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To Preserve Driver's Vigilence by Monitoring Head and Eye Gaze Directions for Drowsiness Detection

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ABSTRACT: Drowsiness is a state of near sleep, or a strong desire for sleep. The sensation of sleep reduces the driver's level of vigilance producing dangerous situations and increases the probability of an occurrence of accidents. Drowsiness behind the wheel is a major contribution to fatal accidents. Around 30-40% of road accidents are caused due to driver drowsiness. It affects the driving ability in the following 3 areas, i) It impairs coordination, ii) It causes longer reaction times, and, iii) It impairs judgment. In the existing systems , the drowsiness is detected by measuring the physiological signals or bio feedback of a driver by attaching a number of electrodes to either his head, chest or his wrist, although these techniques produce an accurate measure of drowsiness, they are less practicable in a real time environment. In this paper, a real time monitoring system using image processing is proposed. Here the visual clues such as eyelid closure percentage , gaze direction, yawning, head position are monitored to identify and predict the drowsiness level of the driver and alert him before any hazardous situations on the road could occur.

KEYWORDS: Drowsiness level, driver fatigue, image processing, accidents, visual clues

I. INTRODUCTION

A Road Traffic Accident (RTA) can be defined as, 'An event that occurs due to inattentiveness of the drivers while driving on the road that causes numerous deaths and loss of money'. These accidentscause high human suffering and socioeconomic losses in terms of injuries, premature deaths,productivity loss, and so on.

According to the National Highway Traffic Safety Administration, about 100,000 police reported crashes are due to fatigue driving every year [2]. Using different techniques to detect driver fatigue/drowsiness is an interesting challenge that would help in reducing accidents. As of now, various efforts have been made in the literature for drowsiness detection of vehicle driver. In the recent years, many nations worldwide have begun to pay a lot of attention to the driver's safety problems. Researchers have been working on the detection of driver's drowsiness levels using various techniques, such as by detecting physiological signals and road monitoring techniques. Physiological signal detection techniques take full advantage of the fact that sleeping patterns of a person is strongly connected with their heart and brain activities. However, all these researches till date involving these kinds of approach need physical electrode contacts with automobile drivers' chest, face, or head making it practically non-implementable in real world conditions.

Autonomous systems designed to analyze driver exhaustion and detect driver drowsiness can become a part of the future intelligent vehicle so as to prevent accidents caused by sleep. A variety oftechniques have been employed for vehicle driver's drowsiness, fatigue and exhaustion detection. Driver operation and vehicle behavior can be implemented by monitoring the steering wheel movement, vehicle speed, accelerator or brake patterns, lateral acceleration, and lateral displacement. These are non- intrusive ways of driver drowsiness detection, but are limited to the type of vehicle and driver conditions [3].

Another set of techniques focuses on monitoring of physiological characteristics of the driver such as heart rate using Electrocardiography (ECG), pulse rate, blood volume using Photoplethysmography (PPG) and brain waves using Electroencephalography (EEG) [4]. Research in these lines have suggested that as the alertness level decreases EEG power of detecting of the alpha and theta bands increase [5], hence providing indicators of drowsiness. Although the use of these physiological signals yields better detection accuracy, these are not accepted widely because of less practicality. A third set of techniques is based on computer vision systems which can recognize the facial appearance changes occurring during drowsiness [6, 7, 8]. Physiological features–based approaches are intrusive because of the measuring equipment that need to be placed in contact with the driver. Therefore, visual features–based approaches have become much preferred because of their non-intrusive nature.

In this paper we propose a direct approach that makes use of vision based techniques to detect drowsiness. The major challenges in this proposed technique includesdeveloping a real time system, Face detection, Iris detection under various conditions like driver position, with/without spectacles, lighting, etc., blink detection, and providing a proper alert to the drivers as well as the near-by vehicles. The focus will be on designing a real-time system that will monitor the open or closed state of the driver's eyes. By knowing the state of the eyes, it is assumed that they are symptoms of driver fatigue and can be used as a warning early enough to avoid a car accident. Detectingfatigue/drowsiness involves the monitoring of eye movements and blinking patterns in a sequence of images of driver's face extracted from the live video stream.

II. EXISTING SYSTEM

The present developments in drowsiness detection can be broadly divided into two types, intrusive and non-intrusive. The intrusive technique [9] for detecting drowsiness involves periodically requesting the individual to respond to a specific signal sent by the system. The task of periodically responding to a signal in due course become tiresome and annoying to the individual. The drowsiness can be detected through non-intrusive techniques by sensing of person operation, physiological phenomenon, and measuring physical changes.

