RESEARCH ARTICLE OPEN ACCESS

Smart System for Drowsiness and Accident Detection

Indu R. Nair, Nadiya Ebrahimkutty, Priyanka B.R., Sreeja M, Gopu Darsan
India

ABSTRACT

Driver fatigue is the major cause of traffic crashes and financial losses. Webcam based system is available which is not efficient. When there is quick head-movement there will be some false detection. At that time face detection fails. Steering wheel based drowsiness detection system, the false detection rate is more due to the odd angle of the steering wheel which makes the system inefficient. These limitations can be corrected by smartphone based drowsiness detection system. A Computer Vision and Mobile Technology using smartphones to monitor visual indicators of driver fatigue, allows the possibility of making fatigue detection system more affordable and portable. The proposed system is a user friendly smartphone-based Fatigue Detection System which can be applied for reducing the accidents caused due to drowsiness. Smartphone front camera is used to acquire live video of drivers to detect the Iris region for drowsiness detection and alert drivers about dangerous driving conditions and behavior. The system also provides facility to alert all contacts saved in the smartphone, if an accident happens.

***Keywords*:-** Computer Vision; Drowsiness detection; Face detection; Iris detection; Haar features

I. INTRODUCTION

Driver assistance systems improves the Road safety. On an average, every 30 second , one person dies somewhere in the world due to a car accidents.. Conservative estimates suggest that a high proportion of fatalities and injuries due to traffic accidents involve impaired drivers.

This is an effective driver fatigue monitoring system for Android mobiles. In this work various driver monitoring methods are explored for Android mobiles. An intelligent system for monitoring driver distraction and fatigue during travel using adaptive template matching and adaptive boosting is designed and implemented.

Sleepiness during driving is a major cause for road accidents. Many people thought that drunken driving is the serious cause of accidents

Due to lack of awareness in drowsy driving which is just fatal. It also deteriorates vigilance, concentration and alertness so that the ability to perform different consciousness-based activities (such as driving) is impaired, decreases awareness, reduces judgment and increases the risk of crashing. Other than drunken driving and rush driving, accidents due to drowsiness is more crucial because the driver is loses the consciousness which leads to serious injuries or death. Not only the people traveling in vehicles are the victims, the pedestrians will also get affected.

Experiments conducted on Android phone results in high accuracy of driver distraction is detected in different scenarios with different vehicles and camera locations. Image preprocessing is done to every frames to avoid noise obtained during video acquisition. A survey was conducted on various designs on drowsiness detection methods to reduce the accidents, which are implemented using Computer Vision as well as Image Processing which are related to each other. Image processing means processing the images, that means analyze the images and produce results for the further experiment. Computer Vision deals with extraction of high dimensional data from computers and converts it into symbolic notations or digital images or videos. In the view of engineering, it's main aim is to automate tasks that the human visual system can do whereas Image Processing use mathematical operations and any form of signal processing.

Here the input can be a image or a series of images, or a video. The various steps in drowsiness detection are image acquisition, face detection, eye area extraction, blink detection etc. Different experiments have been conducted which resulted in high accuracy of driver distraction in different camera locations and vehicles. A real time image processing and computer vision were implemented using Android Studio.

II. BACKGROUND STUDY

Angelos Amditis[1] etal proposed the adaptive lane keeping support system which addresses the development of a system that is able to deal with a large set of different traffic situations. The input to the system comes from cameras, which are supplemented by active sensors (such as radar and laser scanners) and vehicle dynamic data, digital road maps, and precise vehicle-positioning data.

The system is structured on a model-based approach with the use of vehicle-side technologies. Its decomposition is made in three layers: the perception layer, the decision layer, and the action layer. The perception layer consists of a sensor system and image processing. The basic input comes from cameras that are monitoring the road in front of the vehicle. The cameras are supplemented by vehicle CAN bus data, digital road maps, and precise vehicle positioning (GPS). Radar provides supplementary information that is integrated in the data-fusion module. The action layer comprises all system reactions in critical lane departure situations and involves the control of acoustic or/and haptic warning actuators, as well as an active steering actuator. The decision layer determines the current overall situation using a situation model with respect to the driver state, the actual driven maneuver, the environment, the lane, and the street condition. Based on the identified situation, the decision model determines the output to be sent to the actuator system. Input parameters are the most likely path (MLP) of the vehicle, the fused lane data, as well as the estimated future vehicle trajectory. Vehicle data like velocity, steering angle, and yaw rate are also integrated.A vision based method for detecting driver drowsiness and distraction in driver monitoring system is proposed by Jaeik Jo[2] etal.It presents a driver-monitoring systems that contains both drowsiness detection method and distraction detection method. Drowsiness involves a driver closing his eyes because of fatigue, and distraction involves a driver not paying sufficient attention to the road despite the presence of obstacles or people. Here an eye-detection algorithm is designed which combines adaptive boosting, adaptive template matching, and blob detection with eye validation. Also a novel eye state–detection algorithm that combines two techniques PCA and LDA is used. It consists of face-detection, head orientation– estimation, eye-detection, eye-state–detection, drowsiness-detection, and distraction-detection steps. The distraction and drowsiness are determined from the head pose of a driver. The driver-drowsiness level is measured as PERCLOS, which is the percentage of eye closure time during a certain time interval. Similarly, the distraction level is measured as PERLOOK, which is the percentage of time spent not looking ahead during a certain time interval. Here the computational cost of system can be decreased and also eyedetection errors and the consequent false alarms for drowsiness are decreased. The proposed system works during both day time and night time.

