue that deserves more attention, education, and policy initiatives so a substantial amount of lives can be saved and disability averted due to drowsy driving accidents. In an effort to reduce the number of fatigue-related crashes and to save lives, special body and face gestures are used as sign of driver fatigue, including yawning, and eye movement, which indicate that the driver is no longer in a proper driving condition. In this paper, we discuss a **method for detecting driver's drowsiness and subsequently alerting the driver as well as the owner of the vehicle.**

Keywords: Drowsiness, Yawn Detection, Eye_map, Mouth_map, Image Acquisition, Skin Detection

INTRODUCTION

Drowsy driving is the operation of a motor vehicle while being cognitively impaired by lack of sleep. Sleep deprivation is a major cause of motor vehicle accidents, and it can impair the human brain as much as alcohol can. Sleep deprivation has been proven to impair coordination, judgment, memory and ability to retain information and causes longer reaction times. [3] It has been estimated that between 16% and 60% of all accidents have sleep deprivation as a cause. Drowsy driving is implicated in 100,000 car crashes per year, which leave 71,000 people injured and 1,500 dead according to the National Highway Traffic Safety Administration. [6]

Driver fatigue can increase the chances of car accident, reason for this type of car accidents is due to fact that driver fails to take necessary actions prior to collision occurs. Therefore assisting system which will monitor the behavior of driver and also will give the necessary alerts to the driver as well as the owner of the vehicle is used to prevent the road accidents.

The existing systems in this domain which have already been developed and used can be classified into two categories: Intrusive and Nonintrusive systems. Nonintrusive type of system is better suited for real world conditions, since it does not distract the driver.

The four prominent measures to detect drowsiness are:

1. Duration of eye closure
2. Frequency of eye blinks
3. Detection of yawning
4. Head rotation

Using any two of the above mentioned measures leads to accurate results. [9] [12] The system becomes more robust by the usage of eye closure and yawning to detect the drowsy driver.

In this method, we record the drivers face using a camera that is installed the vehicle. In order to detect the yawn, the first step is to detect and track the face using the series of frames shots taken by the camera. We can then detect the location of the eyes and the mouth in the captured face by finding out the eye map and mouth map respectively. These geometrical features are then used to detect weather the person is drowsy or not. If drowsiness is detected a voice alert is given out to alert the driver about his drowsy condition and an SMS an email alert with the driver's drowsy photo is sent to the vehicles owner.

RELATED WORK

There are three techniques being used by researchers to detect drowsiness: [5]

I. Images Processing based techniques
II. Artificial neural network based techniques
III. EEG (electroencephalograph) based techniques.

After reviewing various techniques used for drowsiness detection, we concluded that, different techniques will be suitable according to given conditions. [5] [8] EEG based techniques are efficient but practically it is not suitable for driver to wear electrodes. Artificial Neural Network based technique is simple but if you want better result than 3 neurons is ideally suitable. Image Processing techniques are one of the favorite ones for researchers. These techniques are much simpler and user friendly.

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SYSTEM DESIGN

The driver drowsiness detection system consists of different modules to properly analyze changes in the face of driver. These modules are categorized as:

1. Image Acquisition
2. Face Detection
3. Eye Detection
4. Mouth Detection
5. Yawning Detection

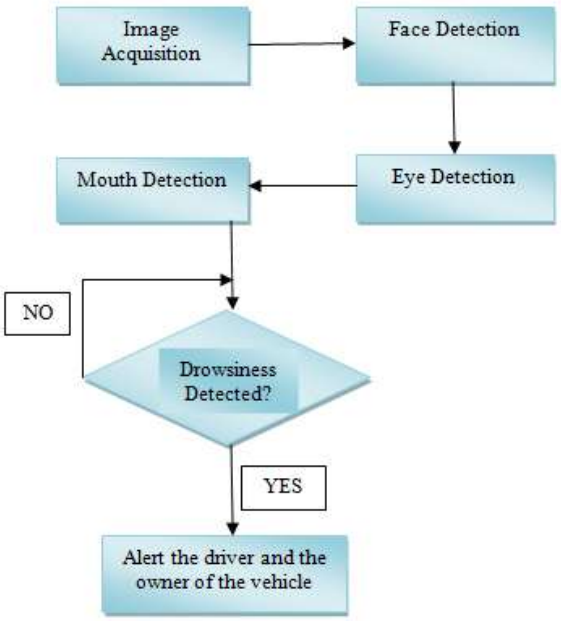

Fig. 1. System Diagram

1. Image Acquisition

Performing image acquisition is always the first step in the workflow sequence because, without an image, no processing is possible. [9] [10] The image that is acquired is completely unprocessed and is the result of whatever hardware was used to generate it, which can be very important to have a consistent baseline from which to work. In this system real-time image acquisition is performed. This involves retrieving images from a source that is automatically capturing images. Real-time image acquisition creates a stream of files that can be automatically processed, queued for later work. The images acquired are stored according to their time-stamps.

