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TRACKING OF EYES TO DETECT THE DRIVER'S DROWSINESS

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ABSTARCT:
This paper describes a system used for monitoring the lack of attention of driver by analyzing visual clue and by predicting the level of alertness of the driver. The proposed system deals with the computation of Percent of Eyelid Closure (PERCLOS) as an indicator to detect driver's drowsiness. The lack of driver's concentration on road increased road accidents. Driver's fatigue and drowsiness are the major causes of traffic accidents on road. Monitoring the driver's vigilance level, and issuing an alert when he/she is not paying enough attention to the road is a promising way to reduce the accidents caused by driver factors. The system is fully automatic and continuously captures pictures of the driver face and each picture is then processed to detect the concentration level. If the concentration level of the driver is up to the mark the system continue its working, if the concentration level of the driver is not up to the mark i.e. driver might be sleeping, the system generates a loud sound to make driver more attentive for the driving. The concentration levels are checked by the picture of the driver and visuals identify the eyelid movement. Scheme firstly takes the image of the driver, after that it crops the eye image from the face. The eye image is then used to detect whether it is open or closed. The system continues the process for five times and if more than three times eye was closed, the system generates the warning indicating that the driver is sleeping.

Keywords: Driver's drowsiness, Fatigue, eyelid movement, Percent eye closure (PERCLOS), Visual clue.

1. INTRODUCTION

THE increasing number of traffic accidents due to a diminished driver's vigilance level has become a very serious problem for society now a days. In Europe, statistics show that between 10% and 20% of all the traffic accidents are due to drivers with a diminished vigilance level caused by drowsiness. In the trucking industry, about a 60% of fatal truck accidents are caused to driver drowsiness. It is the main cause for heavy truck crashes [1]. According to the U.S.A. National Highway Traffic Safety Administration (NHTSA), falling asleep while driving is responsible for at-least 100.000 automobile crashes annually. An annual average of roughly 40,000 nonfatal injuries and 1,550 fatalities results from this crashes. These crashes happen between the hours of midnight and 6 am, involve a single vehicle and a sober driver travelling alone, with the car leaving the roadway without any attempt to avoid the crash. Automatically detecting the visual attention level of drivers early enough to warm them about their lack of adequate visual attention due to fatigue may save a significant amount of lives and personal suffering. Therefore, it is important to explore the use of innovative technologies for solving the driver visual attention monitoring problem. Many efforts have been reported in the literature on developing non-intrusive real-time image-based fatigue monitoring systems [2]. Measuring fatigue in the workplace is a complex process. There are four kinds of measures that are typically used in measuring fatigue: physiological, behavioral, subjective self-report and performance measures [15]. An important physiological easure that has been studied to detect fatigue has been eyelid-movements. Several eyelid-movements were used to measure fatigue like blink rate, blink duration, long closure rate, blink amplitude, saccade rate and peak saccade velocity. An increasing popular method of detecting the presence of fatigue is the use of a measure called Percent of Eyelid Closure PERCLOS [15] .This measure attempts to detect the percentage of eye-lid closure as a measure of real time fatigue which is described in this paper. Scheme firstly takes the image of the driver, after that it crops the eye image from the face. The eye image is then used to detect whether it is open or closed based on Percent of Eyelid Closure. The system continues the process for five times and if more than three times eye was closed, the system generates the warning indicating that the driver is sleeping. This system consists of two steps. First step focus on a discussion of the computer vision algorithms and the hardware components that are necessary to extract the needed visual cues from the images. Second, after extracting these visual cues from the images, check for the driver vigilance by issuing the sensory data fusion and fatigue modeling and conclusion is discussed about driver alertness.