Kohji Murata[3] etal proposed the Noninvasive Biological Sensor System for Detection of Drunk Driving which presents a non-invasive system to detect individuals driving under the influence of alcohol by measuring biological signals. Here frequency time series analysis is used to to attempt to distinguish between normal and intoxicated states of a person as the basis of the sensing system.Here a seat incorporating an air pack sensor that can be attached to an existing automobile seat and reported the capabilities of this seat for non-invasive detection of impairment of a driver who has consumed alcohol. The sensor system in the seat has since been improved. Biological signals were detected from the back of the driver using the air-pack sensor, a noninvasive and non confining method. The extracted signal was defined as an air-pack pulsewave (AP-PW). An algorithm for the detection of alcohol-impaired driving was generated from investigations of the AP-PW. This paper tries to invent a novel system for monitoring drivers non-invasively and detecting the drivers‟ drinking after they start driving. It proposes a new algorithm of the frequency time series analysis to distinguish between the normal and intoxicated states of a person. Measurements of the AP-PW for 20 min also revealed differences due to the consumption of alcohol, suggesting that the AP-PW contains potential information to distinguish sobriety from intoxication.

A system that detect pedestrians using patterns of motion and appearance describes a pedestrian detection system was proposed by Paul Viola,Michael J. Jones and Daniel Snow[4] .It integrates intensity information with motion information. The human motion pattern is well known to be readily distinguishable from other sorts of motion. Here a detection style algorithm which combines motion and appearance information to build a robust model of walking humans is used. The system robustly detects pedestrians from a variety of viewpoints with a low false positive rate. The basis of the model is an extension of the rectangle filters to the motion domain. The advantage of these simple filters is their extremely low computation time. As a result, the pedestrian detector is very efficient.

In this system a detection style approach using information about motion as well as intensity information is described. The system is trained on full human figures and does not currently detect occluded or partial human figures. This paper include representation of image motion which is extremely efficient, and implement a state of the art pedestrian detection system which operates on low resolution images under difficult conditions . Detection style algorithms are fast, perform exhaustive search over the entire image at every scale, and are trained using large datasets to achieve high detection rates and very low false positive rates.

Zibo Li.[5] etal presents an advanced computer vision and mobile technology using smartphones to monitor visual indicators of driver fatigue, allowing the possibility of making fatigue detection systems more affordable and portable. This technology uses the front camera of a smartphone to Drowsiness capture images of drivers, and then uses advanced computer vision algorithms to detect and track the face and eye of the drivers. Head nod, head rotation and eye blinks are then detected as indicators of driver fatigue. A simulated driving study showed that drowsy drivers differed significantly in the frequency of head nod, head rotation and eye blinks, compared to when they were attentive. The smartphone-based fatigue detection technology may have important applications in reducing drowsiness-related traffic accidents and improving driving safety.

To reduce the risks of driver fatigue, we developed a smartphone based technology to monitor visual indicators of driver fatigue, including head nods, head rotations, and eye blinks. This smartphone based fatigue detection technology provides a portable and affordable alternative to existing fatigue detection systems.

Computer vision technology has a wide application in improving driving safety. Many safety technologies (such as fatigue detection system, forward collision warning system and lane departure warning system) rely on computer vision algorithms. However, most of the computer vision-based technologies need devoted cameras and computer processors, thus, making the price of the technologies too high to be affordable for average drivers. The invention of smartphones makes the processors and cameras much smaller in its size and more portable. Smartphone-based computer vision technologies for driving safety does not require additional equipment than the smartphones drivers already have. Thus, smartphone-based technologies are morelikely to be commonly adopted by average drivers and gain a wide popularity..