Once the series of frames of images are obtained further processing on the image is performed to detect the facial features.

2. Face Detection

Various face detection techniques are used to determine the locations and features of human faces in digital images. The main aim of face detection is to detect a facial region irrespective of the position, orientation and illumination of the image.

These techniques mainly detect the facial and non-facial regions of the image. Different techniques used for face detection are namely Knowledge-based methods, Feature invariant approaches, Appearance-based methods, and Template matching methods [4]. Here in this system template matching method is used to extract facial regions.

The first step of face detection is detection of skin color. The input color image is in the RGB format, the technique is to use the color components in the color space, such as the HSV and YCbCr formats. The skin pixel detection is performed with a color map, using the YCbCr color space. In the skin color detection process, each pixel was classified as skin or non-skin based on its color components. Since the factor of illumination needs to be removed for better detection of the individual's facial features, YCbCr color space proves to be very effective to detect skin irrespective of the skin color and illumination. [1] [7] [11]

Skin detection techniques will detect all the skin colored pixels and reject all the background unwanted pixels but still certain noisy pixels will be present. To remove the noise from the image morphological operations are performed. The aim is to get an image with skin region without any noise affecting the results. [2]

Once this is done, system identifies whether the individual whose face was detected is an authorized person. Here the acquired image is compared with every other recognized individual in the database. If a match is found the system is able to recognize the individual otherwise it is an unauthorized driver.

a. Eye detection

The next step in the system is to detect the location of eyes. Locating the eyes and tracking its movement i.e. opening and closure of eyes helps us to confirm that the person is drowsy or not. To detect the eyes eye map based on chrominance component is built. [1] The eye map can be obtained with the help of the following formula:

$$\text{Eye\_Map} = \frac{1}{3}\left\{(C_b)^2 + (C_r)^2 + \left(\frac{C_b}{C_r}\right)\right\} \quad \text{Eq. (1)}$$

The eye map highlights the eyes regions. We can then convert the eye map image to a black and white image using proper threshold. This new image is supposed to include the eyes in white while the rest is all black. However, several pre-processing steps including erosion and dilation are required to identify the eyes in the image.

b. Mouth detection

The next step in detecting the yawn is to track the mouth movement i.e. is opening and closing of

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mouth while yawning. Just like the eye map, mouth map is also based on the chrominance components. The color of mouth region contains stronger red component and weaker blue component than other facial regions. Hence the chrominance component Cr is greater than Cb in the mouth region. [1] Thus, the mouth map can be obtained with the help of the following formula:

$$\text{Mouth\_ Map} = (C_r)^2 \times \left[(C_r)^2 - \frac{\mu \times C_r}{C_b}\right]^2$$

Eq. (2)

$$\mu = 0.95 \frac{\frac{1}{n}\sum_{(x,y)} C_r\,(x,y)^2}{\frac{1}{n}\sum_{(x,y)}\left[\frac{C_r\,(x,y)}{C_b\,(x,y)}\right]}$$

Eq. (3)

The mouth map will then go through some post processing steps such as black and white conversion, erosion, dilation and finding the biggest connected components in the same way as the eye detection scheme. The geometrical features of the face and relative location of the mouth with respect to eyes can be exploited in this step to verify the validity of the detected mouth. [1]

c. Drowsiness detection

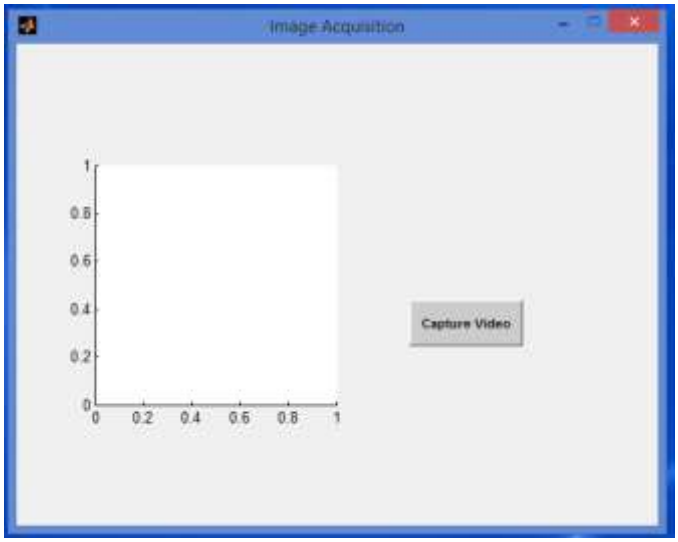
One of the factors to consider when a person is drowsy is yawning. A yawn is an involuntary intake of breath through a wide open mouth usually triggered by fatigue. If one can detect an individual is yawning it can be assured that the person is not fit to drive. Detection of whether an individual is drowsy or not can be done in 2 steps:

1. Yawn component in face is independent of mouth location is detected by identifying the hole in the mouth as a result of wide opening of mouth.
2. The location of the mouth is used to detect the correctness of the detected yawn component.

The large hole is selected as a candidate for yawning mouth and this hole is the non-skin area inside the face. The hole can be related to eyes, mouth or open mouth. It is assumed that the open mouth will be the largest among three which can be a yawning state. [1] In this way the detected yawn state is compared with the available face of yawning state to check the drowsiness of a driver. If the image has a large hole in the mouth region the candidate is said to be in yawning state. If a yawn is detected a sound alert is given out immediately to the driver alerting the driver to stay awake. The owner of the vehicle is then alerted in two ways: Firstly, an SMS is sent to the registered number. Secondly, an email alert with the image of the drowsy driver is sent to the registered owner of the vehicle. If the yawn is not detected the driver is assumed to be driving safely.

EXPERIMENTAL EVALUATION

Step 1: Image Acquisition



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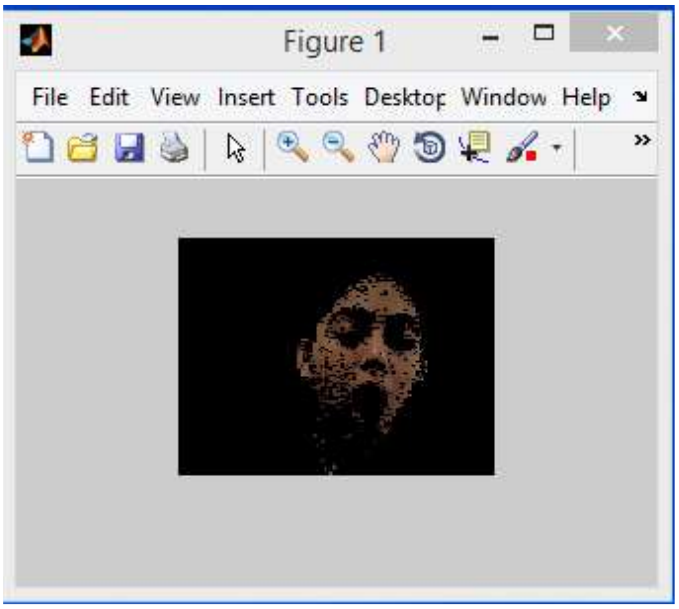
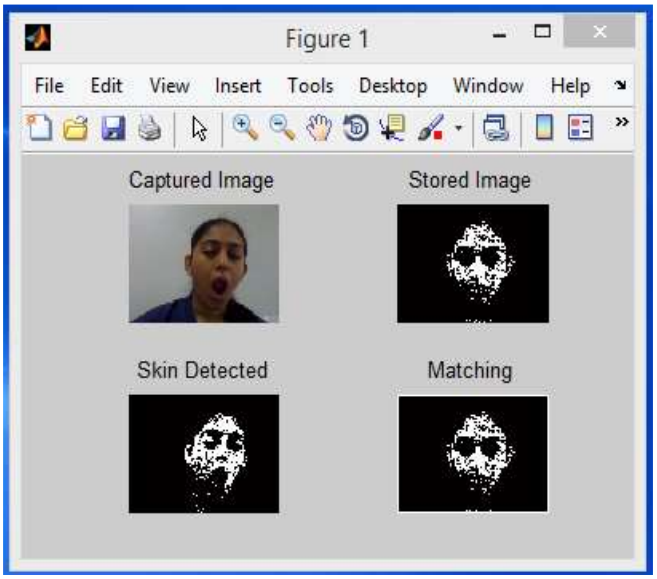
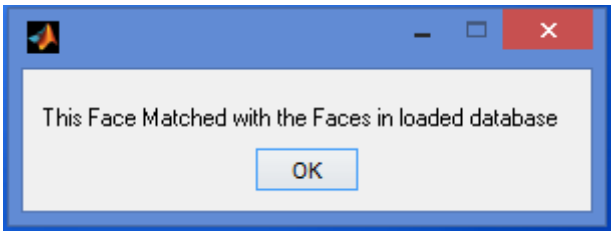
Step 2: Face Detection







