2021 6th International Electrical Engineering Conference (IEEC 2021)
April, 2021 at NEDUET, Karachi, Pakistan

Real time driver drowsiness detection using computer vision techniques

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Abstract: A system used to detect a drowsiness state of a driver based on a nonintrusive approach. This system is fully focused to consistently monitor the state of the person who is driving a vehicle. In this way we can determine whether the person is in drowsiness state or not. This system will help to reduce down fatal accident caused by drowsiness while driving. An alarm system is used to warn if the driver has gone in the state of drowsiness. In our proposed design, system will identify face and eyes, and localize pupil and iris boundary, examine the condition whether both eyes are open or close and system will take drowsiness decision based on eyes state. This system requires no training data and it gives high accuracy with normal computer camera.

Keywords: drowsy detection, fatigue detection, skin detection, face detection, eye region localization, iris detection, projection function, circular Hough transform.

I. INTRODUCTION

Drowsy driver creates a major impact in a huge number of vehicle accidents. According to department of health and human services of America 3.33 percent of adult driver fall asleep and cause fatal accident in their last 30 drives [1]. Drowsiness is a state where a person sleeps or almost likely, it refers to an inability to keep awake or a drive to sleep. The advancement in technologies in today's world makes it possible to make such systems for detecting drowsiness of drives in early stage and prevent fatal accidents. In our purposed system a video camera is used for the tracking of eye movements. The purposed system uses YCbCr color space to detect skin regions to counter the effect of varying illumination [2]. Morphological operations that are dilation and erosion are performed to construct face map [3]. For eye region detection we use Projection function for detecting eye region in much time [4], as detecting drossiness is a real time process for preventing accident. For localization of iris we use circular Hough transform [5], for decision criteria whether the driver is in drowsy state or not, we check region of circle detected from circular Hough transform. If circles region are not iris and have color values similar to skin for more than five hundred milliseconds we generate an alarm as drowsiness detected.

Viola and Jones method that detects face[6] has been used for face detection where as in this paper we have used morphological operations to detect the face. Inactiveness of persons during driving results in traffic accidents [7]. If the person's eye glance is the diverted from the road for more than two seconds, it will cause the occurring of accidents [8].

There are two kinds of techniques are used, intrusive and nonintrusive**.** In the intrusive techniques, the electrodes are used. The electrodes are concerned with electrooculography electroencephalogram and electrocardiogram in order to detect condition of driver.

In the paper [9] Multiple Histograms of systems having principal oriented gradients for measuring the eyes' closeness. Where in the paper [10] the driver's visual information is used for the measurement of drowsiness. Infrared cameras are measured for detecting the driver's eye closure for drowsy state analysis. [11]. In the paper [12], model that is used on artificial neural network using models that are on machine learning is measured for the detection of drowsiness state.

Drowsiness is a state where a person sleep or almost likely. It refers to an inability to keep awake or a drive to sleep. History shows that rate of accidents increased from 2.2 to 2.6 percent for death accidents annually. Most common techniques for finding the drowsiness [13] are sensing of driver operation, vehicle response, physiological features and monitoring driver response [14]. EEG and EOG techniques give best results for detecting drowsiness in driver but these are annoying to driver. So the best approach for ergonomic design of drowsiness system is to monitor head and eye behavior. Almost every big automotive company wants to use more efficiency ADAS in their vehicles to facilitate the customers. The first priority of these companies is the safety of driver and passenger of vehicle. So they used different techniques for safety. Drowsiness Detection System is also used in these vehicles. Every company use different technique for detecting drowsiness. Famous Drowsiness Detection Systems are Driver Alert by Ford, Attention.

II. DROWSINESS DETECTION ALGORITHM

The purposed method is used to identify drowsiness from a simple video camera, an image from camera stream is taken. First face detection is performed in that image then eye region is segmented from face image followed by circular Hough transform in left and right eye region for iris detection, by continuously monitoring eye state, whether eyes aye open are close then drowsiness decision is taken with alarm generation. Fig.1 shows the flow chat of purposed drowsiness detection system.

