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Real-time Intelligent Alert System on Driver's Hypo-Vigilance Detection Using Template Matching Technique.

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Abstract::- According to experts, anyone who do not take break after long period of driving task can cause weariness. This system is one of the major approaches for preventing accidents by fatigue detection and distraction detection. Since there are many systems are available for warning the drivers. As fatigue is the main reason for accidents as well as distraction of drivers especially in the highways and rural areas. Because fatigue reduces driver's perceptions and decision making capability to control the vehicle. This results irritation and the person is no longer paying attention in driving. In this paper, method for face detection and eye tracking from human face image is used. We have discussed method for determining eye template of open eyes and closed eyes. It is based on real-time acquisition of a driver's face images and template matching method is applied to extract hypo-vigilance symptoms.

Keywords: *weariness, fatigue detection, distraction detection, face detection, eye tracking, template matching.*

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Introduction:

Due to improved standard of living in the past few decades, many families possess their own vehicles. Therefore, people use their own cars for any purposes like business or trip. However, too much travelling over a long distance usually makes drivers exhausted. Thus, this fatigue or drowsiness problem has become an important factor of traffic accidents. In order to decrease these traffic accidents, many countries have started to pay attention to the driving safety problem. Many researches show that usually after 2-3 hours of continuous driving, leads to driver get tired. This happens in the early afternoon hours or at midnight, especially after eating lunch; driver drowsiness is much more than other times. In addition to this, drinking alcohol, addicted to drugs and use of any kind hypnotic medicines can also lead to loss of concentration. Monotony of doing any task can reduces the person's concentration leads to distraction. Monotony can be caused by lack of personal interest, doing a repetitive task for long time or external factors (like talking with mobile phone).

The increment in the road accidents due to a driver's weariness has become a serious problem for society. Driving for a long period of time causes excessive fatigue which makes the driver sleepy. Therefore it is necessary to design a system to reduce accidents and keep the alert when fall asleep also focused on the roads while driving. Various studies have shown that around 20% of all road accidents are fatigue-related, up to 50% on certain roads. Recent statistics estimated that annually 1,200 deaths and 76,000 injuries can be caused due to fatigue related accidents. According to the current studies, it is expected that the amount of crashes will be reduced by 10%–20% using driver fatigue and distraction detection systems. Driver distraction can be estimated by head and gaze direction determination. The major problem for distraction detection is that if head is forward and eyes are looking toward the road, does not mean that the driver is paying attention to the road while driving the vehicle.

The proposed system on driver's fatigue and distraction finds the physical and mental condition of a driver based on image processing. The driver state can be estimated by eye closure, eyelid distance, eye blinking rate, gaze direction, yawning, or head rotation etc. This system alerts the driver in hypo-vigilance state (fatigue and distraction both). One can use any one of the different methods for detecting driver's fatigue. These techniques include image processing based techniques, electroencephalograph based techniques, and artificial neural network based techniques. In this paper, technique based on image processing is used. This may involve template matching techniques, eye blinking techniques, yawning based techniques, facial expression of driver to detect driver's drowsiness. There is lack of scientific definition for fatigue and quantitative approaches to measure it but still it can be done with the help of relation between fatigue and eye movement, body temperature, brain activity, breathing rate, etc.

Factors affecting Driving:

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Main factors that affects driving or results in driver's tiredness are: sleep, work, time, and physical. Since people tries to do so much of work in a single day in which they lose time to sleep resulting drowsiness. The lack of sleep over number of days leads to body get collapses and person falls asleep. The human brain is trained to recognize the right time to sleep often by seeing the sunrises or sunsets. Between 2 AM to 6 AM body feels sleepy. There are some physical conditions of person affecting driving including their medication, by being physically unfit or being either underweight or overweight or being mentally stressed causes fatigue. Young male drivers, truck drivers, company car drivers and shift workers are the most at risk of falling asleep while driving. Due to fatigue person is unable to judge when they are going to fall asleep. Prolonged driving on highways with flowing traffic has a negative effect on driver concentration. Driver's distraction from the road or conversations with any other or in cellular talks during driving can lead to serious results.

