Eye Gesture Analysis for Prevention of Road Accidents

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Abstract— Around the globe, death is a daily occurrence mainly due to accidents. Research has been conducted intensively to attempt reduce accidents and extemporize the Driver Assistance System. The core idea for this paper is depicted through a process evolved to enhance effectively the Intelligent Driver assistance system and also a safety system to access the driver’s perspectives with vehicles. The system uses a dynamic CCD camera in the vehicle that observes the driver’s face. A prototype to match the approach is used to compare the Driver’s eye pattern with a set of existing templates of the driver gazing at various focal points inside the vehicle. The windscreen is further divided into segments and a comparison of the driver’s eye gaze pattern with the existing stencil determines the driver’s viewpoint on the windscreen. For instance, in case the driver is detected to be drowsy with closed eyelids for more than a few seconds then he will be alerted automatically.

I. Introduction

The increasing number of accidents is proportional to the driver’s take on the attributed monitoring. This corresponds to the Vigilance level. The lower the monitoring the greater the shift from healthy is driving to hazardous outcomes. This vigilance level affects the perceptions, attitudes and control abilities thereby posing a great threat to themselves and the people around them. Hence, developing a module to constantly watch the driver and incessantly alert him in case of any breach will effectively reduce the number of accidents. In correspondence to this regard, voluminous efforts have been made to developing an active system that ensures safety and effectively reduce the accident levels. The classification for stupor in drivers is as follows:-

1. Sensing of physiological characteristics.
2. Sensing of driver operation
4. Monitoring the response of driver

Accidents or Road hassles are a major problem in this fast pacing world of today. The Global Status Report on Road safety published in 2013, a statistics from 182 countries, accounting for 99% of the world population indicates that total number of deaths in accidents remain as high as 1.24 million per year. Only 7% of the total population has comprehensive and effective road safety rules enforced. Vehicle congestion, road infrastructure and social interaction while driving leads to traffic around the globe. And unfortunately humans tend to be the main source and resource for road accidents. 99% of the accidents occur due to err of the common man. The first three categories consist of both passive and active components. Behavior alteration or attitude amendment is due to information, education, driving instruction and enforcement in the dominion of active safety. The marginal cause can also pertain to government’s enforcement that do not last long. This paper elucidates on the fact that eye-gesture templates matched to the driver’s eye to determine the driver’s viewpoint on the windscreen. Research indicates that gesture recognition techniques can in fact determine the perspective as of the driver with accuracy that suffices to prevent hazardous events.

II. EYE GESTURES

A. Drowsiness

Visual cues like yawn frequency, blinking of the eye, gaze rate, head movements and nonverbal expressions aids detect drowsiness in the driver. Integral aspects are considered to make an efficient observation and stimulated response based on the integral image, Ada Boost technique and cascade classifier.[2] Followed by using the region of interest on the face thereby minimizing the search area for finding the eyes. Anthropometric property techniques are implied to detect the eyes and the exact position is detected by collaborating information from the grey level pixels. This is followed by a mathematical equation to generate random samples of the eyes indicating the exact state of the eye (whether opened or closed). In order to identify whether they eyes being closed or opened the classification technique (support Vector Machine) is used. The drowsiness is detected by the percentage of eye closed and this eye position generated helps determine the driver’s face orientation. Thereby, initiating an alert if the driver’s eyes are closed

Fig. 1: classification technique

B. Driver Attention

Facial features and eyelid movements are the two most important factors used to assess poor driver behavior. A face model that is anthropometrical is used to identify prominent facial features. The image is made robust using few image processing techniques. Effectively to identify facial features from different angles of head pose the Kalman filter is used, which is detailed to have a technique that detects the face by the skin pixels on the image. The color skin histogram technique that used to obtain samples from various scenarios chooses the skin region manually and computes a normalized skin color histogram to validate the RGB-space.
Information such as percentage and duration of the eye closure, nodding and blinking frequency, face orientation and eye gaze is obtained in order to measure the driver drowsiness from PERCLOS.[2] The device is developed by Seeing Machine which is comprised three drowsiness metrics. They are proportion of time the eyes were closed at least 70%: the time the eyes were closed at least 80% and EYEMEAS (EM) where mean square percentage of eye closure rating measured. Using a fuzzy classifier the parameters are fused together to segregate the level of driver’s negligence plus to increase the performance of detection.