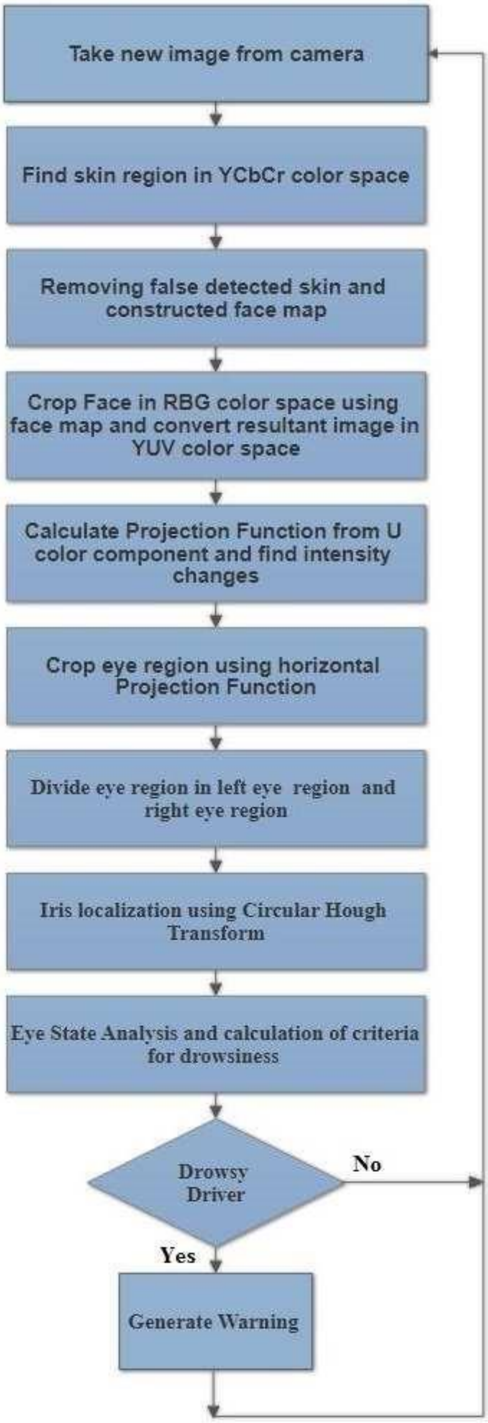

Figure 1: Flow Chat of Drowsiness Detection System

A. Face Detection Algorithm

For a system to monitor eyes for detecting drowsiness, system have to perform a number of steps. In first step we have to find the location of face. In our purposed system face detection is done in YCbCr color space rather than RGB. Hsu et al. [2] present a system to detect face with verifying illuminating environment. The system is designed to detect skin pixels and construct initial skin map, this map represent true skin pixels and false skin pixels. The system will take the large connected set of skin pixels as face, as the larger object in from of camera will be driver face in order to correctly detect drowsy condition. The selected large set of skin pixels makes face map by using morphological operation. Now the map is used to extract face region from original image. Example of skin map and face map or a driver is present in Fig.2. The purposed face detection work excellent on The FAMED face database.

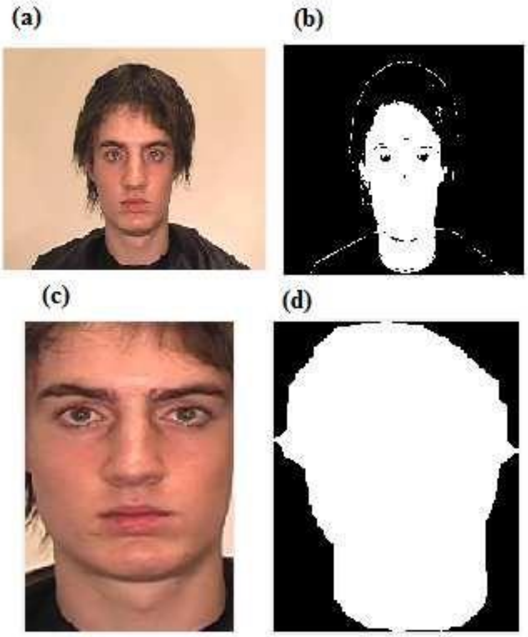

Figure 2: (a) Original Image, (b) Skin region detected, (c) Face Image, (d) Face map

B. Eye Region Localization Algorithm

We extract eye region by from face by using horizontal projection function as we know a rapid intensity change occur in eye region. Shuo [15] purposed an excellent technique for detecting eyes boundaries using Hybrid projection functions in U color component of YUV color space. In our eye region detection, we also use U color component of face. In eye region we first perform histogram equalization on U color component to increase global contrast, resultant face image converted in binary image. Logical and operation is performed in resultant binary image and previously detected face map to avoiding intensities near face. Now hybrid projection function is applied in resultant binary image from logical and operation to check horizontally intensity change. Intensity variations tell us eye and eyebrow region in upper half of the face image. Fig.3 and Fig.4 shows all steps for eye region localization. The purposed eye region detection localization works excellent on The FAMED face database [16].

