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Driver Drowsiness Monitoring

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Abstract*— Day by day more road accidents are happens. The important factors which causes road accidents are driver's drowsiness and fatigue. In this paper, we described a method that monitors driver's level of drowsiness to avoid road accidents.Also this method should then alert to the user in case of any inattention. Here for monitoring driver drowsiness we discuss a method for yawning detection which is based on mouth geometric features changes. The proposed system detect the yawning state as a sign of driver drowsiness. This includes various phases like face detection, face tracking, eye and mouth detection, yawning detection. Our aim is to avoid number of car accidents caused by driver drowsiness.

Keywords— **Drowsiness Monitoring, Skin Colour Detection, Face Tracking, Yawning Detection**

I. Introduction

Driver's fatigue impacts on alertness as well as response time of the driver. It is one of the main reasons that cause traffic accidents. According to National Highway Traffic Safety Administration (NHTSA) estimates, drowsy is contributing factor to 22-24 percent of car crashes which results in 1550 deaths, 71000 injuries and $12.5 billion losses. In 2002, according to National Sleep Foundation (NSF) 51% adult driver had driven a vehicle feels drowsy and 17% had fallen asleep. The accident rate is high because sleepy driver will not take any correct action prior to the collision. So we can prevent road accidents by monitoring driver's level of drowsiness making the use of assisting system. If there is any drowsiness condition or inattention then these system will provide alert to the driver.

Drowsiness decreasing a driver ability to operate a vehicle safely, impact on mental alertness of driver and increasing the risk of human errors which causes fatalities and injuries. There are different signs and body gestures that can be monitored as indicators of driver fatigue. These include daydreaming on road, driving over centre line, yawning, heavy eyes, slow reaction and feeling impatient. In this paper, we choose yawning as a measurement parameter and propose a system for monitoring driver drowsiness and subsequently alerting them.

This paper is organised as follows: In Section II the material and methodology about the detection of driver drowsiness is presented. In Section III result is described. And lastly section IV presents the conclusion of proposed system.

II. Material and Methodology

FACE DETECTION

The first step of yawning detection is detection of driver face. Given a single image the aim of face detection to find all images region which contains face corresponds of its position, orientation and lightening condition. Such a problem is challenging because faces are not constant and have high degree of variability in size, shape, colour and texture. It is basically assume that the monitoring camera is installed inside the vehicle under the front mirror facing the driver at fix angle. Therefore the problem of relative camera, face pose is less challenging in our application while head position might still vary from driver to driver. There is also great deal of variability among face including shape, colour and size. Presence of facial features such as beards, mustaches, and glasses can also make a great deal of difference. The other important factor is lightening condition. This is mainly affected by the environment light that can change depending on the time of the day and weather conditions [iii]. In order to locate face in the image as possible location of face is first estimated based on colour segmentation, identification of skin colour in face uses YCbCr colour model. The use of human skin characteristics in face location will be discussed further. YCbCr skin colour model is discussed as follow:

A. YCbCr Colour Space Model

Skin colour classification is first choice of colour space. Different colour spaces are RGB and HSV colour model for most available image format. The colour space transformation is assumed to decrease the overlap between skin and non-skin pixels. Although there exist many colour faces [iv]. We use YCbCr colour space because it is effective in skin detection. YCbCr is encoded non linear RGB information for image compression work. Colour is represented by luma constructed as a weighted sum of RGB values and two colour difference values Cr and Cb that are formed by subtracting luma from RGB red and blue component.

$$Y=0.2999R+0.587G+0.114B,$$

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Cr=R-Y,
Cb=B-Y

While YCbCr is device dependent this is used under strictly defined condition within closed system. The Y component shows brightness and other two values Cr and Cb describe colour difference rather than colour. The transformation simplicity and explicit separation of luminous and chrominance component makes this colour spaces attractive for skin colour model. [v][vi][vii]. The Y-component has 220 levels ranging from 16 to 235, while the Cr and Cb component have 225 level ranging from 16 to 240.Where R, G, B values are scale to [0, 1]. In contrast to RGB the YCbCr colour space is luma independent, resulting in better performance.

The corresponding skin cluster is given as:

$$Y>80,$$
$$85<Cb<135,$$
$$135<Cr<180,$$
Where Y, Cb, Cr=[0,255].

In another work skin-pixel detection using a very narrow band of values in only the Cr and Cb matrix of YCbCr model of an acquired image as two set of static threshold ranges of 133 <= Cr<=173 and 77<=Cb<=127 are proposed as skin pixel band.

B. Skin Segmentation

The human skin has specific characteristics, RGB colour space, which can be exploited for skin segmentation. The rules governing human skin characteristics and RGB space are described in equation (1). However it should be noted that skin segmentation in RGB colour space is quite sensitive to illumination variation. Therefore we have added another set of rules in the YCbCr space as shown in equation (2) to increase the detection efficiency.

(R>95) AND (G>40) AND (B>20) AND (1)
(max {R, G, B}-min{R, G, B}>15) AND (|R-G|>15) AND
(R>G) AND (R>B) AND (R>220) AND (G>210) AND
(B>170) AND (R>B) AND (G>B).