Drowsiness or sleepiness can be caused by body's biological rhythm. It is happened because of lack of sleep. Since teenagers need at least 9 hours of sleep. Fatigue or weariness is lack of desire to drive which is caused by repetitive task of driving without taking rest. The signs of fatigue includes yawning, tired eyes, heavy eyelids, nodding off, can't concentrate, loss of consciousness, and inability of prediction to fall asleep. Once a driver is drowsy it is difficult to overcome this feeling (only sleep will cure it). Driver can no longer perform important driving tasks (e.g., staying in lane). Driver will experience a decrease in reaction time, coordination, and decision making (all skills needed to drive safely). In the 2011 Road Safety Monitor (RSM), almost one fifth (18.5%) of Canadians reported nodding off or falling asleep at the wheel in the past year. According to Elzohairy 2007 in Ontario, it is estimated just over one-quarter (26%) of all fatal and injury crashes are due to fatigue. In the United States, between 79,000 and 103,000 crashes a year are caused by fatigue, with 71,000 injuries and 1,500 fatalities as studied by NHTSA.

Fatigue has similar effects to alcohol intoxication: A person who has not had proper rest in 17 hours = a person with a blood alcohol concentration of 0.05 (legal limit is 0.08). Fatigue heightens the effects of alcohol, even small amounts (1 or 2 drinks). Hence it is essential to get proper amount of sleep. Take a break every 2-3 hours of driving .Naps and caffeine will ultimately not help and can lead to the body "crashing" (getting tired again suddenly and severely); only sleep will cure fatigue. Driver monitoring system alerts the driver if it detects drowsiness. If a vehicle loses lane position the system alerts the driver with a light and alarm.

Previous work:

In the last few years, many different techniques have been used for developing safety systems. The proposed system can be designed by considering two categories. In one category, driver fatigue is detected only by focusing on eye region. Since there are many researches are present and many symptoms appear in the eyes only to detect fatigue. While in the other category, the symptoms of fatigue and distraction are detected from other regions of the face and head. In this other symptoms including yawning and head nodding are also extracted.

Previous research on driver drowsiness detection has focused on medical science, with the help of medical electroencephalograph (EEG), electrocardiograph (ECG) and electromyography (EMG) to detect a driver's EEG waveform, ECG waveform and EMG wave-form[25][26]. In spite of the accuracy of medical methodology, it's complicated and need certain environment which made it hard to generalize. The research "An Evaluation on Various Vision-based Fatigue Driving Detection Methods" which was conducted compared four methods and nine parameters fatigue driving results, and PRECLOS especially P80 detection method shows it's superiority[27][28].

In 2003, Wang et al. [9] proposed a technique for monitoring driver fatigue. Like [24], the Gaussian distribution of skin colors in the RGB color model is used to locate a face region. Then, the face is binarized with a fixed threshold to locate the eyes' positions with some geometric restrictions and to track the eyes by using the Hausdorff distance template matching. Finally, the features of the eyes are analyzed by the Gabor filters, and the states of driver's eyes are classified by neural networks. Since the eyes are detected with a fixed threshold, this system might not resist illumination changes.

In 2004, Wang et al. [10] proposed another method for driver fatigue detection by monitoring mouth movement. Similarly, the Gaussian distribution of skin colors is used to locate a face region. Then, a Fisher linear classifier is used to detect the mouth of the driver, and a Kalman filter is used to track the mouth movement. However, the mouth movement may not be a reliable feature for detecting drowsiness because the mouth shapes will also change when talking, eating, laughing, and so on. It is not easy to classify the mouth movement into a correct drowsy state.

In 2005, Dong and Wu [11] also presented a driver fatigue detection algorithm based on the distance of eyelids.

Instead of using the RGB color model, this method utilizes the Gaussian distribution of skin colors based on the YCbCr color model to detect the face region. Then, horizontal projection is used to locate eyes' positions, and the gray scale correlation is used for eye tracking. Finally, the distance of eyelids is calculated to detect fatigue. Although the method can resist the influence of illumination changes, it is not easy to distinguish the distance of eyelids of closed eyes or open eyes by small difference of eyelid's distance, especially when the person having long eyelashes.