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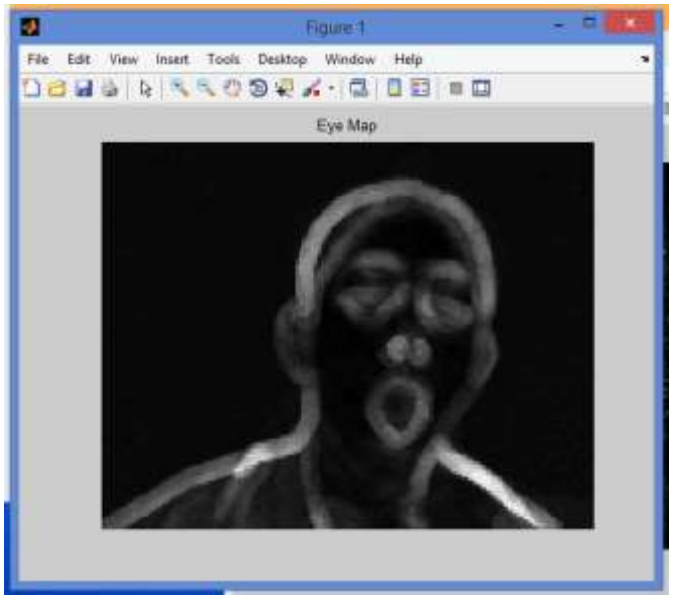
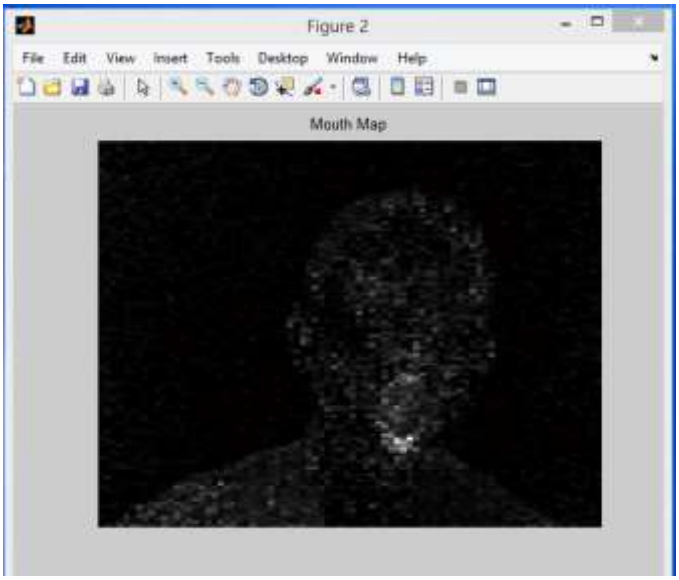
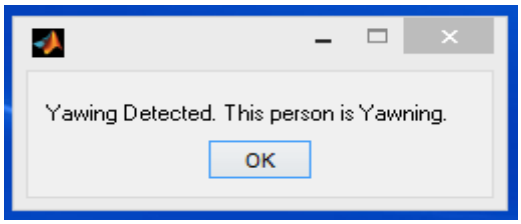
Step 3: Eye Detection



Step 4: Mouth Detection



Step 5: Drowsiness Detection



Step 6: Alert

Alert will be in two forms:

1. Sound Alert to the driver.
2. An SMS and email alert with the image of the drowsy driver to the owner of the vehicle.

CONCLUSION

The main aim of the system is to avoid accidents on road due to fatigue. In this paper, we have developed the drowsiness detection system based on eye closure and yawning. System will alert the driver immediately when the drowsiness conditions are met. Thus, encouraging the driver to take a break or drink caffeine. The system alerts the owner of the vehicle with a SMS and an email containing drowsy image of driver. Thus, ensuring that the driver takes a break and not putting anyone's life at risk. Many accidents can be avoided if the driver is vigilant. Image processing offers a noninvasive and cost effective way to detect drowsiness efficiently. We have applied the face detection algorithm to more than 100 images with different characteristics. The images are taken with various conditions such as different light reflection and directional lightings. The system is able to accurately detect the drowsiness in the individuals with proper illumination. The system fails to detect skin when the lighting condition is dark. This application can be modified and used to detect sleepiness among the students in the classroom or conference room etc. Another application may be in coffee or tea dispenser machines where is an employee is found sleepy the dispenser will automatically alert the drowsy employee and serve the beverage of the individuals choice.

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