Cb-Cr colour space is a strong determination of skin colour. The following rules apply to this colour space.

(Cr<=1.5862*Cb+20) AND (2)
(Cr>=0.3448*Cb+76.2069) AND
(Cr>=-4.5652*Cb+234.5652) AND
(Cr<=-1.15*Cb + 301.75) AND
(Cr<=-2.2857*Cb+432.85)

HSV space is the last space to be used. Hue values demonstrate the clearest separation between skin and non-skin regions.

H<25 AND H>230 (3)

The result of the skin location technique is a black and white image which highlights the skin location by converting the face to white and the background and the areas around the driver to black. These background eliminations reduce the errors due to false object detection in the background. The face is detected by finding the largest white connected component and will cut that area.

Face Tracking

Now next step is face tracking, in which we can use the detected face as a template in future frame. Tracking the face involves much easier and less time consuming operation than face detection, allowing the monitoring system to operate in real time with a reasonable amount of processing power. In face tracking we uses canny edge detection for good face detection and good face localization of edges. That means, the algorithm should mark as many real edges in the image as possible and edge marked should be as close as possible to the edge in the real image.

Canny edge detection algorithm performs better than other under almost all scenarios and performs well under noisy condition [i]. The method uses two thresholds to detect strong and weak edges and include the weak edges in the output only if they are connected to strong edges. The canny method applies two thresholds to the gradient: a high threshold for low edge sensitivity and low threshold for high edge sensitivity. Edge starts with the low sensitivity result and then grows it to include connected edges pixels from the high sensitivity result. This helps in filling gaps in the detected edges.

Eye Detection

Once the face is detected and track, the position of the eye will be detected. In eye detection the eye map equation is used based on chrominance components for mapping of eyes. The eye region is highlighted by using eye map [ii]. The eye map equation is as follows:

Eye_location=1/3{(Cb) ^2+ (Cr) ^2+ (Cb/Cr)}. (4)

After that eye map image is converted into black and white colour image. This means that whole image part will be converted into black and only eye region is located in white colour. In eye detection technique proper threshold value is used. In yawn state eye region having less threshold value compared to the threshold of normal eye position. In addition, we use some geometrical features of the eyes in the final step to reject the false detection. So for detection we do not uses geometrical facial features and we rather use them for verification purpose.

Mouth Detection

In this phase, the location of mouth is identified on the basis of colour information. Also the lips location is finding for measuring yawn state. For this purpose mouth area will be segmented in the face. In the mouth region, the red colour component is the strongest component while the blue component is weakest [ii]. Mouth detection is based on colour information. In our method, difference between face colour and lips colour is used. The following equations are used to generate the mouth detection (map).

$$\text{Mouth\_map} = (C_r)^2 \times \left((C_r)^2 - \frac{\eta \times C_r}{C_b} \right)^2$$

$$\eta = 0.95 \frac{\frac{1}{n} \sum_{(x,y)} C_r(x,y)^2}{\frac{1}{n} \sum_{(x,y)} \left(C_r(x,y) \big/ C_b(x,y) \right)} \qquad (5)$$

This detection done will be black and white regions to finding the largest connected component. In mouth detection geometrical features of the face and position of mouth with respect to eye can be exploited and verify the validity of the detected mouth.

Yawn Detection

In this phase, we detect the yawn mouth position. For this purpose various parameters are used. The yawning detection is based on non skin area that is hole in mouth while opening a mouth. When mouth start to open then threshold pixel value is also increases as compared to normal position of mouth which is nothing but yawning state. This is the first way of yawning detection. Also there is another way for yawning detection that checks the validity of detected component using mouth location. Also we assume relative location of the open mouth with respect to the lips.

III. Results

Figure shows the result of proposed system from database. In that we apply face detection on more than one image. Each image has various facial features like skin, colour, haircuts, beard, and eye glasses. The face detection done is depends on various algorithm that are insensitive to the changes in lighting condition, skin type and geometrical facial features. After performing face detection, face tracking is done. Detected face is used as an input for face tracking. Next step towards yawning detection is face track image is used for detection of eyes and mouth location. By using these detections, possibilities of yawning mouth is detected.

This whole procedure is shown in following figures: Figure 1 and Figure 2 [xiv].

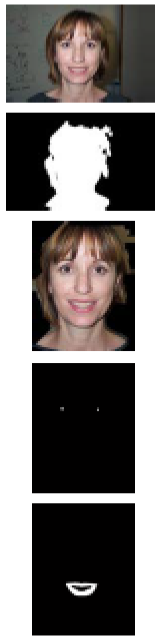

Figure 1: Face attributes detection

Figure 2: Yawning detection

IV. Conclusion

In this paper, we propose a method for driver drowsiness detection based on yawning detection. To train and test our method we capture number of video. System development based on more features including mouth features, eye features, skin type, and changes in lighting condition. It avoids false detection. By using proposed system we can prevent road accidents.

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