III. PROPOSED SYSTEM

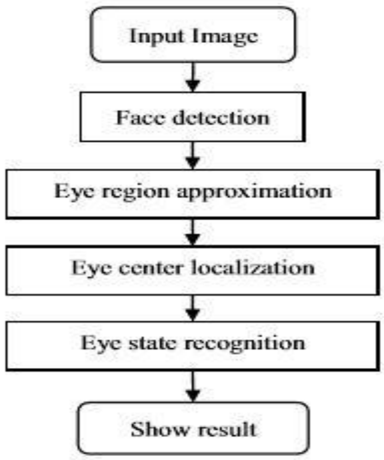
Driver Fatigue Detection System (called FDS) has been proposed by the author in a recent work. The FDS aims to monitor the driver and the alertness to prevent them from falling asleep at the wheel. In the present paper, the FDS software is modified Application is introduced to be run in smartphone instead of Laptop which is very hard to fixed in car and use all advantages of smartphone like camera and late weight. Application uses image processing technique and Snapdragon library which is a library in Qualcomm Company used to detect driver's fatigue state. Image processing realizes highly accurate and reliable detection of drowsiness. Also it offers a non-disturbing approach for detecting drowsiness without disturbed the driver. The developers have seen some of the popular image processing techniques. These techniques are: yawning detection, head nodding detection and eyelid movement.Yawning technique has several drawbacks such that lip positions are difficult to detect precisely. Head nodding technique also has many drawbacks which are: this method requires equipment to be attached by electrode to the vehicle operator, which can be intrusive. The operator performance has probably already declined to unsafe levels before the head nods forward in a fatigued sleepy state. The system detects drowsy state using eyelid movement technique.

This section explain the different algorithms used in Application system. 2.1.1 Face detection using Haar-like Classifier Cascades In this system the developers use Data Classification Mining technique for detecting face. Classification is "the task of assigning objects to one of several predefined categories". It is "the task of learning a target function (classification model) that maps each attribute set to one of the predefined class label". The classification model can serve as an explanatory tool to distinguish between object of different classes ". Figure 1 illustrates the face detection procedure used in the Application system.

For our methodology, it can be divided into 2 main parts as shown in Fig. 2 that is localization and recognition. In localization part, it is used for finding location of face, eye region, and eye center in the frame. For recognition, it uses cropped region around eye center to recognize eye state. The detail of each method will be shown following.

IV. FACE DETECTION

Face detection is the first step of FDS. This research uses Haar Cascade technique proposed by to detect and crop face region. This technique based on Haar features that represent in form of high and low intensity area as shown The presence of Haar feature is determined by subtracting the difference between high and low intensity area. If the difference is satisfied the condition, that feature is said to be present. To guarantee, ROI must be tested with so many Haar features (around 100 patterns).



To reduce false positive that may come from passenger, this system detects only the biggest face in the frame that is considered as driver face. However, this method can detect up right and frontal face. The result of this step is shown in Fig. 4 (b) as red rectangular box.

V. EYE DETECTION

A. Eye region approximation

Since human eye locations usually fix in human face detected by previous step. We approximate eye region based on height and width of human face by using Eq. (1).

$$E_X = 0.29 \times F_h, E_y = 0.125 \times F_w$$
$$E_h = 0.29 \times F_h, E_w = 0.33 \times F_w$$

where Ex and Ey are x and y coordinate of eye region, Eh, Ew, Fw, and Fh are width and height of eye region and face respectively as shown in Fig.4 (a). By using this technique, eyes are always in this region but different location for each person. The result of this step is shown in Fig. 4 (b) that is blue rectangular box.

B. Eye center localization

As shown in Fig. 4 (b), eye regions (blue box) are still too large for recognition (that has a lot time complexity). We need to reduce its area by cropping only area around the eye center. To localize the eye center, we adopted the method for localizing the eye center [9] and propose circular object detection by finding cosine angle between unit gradient vector UGV (gi) and distance vector (di) that can be calculated by Eqs. (2) and (3) on each candidate point. UGV has been proven by that it has same pattern for each luminance and distance vector is not intensity information at all. Therefore, this method is less effect to lighting conditions.

$$d_i = x_i - x_c$$

$$\cos\theta = \frac{d_i \cdot g_i}{\|d_i\| \|g_i\|}$$

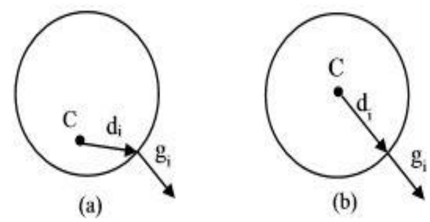


Fig. 5: distance and gradient vector of (a) non-center and (b) center of circle.