Proposed work:

Distraction means that drivers can pay attention, but their attention is shifted away from the primary driving task to some secondary task or attracted by some attractive object/event. Fatigue means that drivers have exhausted their attention energy and cannot maintain sufficient attention to driving. The causes of distraction and fatigue are different, and they impose different influences on the driver and driving performance.

We are developing an application for Four Wheeler Vehicle Drivers. This application helps drivers to prevent from accidents while driving especially at night. The proposed system basically works on three modules. Each module is specially defined to perform specific operation on data and every module performs certain task. The detail information about modules is as follows:

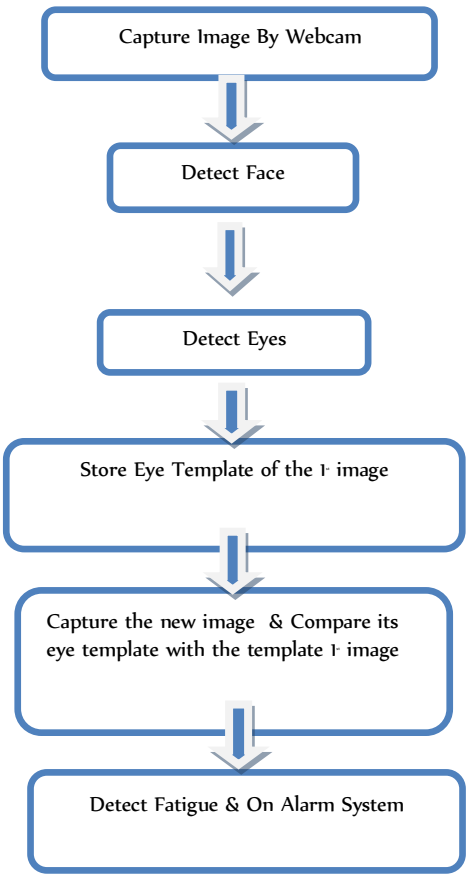

Fig.1: flowchart for the proposed work

The proposed system is a real time intelligent alert system that can detect driver hypo-vigilance (both fatigue and distraction) by processing of eye regions. Flowchart of our system is shown in Figure 1. After image acquisition, face detection is the first stage. Then, symptoms of hypo-vigilance are extracted from the eyes of an image.

1. **Face detection**:

In the proposed systems, face detection is the first part of image processing operations. In this system fatigue and distraction is detected based on processing of facial region especially the eye region that is why face detection is considered as very important part of the system. As detecting eyes directly is quite a difficult task, face is detected at first and then eyes are detected. Learning-based methods deal with face detection using a number of training samples. Generally, learning-based methods have less error rates in face detection, but these methods usually have more computational complexity. Viola *et al.* [36] presented an algorithm for object detection, which uses very simple features named Haar-like features. In this algorithm, many numbers of Haar-like features are extracted from the image, and a number of effective features are selected using AdaBoost algorithm, and then these features are processed in a hierarchical structure similar to the decision tree. Due to the simple extracted features and selection of the best features, this algorithm is relatively fast and robust.

2. **Eye detection**:

Eye-detection has got two phases one is eye tracking and other is template matching. Because the value of pixels in eye region is relatively lower than other region of face. The original color information of the detected eye region is first converted into gray scale. We calculate the average gray value along X axis and roughly find the eye region. In template matching, one can use the states of eye i.e. if driver closes eyes for some particular time then system will detect it as and generate the alarm. Because in this techniques system has both close and open eyes template of driver. This system can also be trained to get open eye template as normal and closed eye templates as sleepy. This method is simple and easy to implement because templates of both open and closed eye states shown in figure 2 are available to system. Researchers have used this technique in [1][4][5].

Fig.2: Templates of open and closed eye states.