Among these methods, the most accurate one is the nonintrusive technique based on human physiological phenomenon. It can be realized in two ways: The first kind gives emphasis on computing changes in physiological signals, such as brain waves, breathing pattern, heart rate and eye blinking and the later determines physical changes such as leaning of the drivers head, sagging posture, and the open/closed states of the eyes.

In all these methods the one based on heart wave and brain wave are not realistic, since the electrodes monitoring the signals would have to be attached directlyonto the person's body, and hence it will be annoying and distracting to the driver.

III. PROPOSED SYSTEM

The proposed system has to face different range of obstacles for identifying the current condition of the driver like whether he is active, drowsy, fatigue or under micro sleep. The operations involved are, capturing the face of the driver in a good quality video through a camera and then identifying the head position of the driver and the location of the eyes which provides the vital information required such as the percentage of closure and blinking rate. Then analyzing all the information gathered from the captured video, it should be processed accurately to determine the level of drowsiness the driver is currently in. After analyzing the drowsiness level and ifthe driveris foundto be in danger of falling asleep, a proper alert is provided to him by a voice alert and a mild vibration through a motor attached to the seat belt. The system architecture of the proposed system is represented in Fig 1.

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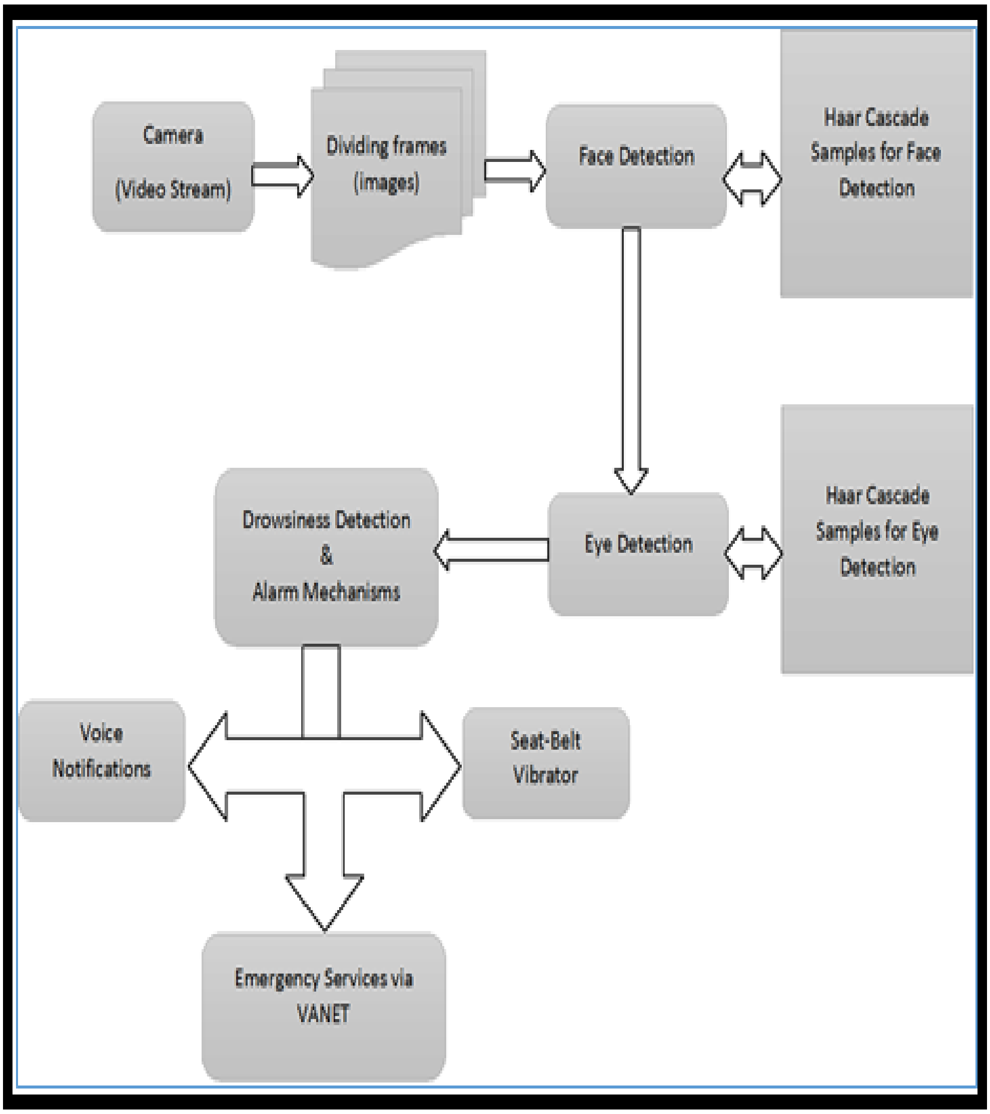