Figure 3: (a) U color component of face, (b) histogram equalization of U Color Component, (c) binary image of histogram equalization of U Color Component, (d) AND product of face map and compliment of binary image

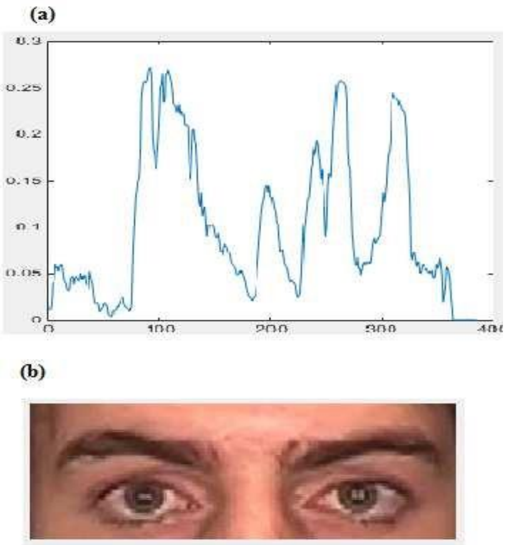

Figure 4: (a) Horizontal Projection Function, (b) Eye cropped region

C. Eye Localisation

In our algorithm, we have used the circular Hough Transform on the extracted eye region through the projection functions to locate the iris position. Hideki Kashima et al [5] used circular Hough Transform (CHT) to find iris position. Yasutaka Ito et al [17] used the circular Hough transform over the whole face to detect the eye region. W. M. K Wan Mohd.

In The paper [18] CHT is used to determine the eye region. When eye is open, size of iris is circular, so the CHT detects the circular shape and localize the iris position. In order to improve further output of CHT, the active contour method was used. When the eye is open, the shape of iris is not completely circular as it is hidden to some extent in the eye lids. The active contour method will shrink the circle to its actual iris position as shown in Fig 5.

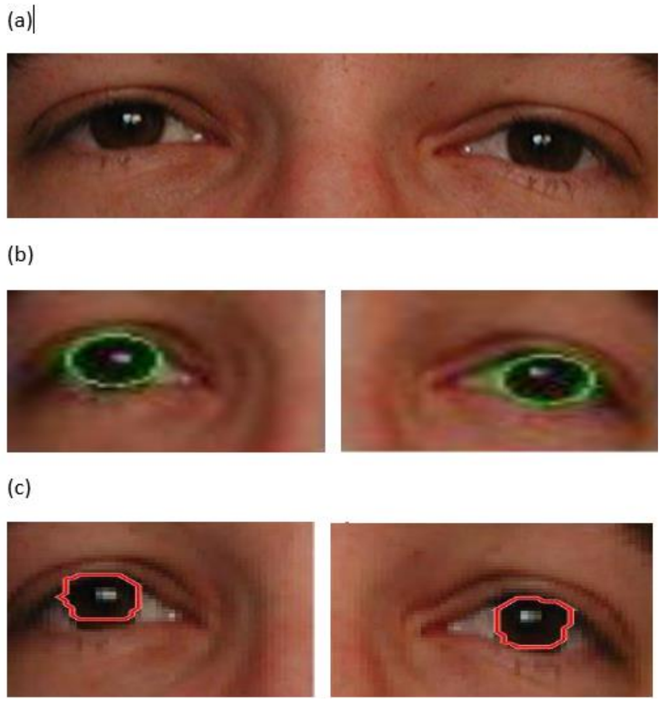

Figure 5: (a) Cropped eye region (b) circular Hough transform used (c) Active contour used on eyes

D. Eye State Analysis

Once the iris is localized, then we have to check whether the eye is open or close.

As the position of iris is localized and we know that the color of the iris is black, so the skin pixels of the eye are detected. The ratio of skin pixels of both eyes i.e. left and right eye is taken, then the hard threshold is set that if the ratio is greater than the 10%, then the eye is declared as open if this ratio lesser than 10% then the object is in drowsy state.

III. Conclusion

The face and the eye regions are extracted in almost every image. There are few restrictions to this system that are, the face should be at front position, and it should have brown skin color. This system will not work well on the dark skin peoples like African and Nigerians. If the face is at front position then, eyes are extracted well.

IV. RESULTS

Our algorithm detects whether the person is active or in drowsy state. The results are shown below in Figures. 6 and Fig.7. The Fig 6 explains that eyes are closed and person is in the drowsy state whereas from Fig 7 it is cleared observed that person is in the active state and he can derive the vehicle.

Figure 6: Drowsy Driver

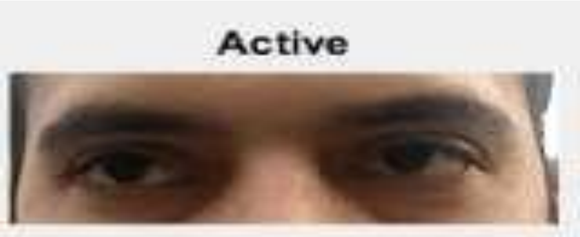

Figure 7: Drowsy Driver

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