Eye State and Head Position Technique for Driver Drowsiness Detection

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Abstract - Many Driver Drowsiness Detection systems have been developed using eye and face detection methods but in this paper we have advanced the previous systems by adding the concept of head position technique. Till now none of the systems developed, have used the head position of the driver to detect the drowsiness, every paper have focused only on the face and eye detection concept. The head position technique is a newly introduced feature which enhances the performance of the system to a great extent. The systems capture frame and detects the face and eyes using HAAR-like classifiers, if the face is detected and eyes are closed then head position is monitored for next few frames, if the face is aligning down gradually and continuously then the alarm is activated.

Keywords –Head position technique, drowsiness detection and HAAR-like classifiers.

I. INTRODUCTION

Most of the road tragedies occur due to driver’s carelessness while feeling drowsy. This topic is subject of research from past few years. There are two basic techniques through which drowsiness of person can be detected. One includes physical monitoring devices attached to body which keeps a check on physiological signals including brain waves, blood pressure, heart rate and body alignment. The other one is done by using image processing, frames of the driver’s face is captured and image processing is applied to check whether eyes of the driver are open or closed. There have been many researches in this field, BUT all are based on mainly eye and face detection. Here we have introduced a new feature “Head Position Technique”, which enhances the performance of the present systems. Apart from detecting the state of eyes this system will also include the position of head as major criteria to detect the drowsiness of the driver.

Apart from decreasing the rate of false detection of the previous system we have also introduced the “head position technique (HPT)” in the present algorithm, which increases the reliability and performance of the system. The HPT works on the fact that any person when feeling drowsy while sitting leans forward and his head position moves continuously downwards. We have added few computations in our advanced algorithm to detect whether the head position is descending gradually and continuously then alarm is activated.

The rest of the paper is organized as follows: Literature survey is given in section II, HAAR like features are explained in section III. The Proposed algorithm is explained in section IV. Experimental simulated results are presented in section V. Concluding remarks are given in section VI.

II. LITERATURE SURVEY

Recalling the history, in 2002 Ji and Yang [1] (2002) has presented a detection drowsiness system based on infrared light illumination and stereo vision. This system localizes the eye position using image differences based on the bright pupil effect. Afterwards, this system computes the blind eyelid frequency and eye gaze to build two drowsiness indices: PERCLOS and AECS. Bergasa and his colleagues [2] in 2004 developed a non-intrusive system that also used infrared light illumination, this system computes driver vigilance level using finite state automata with six eye states that computes several indices, among them, PERCLOS; on the other hand, the system is able to detect inattention through face pose. Horng et al.[3] (2004) has shown a system that uses a skin color model over © space...
for face detection, edge information for eye localization and dynamical template matching for eye tracking. Using color information of eyeballs, it identifies the eye state and computes the driver’s state. Brandt et al. [4] (2004) has shown a system that monitors the driver fatigue and inattention. For this task, he has used VJ method to detect the driver’s face. Using the optical flow algorithm over eyes and head this system is able to compute the driver state. Tian and Qin [5] (2005) have built a system for verifying the driver’s eye state. Their system uses Cb and Cr components of the YcbCr color space; with vertical projection function this system localizes the face region and with horizontal projection function it localizes the eye region. Once the eyes are localized the system computes eye state using a complexity function. Dong and Wu [6] (2005) have presented a system for driver fatigue detection, which uses a skin color model based on bi-variate Normal distribution and Cb and Cr components of the YcbCr color space. After localizing the eyes, it computes the fatigue index utilizing the eyelid distance to classify between open eyes and closed eyes. Marco, José and Arturo [7] proposed a system to detect the driver’s drowsiness which worked on gray scale images taken with the camera inside the IvvI (Intelligent Vehicle based on Visual Information) vehicle.

Pia M. Forsmana, Bryan J. Vila [8], in January 2013 proposed a method for detecting driver drowsiness at more moderate levels of fatigue with consideration that Lane variability is an important metric of drowsy or otherwise unsafe driving. They simulated their model on 29 subjects for day, afternoon and night shifts. This model is basically the first steps toward developing a more comprehensive driver drowsiness detection system that is sensitive before fatigue levels become critical. Their result is taken on two variance i.e. steering variability and lane variability. They found that the lane variability factor scores increased more toward the end of the night shift than toward the end of the day shift. Also the steering variability factor scores increased toward the end of the night shift but decreased toward the end of the day shift. This finding implies sensitivity to moderate levels of fatigue. They demonstrated that the transfer function between steering wheel input and change in lateral lane position can be used effectively to estimate the relative changes in lateral lane position based solely on the steering wheel angle.

Pallavi M, S. Gawali [9] in 2012 their research paper demonstrated the new non-intrusive approach for monitoring driver drowsiness depending on the driver and driving data fusion. They use percentage of eye closure (PERCLOS) model for estimating driver status. The driving information such as lateral position and steering wheel angle also use for drowsiness detection. Multilayer perceptron neural network has been trained for optimal performance score in this research paper. In their research they presented a real-time, nonintrusive driver drowsiness detection system by building biosensors on the vehicle steering wheel and driver’s seat to measure driver’s heart beat signals. Heart rate variability (HRV), a physiological signal that has set up links to waking/sleepiness stages, is analyzed from the heat beat pulse signals for the detection of driver drowsiness. This measurement of heat beat signal from biosensors on the steering wheel means this drowsiness detection system has almost no annoyance to the drivers, and the use of a physiological signal can ensure the drowsiness detection accuracy.