IV. IMPLEMENTATION

Fig 1 shows the various important blocks in the proposed system and the high level interaction. It can be seen that the system consists of 6 distinct modules namely, (i) Video acquisition, (ii) Dividing into frames, (iii) Face detection, (iv)Eye detection (v) Drowsiness detection and (vi)Alerting Mechanisms. In addition to these there are two external hardware components, Camera for video acquisition and an audio alarm. The functionality of each these modules in the system can be described as follows:

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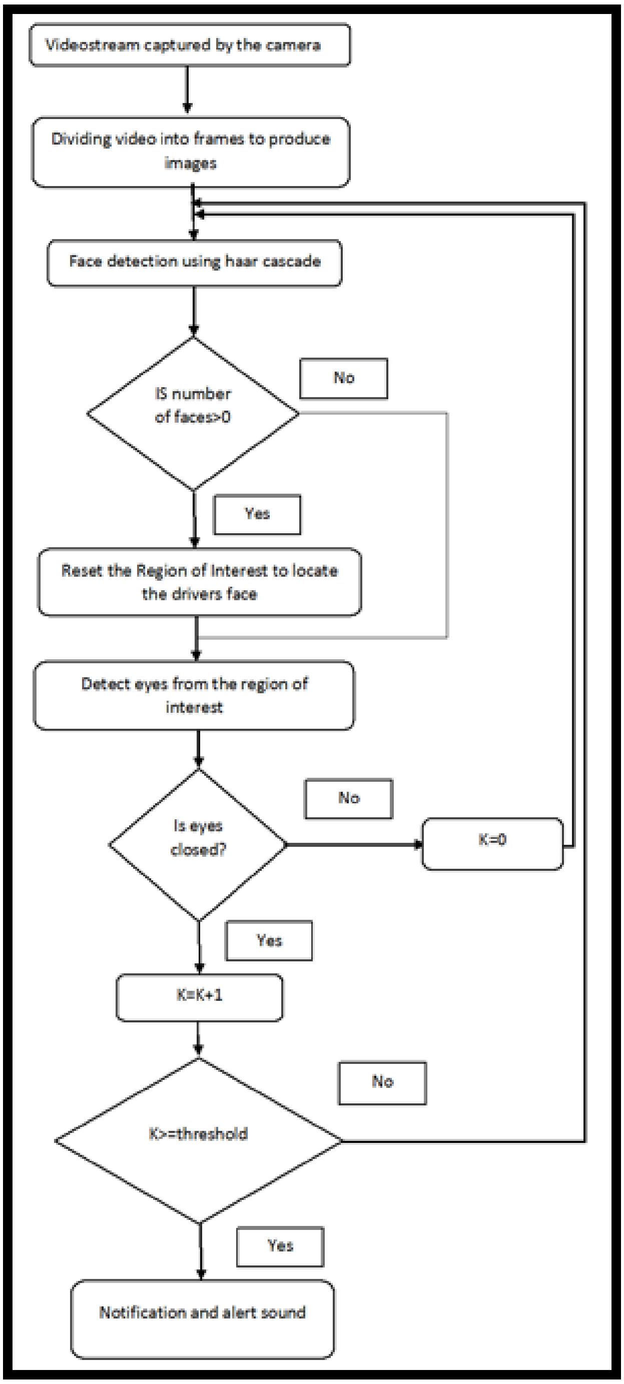

A. Video Acquisition

OpenCV has extensive support and features for acquiring and processing live video stream. OpenCV does not specify any minimum requirements on the video stream from the camera, however by default it expects only a particularresolution of the video, if the resolutions do not match, then an error is thrown. This error can be countered, by overriding the default value, which can be achieved, by manuallyspecifying the resolution of the video being recorded.

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B.Dividing into frames

Once the video has been acquired, the next step is dividing it into a series of frames/images. This is done as a 2 step process. The first step is to grab a frame from the camera, and once this is achieved, the next step is to retrieve the grabbed frame. While retrieving, the image/frame is first decompressed and then retrieved. However, the two step process took a lot of processing time as the grabbed frame had to be stored temporarily. To overcome this problem, the 2 step process is combined into a single step process, where a single function grabs a frame and returns it by decompressing.

C.Face detection

Once the frames are successfully extracted the next step is detecting the face in each of these frames retrieved. This is achieved by making use of the Haarcascade file for face detection. The Haarcascade file contains a number of features of the face, such as height, width and thresholds of face colors. It is constructed by using a number of positive and negative samples. For face detection, first the cascade file is loaded. Then it passes the acquired frame to an edge detection function, which detects all the possible objects of different sizes in the frame. To reduce the amount of processing, instead of detecting objects of all possible sizes, since the face of the automobile driver occupies a large part of the image, we can specify the edge detector to detect only objects of a particular size, this size is decided based on the Haarcascade file, wherein each Haarcascade file will be designed for a particular size. Now, the output the edge detector is stored in an array. Now, the output of the edge detector is then compared with the cascade file to identify the face in the frame. Since the cascade consists of both positive and negative samples, it is required to specify the number of failures on which an object detected should be classified as a negative sample. The output of this module is a frame with face detected in it.