Fig. 5 (b) shows that if candidate point (c) is located at the center of circle, the distance vector and UGV will have same direction. It means that cosine between two vectors is almost 1 and lower value for other points (Fig. 5 (a)). The score of each candidate point (Sc) is calculated by Eq. (4) within blue rectangular box.

$$S_c = \sum \cos\theta / N$$

where N is number of pixel in the region of interest. The location of eye center is location that has maximum value Sc. After we get location of eye center, we will crop area around eye center for recognition in the next step. The cropped region is green rectangular box as shown in Fig. 6.

C. Eye state recognition

To recognize eye state, we use cropped region from previous step and use Eq. (4) again to make score (S). When eye is opened, eye pupil will appear and make value of S higher. For closed eye, S is dropped because there is no circle in that region. Therefore, we can threshold for classification to every frame. However, closed eye may have some small dark circle around the corner. Therefore, we use S at the center of green rectangular box in Fig.6.

After obtaining score, we can recognize eye by threshold the value of S. To reduce percentage of error, we use previous and current eye state result in TN millisecond by using Eq. (5) where tc is total time duration of closed eye state, number of frame recognize as closed eye state divided by frame rate, within period TN and P is percentage value for thresholding.

VI. NOTIFICATION

After the detection of drowsiness using the face and eye detection techniques, a warning is given to the driver in the form of an alarm noise, loud enough to wake the driver up. Default alarm of the mobile can be used as the alarm for the application. A timer is set after the driver is detected as drowsy, which is a very small value for producing the alarm as soon as possible. The alarm, continuously make noise till the driver wake up and put it off manually.

VII. ACCIDENT DETECTION

If the driver met with an accident before he wake up then the accident is also detected in this research by considering the movement of the mobile phone. If the phone shake rapidly or improperly or fall from a height. It is considered as an accident and a message is send to the predefined contact. A contact list is set with the contact numbers of friends or relatives to ensure them that the person is not in a condition to drive more so that they can make remedies for that. Since we cannot blame a person for being drowsy while driving as it is happening unknowingly. Alerting the friends or relatives along with the driver could be much effective in saving life.

VIII. EXPERIMENT RESULTS

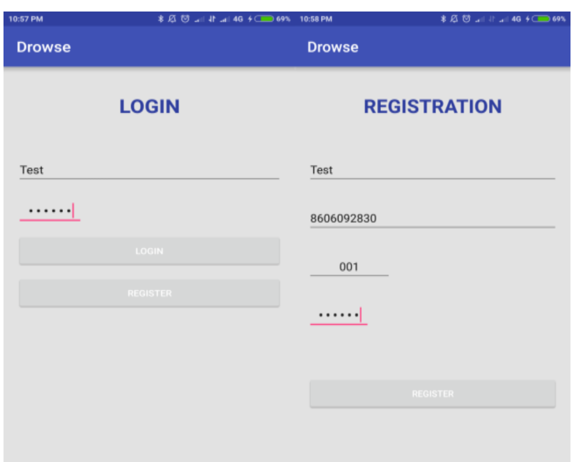


Fig.. Screen shots of login and registration page.

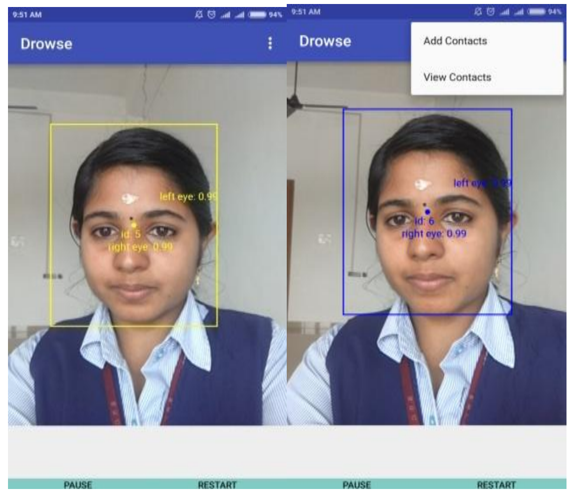


Fig.. Screenshots of face and iris detection.

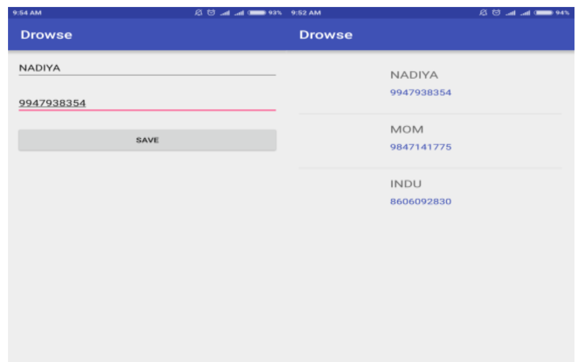


Fig..Screenshots of Addcontact andViewcontact.