2. EYE DETECTION AND TRACKING

Fatigue monitoring starts with extracting visual parameters that typically characterize a person's level of vigilance. This is accomplished via a computer vision system. Computer vision system provides algorithms and tools for the design and simulation of computer vision and video processing system. In this section, we discuss the computer vision system we developed to achieve this goal. Fig.1 provides an overview of our visual-cue extraction system for driver-fatigue monitoring. The system consists of camera: focusing on the face. The system starts with eye detection and tracking. The goal of eye detection and tracking is for subsequent eyelid-movement monitoring. A robust, accurate, and real-time eye tracker is therefore crucial. In this research, we propose real-time robust methods for eye tracking under variable lighting conditions and facial orientations, based on combining the appearance-based methods and the active infrared (IR) illumination approach. Combining the respective strengths of different complementary techniques and overcoming their shortcomings, the proposed method uses active IR illumination to brighten subject's faces to produce the bright pupil effect. The bright pupil effect and appearance of eyes (statistic distribution based on eye patterns) are utilized simultaneously for eyes' detection and tracking.

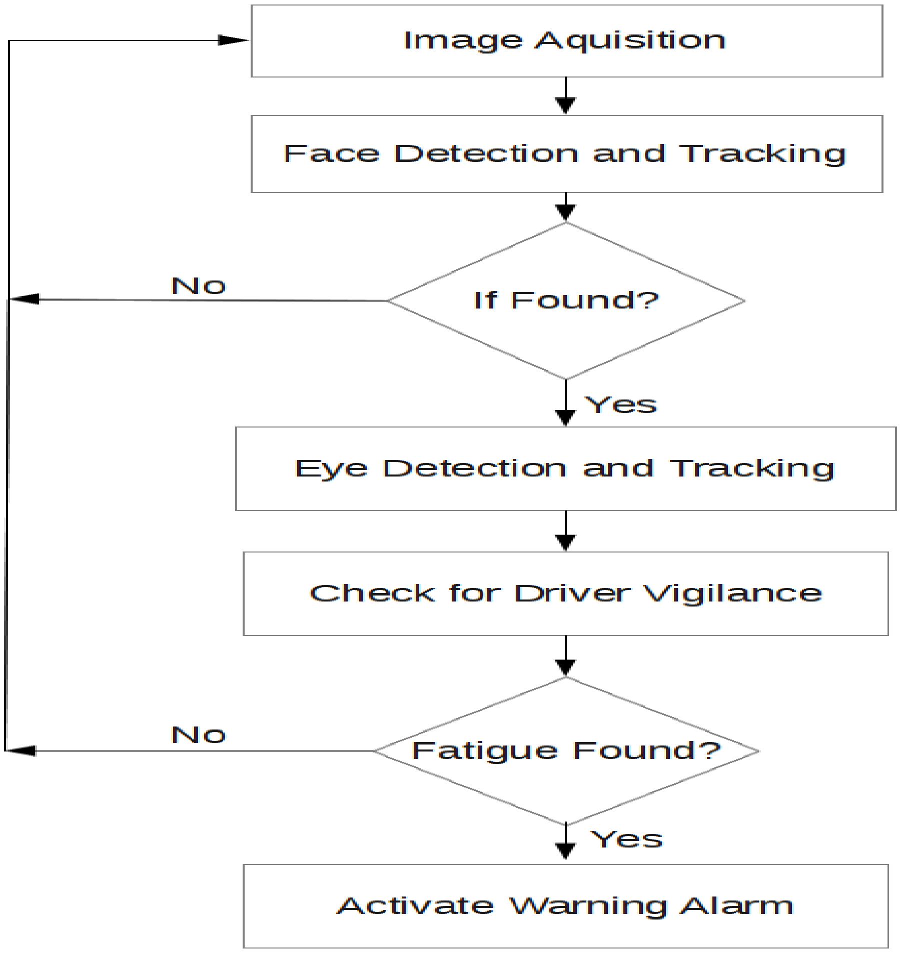

Fig. 1. Flowchart of the proposed Driver's fatigue and drowsiness detection system