D.Eye detection

After detecting the face, the next step is to detect the eyes; this achieved by making use of the same technique used for face detection. To reduce the amount of processing, the region of interest before trying to detect eyes is set. The region of interest is set by taking into account the following: (1) The eyes are present only in the upper part of the face detected and (2) the eyes are present a few pixels lower from the top edge of the face.

Once the region of interest is marked, the edge detection technique is applied only on the region of interest, thus reducing the amount of processing significantly. The same technique used in face detection is used for detecting the eyes by making use of Haarcascade Xml file for eye detection. For efficient detection the following steps aretaken:

- Out of the detected objects, the object which has the highest surface area is obtained. This is considered as the first positive sample.
- Out of the remaining objects, the object with the highest surface area is determined. This is considered as the second positive sample.
- A check is made to make sure that the two positive samples are not the same.
- Now, we check if the two positive samples have a minimum of 30 pixels from either of the edges.
- Next, we check if the two positive samples have a minimum of 20 pixels apart from each other.

After passing the above tests, conclusion is made that the objects i.e. positive sample 1 and positive sample 2 are the eyes of the automobile driver.

E.Drowsiness detection

Once the eyes are detected, the next step is determining whether the eyes are in closed or in open state. This is achieved by extracting the pixel values from the eye region. After extracting , we check if these pixel values are white, if they are white then it infers that the eyes are in the open state, if the pixel values are not white then it infers that the eyes are in the closed state.

This is done for each and every frame extracted. If the eyes are detected to be closed for two seconds or a certain number of consecutive frames depending on the frame rate, then the automobile driver is detected to be drowsy. If the eyes are detected to be closed in non-consecutive frames, then it is declared as a blink. And when the blink rate increases as time passes then a assumption is made that the driver is under the danger of falling asleep and as the rate increases beyond a threshold level then the driver is under the verge of falling asleep.

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F.Alert mechanism

There are three levels of alert mechanisms are proposed. The first two are used to make the driver stay alert and third is used to alert the others to provide a significant amount of time if any unfortunate miss behaviors are identified.

a) *Voice Alert*

When the driver is identified to be under drowsy state an audible voice alert is provided using FreeTTS. FreeTTS is a speech synthesis system writtenentirely in the JavaTM programming language. It is based upon Flight: a small run-time speech synthesis engine. It is used to provide different variations of voicealerts like using the driver's name. Or to improve system performance a standard voice alert that is prerecorded could also be used.

b) *Seat-belt Vibrator*

As the driver falls asleep a mild vibration is provided using a motor attached to the seat belt. It acts like a wakeup call and the driver might recuperate his control before any miss happenings can occur. The main aim of this is to increase the chances of the driver regaining his consciousness at an early stage of drowsiness.

c) *Emergency services using VANET*

The emergency services canbealsonotifiedifthedriver requires medicalassistance, forexample, dueto excessive stress. Theinformation sent fromthe vehicle's On-BoardUnit (OBU),totheemergency servicesincludes theinformation collected fromthe driver monitoring system and vehiclescharacteristics, aswellasOBUlocation. Accurate OBU location in open-air scenarios can be provided by the Global Navigation Satellite Systems. However, in dense urban and underground scenarios, these systems suffer from the weakness (or even the blockage) of their signals when the receiver operates in non-line-of-sight conditions. Switching between technologies, such as wideband communication provided through 3G radio network-based localization methods, allows determining the most accurate position of the OBU. Pedestrians and other drivers may also be warned of a driver's incapability to drive properly, through the use of notification messages forwarded to their own OBU (e.g., smart phones) using vehicle-to- pedestrian or infrastructure-to-pedestrian communications.

V. CONCLUSION AND FUTURE ENHANCEMENT

The primary goal of this project is to develop a real time drowsiness monitoring system in automobiles. Each of the components discussed can be implemented independently thus providing a way to structure them based on the requirements. Four features that make our system different from existing ones are (a)Focus on the driver, which is a direct way of detecting the drowsiness, (b) A real-time system that detects face, iris, blink, and driver drowsiness (c) A completely non-intrusive system, and Cost effective. Further this system can also be integrated with that of VANET's (Vehicular ad hoc Network) to inform the third parties or emergency services in case of any mishap.

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