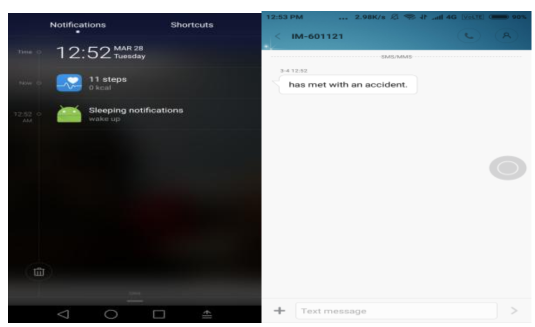


Fig.. Screenshots of notifications

IX. CONCLUSION AND FUTURE WORK

In this paper, we propose a drowsiness detection method using the cross-correlation between distance and gradient vectors. We first detect a human face based on the Haar features. The eye region can be approximately determined within the detected facial region. Within the eye region, we locate a dark circular object that corresponds to a pupil. Since the distance and gradient vectors are normalized in the computation of cross-correlation, the method works well regardless of the intensities of an input image. This helps to detect the pupil under various lighting conditions. The computational cost of the proposed method is low and it works at video rate. As future work, we plan to test the proposed method on more video sequences in more diversified lighting conditions.

ACKNOWLEDGMENT

We are deeply expressing our sincere gratitude to our project guide Prof. Gopu Darsan who always supported and guided us with valuable comments. We express our immense pleasure and thankfulness to all faculty members of the Department of Computer Science & Engineering of Sree Buddha College of Engineering, Alappuzha.

REFERENCES

[1] A. Amditis, M. Bimpas, G. Thomaidis, M. Tsogas, M. Netto, S.Mammar, A. Beutner, N. Möhler, T.Wirthgen, S. Zipser, A. Etemad,M. Da Lio, and R. Cicilloni, "A Situation-Adaptive Lane Keeping Support System: Overview of the SAFELANE approach", in *Proc. IEEE Trans. Intell. Transp. Syst.*, vol. 11, no. 3,September 2010.

[2] Jaeik Jo, Ho Gi Jung, Kang Ryoung, Jaihie Kim, "Vision –based method for detecting driver drowsiness and distraction in driver monitoring system", in *Proc. Optical Engineering*, vol . 15,no.12,December 2012.

[3] Kohji Murata, Etsunori Fujita, Shigeyuki Kojima, Shinitirou Maeda, Yumi Ogura, Tsutomu Kamei, Toshio Tsuji, "Noninvasive Biological Sensor System for Detection of Drunk Driving", in *Proc. IEEE Trans. Info. Tech. Biomedicine*, vol. 15, no. 1, January 2011.

[4] Paul Viola Michael J. Jones Daniel Snow,"Detecting Pedestrians Using Patterns of Motion and Appearance" , in *Proc. of the Ninth IEEE International Conference on Computer Vision (ICCV'03)* 0-7695-1950-4/03.

[5] Zibo Li, Guangmin Sun, Fan Zhang , Linan Jia, Kun Zheng, Dequn Zhao", "Smartphone Based Fatigue Detection System using Progressive Locating Method", in *Proc.IET Intell. Transp. Syst.*, pp. 1–9,January 2015.

[6] Bappaditya Mandal, Liyuan Li, Gang Sam Wang, and Jie Lin ,"Towards Detection of Bus Driver Fatigue Based on Robust Visual Analysis of Eye State", in *Proc. IEEE Trans. Intell. Transp. Syst.*, vol. 18, no. 3,March 2013.

[7] Behnoosh Hariri, Shabnam Abtahi, Shervin Shirmohammadi, Luc Martel., "Demo:Vision Based Smart in-Car Camera System for Driver Yawning Detection", in *Proc. IEEE Trans. Intell. Transp. Syst.*,2016.

[8] P. M. Forsman, B. J. Vila, R. A. Short, C. G. Mott, and H. P. A. van Dongen," Efficient Driver Drowsiness Detection at Moderate Levels of Drowsiness", *International Journal of Accident Analysis and Prevention*, page no:341-350, September 2012.

[9] Vandna Saini, Rekha Saini ,"Driver Drowsiness Detection System and Techniques: A Review*", in Proc of. IJCSIT* Vol. 5 (3) , 2014, 4245-4249.