2.1. IMAGE-ACQUISITION SYSTEM

Image understanding of visual behaviors starts with image acquisition. The purpose of image acquisition is to acquire the video images of the driver's face in real time. We can use The IR illuminator which serves three purposes. First, it minimizes the impact of different ambient light conditions, therefore ensuring image quality under varying real-world conditions including poor illumination, day, and night. Second, it allows us to produce the bright/dark pupil effect, which constitutes the foundation for detection and tracking of the proposed visual cues. Third, since near IR is barely visible to the driver, this will minimize any interference with the driver's driving. Specifically, our IR illuminator consists of two sets of IR light-emitting diodes (LEDs), distributed evenly and symmetrically along the circumference of two coplanar concentric rings. The center of both rings coincides with the camera optical axis. These IR LEDs will emit non coherent IR energy in the 800–900-nm region of the spectrum. The bright pupil image is produced when the inner ring of IR LEDs is turned on and the dark pupil image is produced when the outer ring is turned on, which is controlled via a video decoder. An example of the bright/dark pupils is given. Note that the glint, the small bright spot near the pupil, produced by cornea reflection of the IR light, appears on both the dark and bright pupil images.

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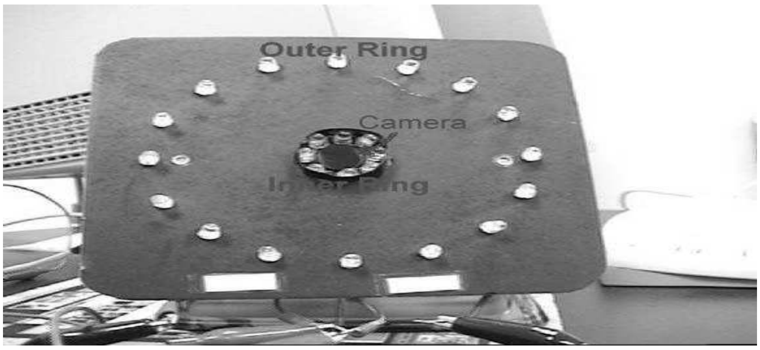


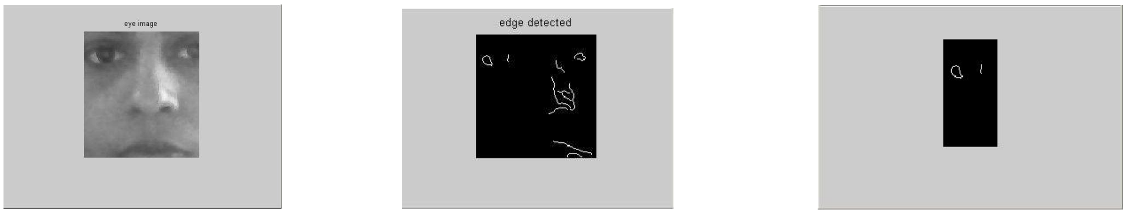
Fig. 2 Actual Photograph of the Two-Ring IR Illuminator Configuration

2.2 EYE DETECTION ALGORITHM

Eye-tracking starts with eyes detection. Fig. 1 gives a flowchart of the eye-detection procedure. Eye-detection is accomplished via pupil detection due to the use of active IR illumination. To detect the eyes are whether open or close was a quite challenging task.. We can use edge detection method for detecting the edges of eyes in which edges are based on the white pixels. Many different approaches were implemented for the detection of the status of the eyes. Some of them are listed below: we can find edges of eyes in images using Sobel, Prewitt, Roberts, or Canny method. Edge detection is an essential preprocessing step in many computer vision algorithms. Within this project we implement one of these methods, the Canny Edge Detector. The Canny edge detector is a popular method for detecting edges that begins by smoothing an image by convolving it with a Gaussian of a given sigma value. Based on the smoothed image, derivatives in both the x and y direction are computed; these in turn are used to compute the gradient magnitude of the image. Once the gradient magnitude of the image has been computed, a process called 'non maximum suppression' is performed; in which pixels are suppressed if they do not constitute a local maximum. The final step in the canny edge detector is the hysteresis operator, in which pixels are marked as either edges, non edges and in-between, this is done based on threshold values. The next step is to consider each of the pixels that are in-between, if they are connected to edge pixels these are marked as edge pixels as well. The result of this edge detector is a binary image in which the white pixels closely approximate the true edges of the original image. We have implemented the canny edge detector in Matlab.