Arun S. and Kenneth S. [10] in 2012 write a review paper discussing the advantages and limitations of vision based, behavioral based and physiological sensor based measurement for drowsiness detection at last they proposed a hybrid approach to make measurements accurate. Below table lists the conclusion of their work done. Yong Du, Peijun Ma [11] in 2008 published a research paper on effective vision based driver fatigue detection method. In this at primary stage, the inter-frame difference approach binding color information is used to detect face. If face is exists, the face area is segmented from the image based on a mixed skin tone model. Then the process of crystallization is applied to obtain the location of eyes within face area. Later eye area, average height of the pupil and width to height ratio are used to analyze the eye’s status. Finally, the driver fatigue is confirmed by analyzing the changes of eye’s states. Marco Javier Flores and Jose Maria Armingol [7] in 2008 presented the basic model for drowsiness detection. For this they used Viola & Jones (VJ) method to detect the driver’s face. Once face is detected SVM is used to detect eye status from trained data. Although this approach is simple and effective but it gives many false result.

III. HAAR LIKE FEATURES

HAAR like features were introduced by Viola and Jones, they are digital image features used in object recognition which considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel
intensities in each region and calculates the difference between these sums. In the detection phase, a window of the target size is moved over the input image, and for each subsection of the image the Haar-like feature is calculated. This difference is then compared to a learned threshold that separates non-objects from objects. The key advantage of a Haar-like feature over most other features is its calculation speed. There are three main parts in which Haar like features work: Integral Image, Training the classifier and Cascading. An integral image can be obtained by computing the sum of two pixels above and to the left of the original pixel. The idea is to make a rectangle which is used as a feature for the comparison. There are 18 types of features. The rectangle shape is divided into two areas viz. black and white. First take the sum of the black and white individually. Then subtract the sum of white area from the black area. The task of training the classifier includes the features selected by AdaBoost. AdaBoost is a learning algorithm which uses weak features for classification to form a strong classifier. The weak features are reweighted to correct the previous features [12].

A. Introduction:-
In the proposed algorithm, firstly we capture the frame from the camera and convert it into a gray scale form. Then we equalize the histogram to take care of really bright or really dark conditions. After that, face detection is performed, using HAAR like features. Using this technique, if face is detected then we set the center point of face and set ROI i.e. region of interest.

ROI is defined as a selected subset of samples within a dataset identified for a particular purpose. We have set the center point of face as ROI because for further computation we need to detect to the eyes of the driver. Once the ROI is set it checks for the eye status, simultaneously system checks for the head position in these frames, if eyes are found close AND the head is aligning down gradually and continuously then the alarm is activated.

B. Algorithm:-
Step: 1. Grab frames from mounted camera.
Step: 2. Repeat steps 2 to 12 for each frame.
Step: 3. Convert frame into gray scale.
Step: 4. Equalize the histogram to take care of really bright or really dark conditions.
Step: 5. Detect driver face using trained Haar-feature template.
Step: 6. If face is found then
Step: 7. Get the face center point and set ROI.
Step: 8. Detect open eyes in defined ROI.
Step: 9. If face is found but eye state is close then.
Step: 10. Check if head position is aligning down gradually and continuously then
Step: 11. Check this situation for next continuous 5 frames if found same scenario then
Step: 12. Activate the alarm.

When we apply this proposed algorithm, our expected results will be in this form:

![Figure 2](image)

Figure 2 (a) Source Frame captured from camera (b) Converted Gray-scaleframe (c) Histogram equalization on the frame (d) Final frame detecting the states

V. EXPERIMENTAL RESULTS

The proposed algorithm is simulated on openCV 2.4 under Ubuntu 12.4 environment. The simulation has been done on 10 different people under different illumination and weather condition. The results are compared with the classical solution [11, 7] resulting in decreasing false detection rate to a negligible level.
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Figure 3 (a) Eyes closed but not drowsy (b) Normal state (c) Drowsy state

Figure 4. Drowsy state with head position gradually moving down

Figure 5. Simulated results of classical algorithm [11, 7] showing high false rate (a) Only one eye detected (b) Warning of drowsiness in normal state, (c) False detection (warning in open eyes state)

Figure 6. Simulation results of proposed algorithm with decreased false rate (a) Normal state (b) Drowsy state (c) Drowsy state (head going down gradually)

VII. CONCLUSION
As depicted by the simulated result, the proposed system is considerably more reliable than the previous systems; another additional benefit is the diminished false rate by judging against the conventional approach. Although the proper illumination remains a problem in our approach, but the overall operation and functioning is improved at the same time this method is highly non-intrusive. The future works include the further addition of measuring the
yawning frequencies to determine the drowsy state, and making the system more advance in responding to a less illuminated environment.

REFERENCE