3. **Fatigue detection**:

As the face of the driver is detected and the eyes are tracked successfully, we are intended to check the variations of the eyes continuously. A template matching technique is then used to detect whether the eyes of the driver are open or closed. Based on the blink rate and the rate of capturing images the open and closed variations of the eyes are judged. The threshold is fixed to capture the image of face and eyes are traced. If the eyes remain closed for a certain period of time (3 to 4 seconds), the system will detect that the person has fatigue and gives him a warning signal. The system also checks for errors; once an error is detected, the system will go back to the face detection stage. The main goal is to detect micro-sleep (short periods of sleep) symptoms. This can only be achieved by monitoring the eyes of the driver throughout the entire video sequence. In this the colors of the eyeballs in the eye templates are used directly for fatigue detection. Here the eye templates are converted to the grey scale model. According to the observation, the value of eyeball pixels normally falls between 0.00 and 0.14. When the eyes are open, there are some eyeball pixels. When the eyes are closed, there are no eyeball pixels. By considering the eyeball pixels, it is easy to detect whether the eyes are open or closed. An alert is made to the driver once the fatigue is detected. The system simultaneously detects fatigue. In case the eyes of the driver remain closed for a long period of time, the system gives a fatigue alert.

Experimental Results:

There is no tool for measuring the fatigue and distraction; therefore, symptoms related to eye region is extracted and fatigues is detected through this detection the proposed system alerts the driver via an alarm system. In the fig.1 the starting window of the proposed system have been shown with four buttons start camera, get face, get eyes, and process extracted eyes buttons. As we click on start camera button the webcam

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of PC or laptops will turn on showing on fig.2. By clicking on get face button face is extracted from the captured image (fig.3.) as well as by clicking on get eyes button we get the left eye and right eye both as in fig.4. After pressing process extracted button a new window opens in which the extracted eye template is used to determine whether eyes are open or closed as shown in fig.5. By this process the system generates an alarm if found close.

Fig.1: Starting Window for system

Fig.2: Window showing camera ready to take image.

Fig. 3 : Window showing face is extracted from the captured image.

Fig. 4: Window showing eye tracking from the image.

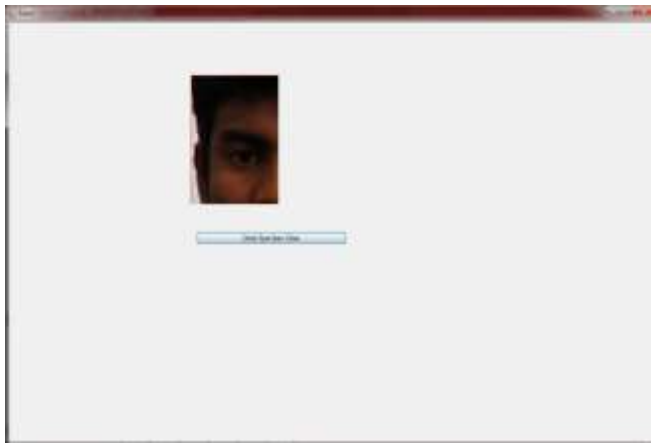

Fig. 5: Using this extracted eyes we check whether eyes are open or closed.

Conclusion:

In this paper, the face is detected and eyes are tracked from the captured human face image at the real time. Then the eye templates were trained as normal eye and sleepy eye template and a counter is set for capturing images. If found closed eye templates for more than 3 sec finally the system detects the fatigue and an alert is given. This happens only because of face is detected successfully but if face is not detected carefully it is difficult to locate eyes from the image. Thus face detection algorithm should be able to detect face in different light conditions (day and night), environments with sudden light changes (entrance to or exit from a tunnel) and different skin colors (especially for black skins). If the system fails to do this symptoms of fatigue and distraction can be detected from other regions of the face and head. In this hypo-vigilance symptoms including yawning and head nodding can be extracted and warning is given.

The driver may drowse without any symptoms of unbalanced controlling of the car; therefore the system will not

detect the driver drowsiness. The system can make an alarm as soon as the symptoms of fatigue or distraction in the driver face are occurred. Future driver face monitoring systems can recognize driver feeling and emotion by extracting the driver facial expression. If a vehicle loses lane position the system should alerts the driver with a light and alarm send S.O.S message to police.

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