Sample results of Eye detection and boundaries for open –eye driver's face using canny edge detection method are shown in Fig.3.

(a) (b)

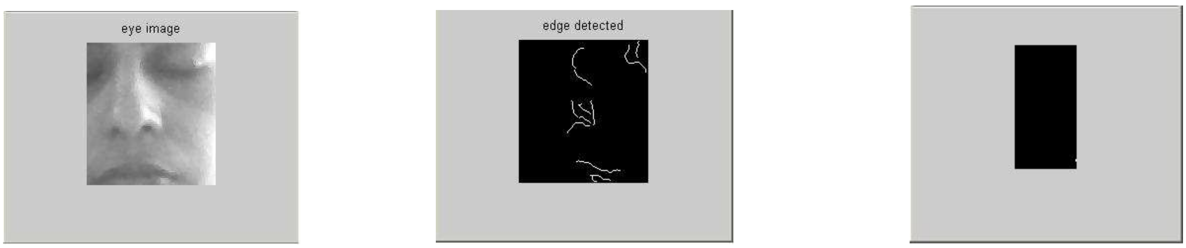


(c) (d) (e)

Fig. 3 a) An input RGB image b) Differential Image c) Face detection d) Edge detection using Canny edge detection method e) Left eye edge detection using Canny edge detection method

Sample results of Eye detection and boundaries for closed –eye driver's face using Canny edge detection method are shown in Fig. 4.

(a) (b)



(c) (d) (e)

Fig. 4 a) An input RGB image b) Differential Image c) Face detection d) Edge detection using Canny edge detection method e) Left eye edge detection using Canny edge detection method

Because distance of eyelid in the corner of eyes is small so these lines here are more than the lines in the middle of eyes. As we know the eyes to be found in the top middle of face means 3/5 of the face. According to our ability to recognize eyes state from one of them, so we can crop images from the middle and search exact eye location in this area. Now in this area just eyebrow and eye exist. The decision on whether the driver's eye is closed or not is based on the percentage of eye closure .In this current work the eye closure calculation is performed over the left eye. First the edges of the eye are detected by using Canny detection method using a threshold of 0.5. The result of Canny detection method is a binary image which is then used for further processing. Then the percentage of eye closure is calculated programmatically based on the detected white pixel.

A predefined closure percentage of 60% is used as the threshold for drowsiness level. If the percentage of eye closure is found to be more than or equal to 60% then the system considers that the driver is feeling drowsiness.

3. RESULTS

The system is currently running on PC Pentium IV (1, 8 GHz) in real time (50 fields-25 frames/s) with a resolution of 400x320 pixels. The prototype has been implemented and experiments have been performed on specimen images of different driver faces and the initial results are very motivation the system is avail to successfully detect eye position and capture the percentage of eye closure (PERCLOS). While performing this experiments the camera was placed at distance of 30cm minimum to70 cm maximum from driver's eye otherwise problem will arise. And the ambient light was varied for different illumination intensity.

IV. CONCLUSION AND FUTURE EXTENSIONS

Through research presented in this paper, we developed an Non-intrusive prototype computer vision system for real-time monitoring of a driver's vigilance. First, the necessary hardware and imaging algorithms are developed to simultaneously extract visual cue that typically characterize a person's level of fatigue. The initial experimental results are very encouraging but there are some issues to be addressed such as range of ambient light for which the system may work properly should be increased, the position of the camera in terms of distance and orientation from the driver's face should not effect the results. Another point of optimization for this system is the execution time of the system. This execution time includes two components. First the time taken to capture the image and second the response time taken to detect the percentage of eye closure. Further the research is been carried out to add these issues and optimize the system in terms of execution time. The authors are working to interface it with the hardware components that will activate a driver alarm when the percentage of eye closure is detected to be below the mentioned threshold. Efforts are being made to design the system in such a way that after activating the alarm and receives no response from the driver the system will automatically trigger a microcontroller based braking system that will take control of the vehicle and will perform as programmed.

5. ACKNOWLEDGEMENT

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