C. Driver Distraction

Driver distraction occurs due to various reasons during the driving period. It can be either picking up the phone, texting or other distractions like music, PDA devices etc. A few techniques have been employed to assure total attention of the driver and indicate distraction. This information is composed based on eye gaze, lips detection, head position etc. Driver’s distraction was deduced by researchers using rules based on gaze, head lane tracking data and by fusing them together with support vector machine classification technique. The Face Lab of Seeing Machines is applied to obtain the eye features of the driver. Face Lab is a device to calculate head rotation and analyses eye states (e.g. saccades, eye blinking, eye gaze direction etc.). The direction of the gaze and the positioning of the head determine the driver’s attention when he is not looking at the road. The output mapping also assists in indicating when the driver is engaged in division of attention. And most importantly it is able to generate the driver’s intent to changes lanes. The Kernel function used for mapping and the Support Vector Machine Algorithm to classify the driver’s behavior as a consequence of better adaption to timely changes.[2] The inference depicts that the eye gaze and rotation of the head obtained is sufficient to be employed in driver distraction system.

D. Eye Gesture Analysis

1) Head Rotation

While making an observation the driver rotates his or her head around the focal point. Consider x axis to be the horizontal coordinate with respect to y the vertical coordinate and if the head is at origin, the turning towards left or right side oscillates about the y axis. While driving the routine rotations are limited to the x axis and y axis.[2] Therefore the following extract will elucidate on x axis and y axis rotations. To begin this process, it is essential to capture eye-gesture templates of the driver in varied head poses and to select the appropriate template set upon an estimate of the rotation of the head followed by a calibration driver rotating over her head to face each of the 24 windscreen cells and a complete set of eye motion templates are taken for each head pose. For instance, the calibration driver rotates over her head facing a windscreen cell and eye-gesture templates captured of the driver looking at all 24 windscreen cells while keeping her head pose fixed. The 24 focal-points will consists of be 24 unique sets of eye-gesture templates with each set containing 24 templates. Under regular driving conditions, the driver’s head rotation is estimated by the methodology presented based upon estimating the 3D rotation of the head from relative positions of facial feature points in the 2D video image of the face capturing the templates and closing on the closest match.

2) Forward and Backward Displacements

The driver’s seat can be adjusted and hence the distance and the point of view for the driver can affect the accuracy of the reading of the point of regard. The point of regard deviates by (Δx, Δy) irrespective of the direction of movement i.e. forward or backward.[2] The change in distance Δd of the driver’s head from the point-of-regard element with respect to the calibration distance d and the viewing angle θ affects the value of the Δx and Δy. The pink head representing the calibration of the head position with d being the distance of the pink head from the windscreen. The blue head represents a backward displacement of Ad. The horizontal position x is representing the distance of the point of regard from the neutral, forward facing eye-gaze position and Δx represents the change in the point of regard resulting from the backward displacement of the driver’s head. The eye-gaze viewing angle remains the same in both the pink head position and the blue head position.

3) Horizontal and vertical displacements

To explain the horizontal and vertical displacements of the head from the standardized position, imagine that the driver’s head is within a 2d mapping grid, figure 2 illustrates an eye gesture mapping grid used to denote the mapping between eye gesture templates and the point of regard elements inside the vehicle as the driver changes his position horizontally or vertically. In the figure a grid of 64 cells is used and two drivers are shown. The pink driver is the shorter of the two drivers. Her right is located in cell (4, 5). If the pink driver is in the calibration position and her hear is in a neutral position, forward posing side. The pink driver’s left eye as she looks at the center of the point of regard elements(windscreen cells) creates the Eye gesture templates, there would be 24 corresponding eye templates calibrated for the pink driver’s left eye located in cell (4, 5) in the forward facing head pose.
As long as the pink driver’s left eye and an eye gesture template looking at a particular cell indicate that the she is looking at that windscreen cell.

However, this is not the case for the blue driver who is taller, positioned to the left of the pink driver. His left eye is located within cell (2, 4). A bout between the blue driver’s left eye and an eye gesture template looking at a particular windscreen cell may not necessarily indicate that the blue driver is actually looking at that windscreen cell due to the fact that his left eye is displaced one cell to the left and two cells above the calibration cell.[1]

If the driver’s left eye moves horizontally by $\Delta x$ and vertically by $\Delta y$ from the calibration position then the drivers point of regard on the windscreen or mirror will also move by $\Delta x$ and $\Delta y$ provided the drivers head movement is limited to the XY plane and the gaze direction remains unchanged. The Ni-DASS system will measure $\Delta x$ and $\Delta y$ in pixels in the video image from the on board CCD camera observing the drivers face. It is necessary to determine the scaling between the real world and the pixel displacements within the video. In order to calculate the real world displacement values, This can be achieved simply by measuring the height of the calibration of the driver’s head in the real world units and dividing by the length of the calibration driver’s head in pixels within the video.

III. IMPLEMENTATION

Once the eye gesture analysis is done (i.e.) once the different states of the driver’s eye have been analyzed, the driver’s attention has to be brought back towards driving to prevent accidents. If it is found that the driver’s eyes are closed for more than 3-4 seconds then an automatic alarm will be initiate which will bring back the driver’s attention towards driving.

Another idea is that, modifications can be made on the mechanics of the car. A system can be designed in such a way that if the alarm is initiated then automatic breaks come into action which will cause the speed of the moving car to be decelerated to an extent. The amount of speed to be decelerated will be designed along with the control system.

IV. FEATURES

A very frequent reason is the features tend to encode adhoc domain knowledge which is difficult to learn and requires extensive quantity of training data. In this case there is also another critical impetus for the features: being that feature based operates faster than pixel based. The simple features used are reminiscent of Haar basis functions which have been used by Papageorgiou et al.

More explicitly, we may use three kinds of features.[1] The value of a two-rectangle feature is the difference between the sum of the pixels within two rectangular regions. The sections have the same size and shape and are horizontally or vertically adjacent (see Figure 1). A three-rectangle feature computes the sum within two rectangular regions subtracted from the sum in a centre rectangle.[1] Finally a four-rectangle feature computes the difference between diagonal pairs of rectangles.

Fig. 3 shows relative to the enclosing detection window. The sums of the pixels which lie within the white rectangles are subtracted from the sum of pixels in the grey rectangles.

Two-rectangle features are shown in (A) and (B). Figure (C) shows a three-rectangle feature, and (D) a four-rectangle feature.

V. INTEGRAL IMAGE

Rectangular features can be computed very fast using an intermediate representation for the image which is called the integral image. The integral image at location $x,y$ contains the sum of the pixels above and to the left of $x,y$, inclusive:

$$i(x, y) = \sum_{x' \leq x, y' \leq y} i(x', y'),$$

Fig. 4

The sum of the pixels within rectangle D can be computed with four array references. The value of the integral image at location 1 is the sum of the pixels in rectangle A. The value at location 2 is $A + b$, at location 3 is $A+C$, and at location 4 is $A+B+C+D$. The sum within D can be computed as $4+1-(2+3)$.

VI. FACE DETECTION

The focus of the first feature seems to be on the provision that the region around the eye is often darker than the other facial fronts of nose and cheeks. This property is prominently large in comparison to detection with sub window and is slightly insensitive to the size or location of the face. The second feature selected dwells on the property that the eyes are darker than the bridge of the nose.

In fig. 3, the first and second features is selected by AdaBoost. The two features are shown in the top row and then overlaid on a typical training face in the bottom row.[1] The first feature measures the difference in intensity between the region of the eyes and a region across the upper cheeks. The feature capitalizes on the observation that the eye region is often darker than the cheeks. The second feature compares the intensities in the eye regions to the intensity across the bridge of the nose.
VII. CONCLUSION

This Intelligent Active System will effectively ensure a decrease in number of road accidents on average. Many other factors may also be taken into account like the speed of the vehicle and distance maintenance and lane management. However, eye-gesture analysis helps reduce the major road accidents.[1] The results infer that this approach might be best suited for point of regard situations in which determination of high accuracy is not crucial. Such situations would lead to hazard awareness systems where the ADAS system would alert the driver if he or she is failing to observe a hazard on the road by detecting situations when the driver is positively not paying attention.

REFERENCES