Computer Vision Based Driver Drowsiness Detection System

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Abstract— Nowadays, The main reason for most of the accidents is driver drowsiness in the most of countries. Detecting the driver yawning and eye tiredness is the easiest way for measuring the drowsiness of driver. The existing systems in the literature survey, are providing slightly less accurate results due to low clarity in images and videos, sensor problems hardware problem. In order to solve this problem, a driver drowsiness detection system is proposed in this paper, which makes use of eye blink counts and yawn counts for detecting the drowsiness. The proposed framework continuously analyzes the eye and mouth movement of the driver and alerts the driver by sounding the alarm when he/she is drowsy. An alarm will be generated to warn the driver when the eyes are detected closed for too long time,. The proposed system is implemented on Python and uses OpenCV library, with a single camera view (Raspberry Pi/Webcam). It provides good performance by accurate drowsiness detection results and thereby reduces the road accidents.

Keywords: OpenCV, Eye Detection, Blink Count, Yawn Count, Image processing

I. INTRODUCTION

The motor vehicle's number in developing countries has been gradually increased over the decade. Official investigation reports of a high proportion of traffic accidents are due to dangerous driving behavior, such as drunk and drowsy driving. In further overview, many sleep-related vehicle accidents occur during the periods of around early morning and evening time, and it is often pointed out that night shifts make drivers particularly vulnerable.

Driver drowsiness is a serious problem which seriously reduce the response time and also decreases drivers awareness and judgment. The creation of a driver monitoring system capable of producing warning to the driver upon detecting signs of drowsiness can prevent road accidents and thus save lives. From another prospective, In computer science engineering, image processing gained popularity, selected fields which has impacted in multi dimensional way. If image processing technique are used for drowsiness detection, it can simultaneously reduce road accidents promise scheme which detect driver drowsiness with help of image processing parameters such as blink count and yawn counts.

II. MOTIVATION

A Drowsy Driver Detection system, traffic detection system, vehicle intrusion detection, are the new approaches for the automobile and security. In recent time's driver's fatigue connected crashes have very enlarged. so as to reduce these problems, I've incorporated driver alert system by continuously watching each the driver's eyes and mouth for the eye closure detection and yawning detection, using image processing and machine learning techniques

III. LITERATURE SURVEY

Seat Belt Vibration As A Stimulating Device For Awakening Drivers proposed by Satori Arimitsu et al. [1], presents a driving system with safety that uses a seat belt vibration as a stimulating device for awakening drivers. The vibration stimulus contains pulsation tension, which was applied by the seat belt motor retractor. Magnitude, duration, and repetition rate of the additional tension were the major parameters that determined the awakening effect of the stimulus. A driving simulator is constructed, which was able to induce driver's drowsiness. In the experiments using the driving simulator, the driver's drowsiness was detected by changes in the driver's eye movements measured by electrooculography (EOG) and/or changes in facial expression of the driver monitored by the examiners through a video camera, subjective evaluation, and lane deviation. Exerting additional tension of 130 N for 3 cycles at duration and interval of 100 ms was the most effective pattern for awakening the driver without causing discomfort.

Development of wireless brain computer interface with embedded multitask scheduling and its application on real-time driver's drowsiness detection and warning proposed by chin-teng lin et al. [2] presents biomedical signal monitoring systems have been rapidly advanced with electronic and information technologies in recent years. However, most of the existing physiological signal monitoring systems can only record the signals without the capability of automatic analysis. In this paper, proposed a novel brain–computer interface (BCI) system that can acquire and analyze electroencephalogram (EEG) signals in real-time to monitor human physiological as well as cognitive states, and, in turn, provide warning signals to the users when needed.

Noninvasive Biological Sensor System for Detection of Drunk Driving proposed by K Murata et.al [3] presents Systems capable of monitoring the biological condition of a driver and issuing warnings during instances of drowsiness have recently been studied. Moreover, many researchers have reported that biosignals, such as brain waves, pulsation waves, and heart beat are different between people who have and have not consumed alcohol. Currently, by measuring biosignals. In this paper, a new algorithm to distinguish between the normal and intoxicated state of a person is proposed as the basic theory of the sensing system. The most common factors in traffic accidents caused by human error are driving under the influence of alcohol, drowsiness and inattention, also known as the "Big Three". In order to research has been conducted on systems for monitoring drivers' biological signals such as EEG (sleepiness in driving) motor behavior, divided attention and/or mental workload under the influence of alcohol. But,

few reports have addressed non-invasive methods for monitoring the condition of a driver.

On-line detection of drowsiness using brain and visual information proposed by Antoine picot et al. [4] presents a drowsiness detection system using both brain and visual activity is presented in this paper. The brain activity is monitored using a single electroencephalographic (EEG) channel. An EEG-based drowsiness detector using diagnostic techniques and fuzzy logic is proposed. Visual activity is monitored through blinking detection and characterization. Blinking features are extracted from an electrooculographic (EOG) channel. Features are merged using fuzzy logic to create an EOG-based drowsiness detector. The features used by the EOG-based detector are voluntary restricted to the features that can be automatically extracted from a video analysis of the same accuracy. One major advantage of the system is that it does not have to be tuned for each driver.

Visual Analysis Of Eye State And Head Pose For Driver Alertness Monitoring proposed by Ralph Oyini Mbouna et al. [5] presents visual analysis of eye state and head pose (HP) for continuous monitoring of alertness of a vehicle driver. Most existing approaches to visual detection of nonalert driving patterns rely either on eye closure or head nodding angles to determine the driver drowsiness or distraction level. The proposed scheme uses visual features such as eye index (EI), pupil activity (PA), and HP to extract critical information on non alertness of a vehicle driver. EI determines if the eye is open, half closed, or closed from the ratio of pupil height and eye height. HP provides useful information on the lack of attention, particularly when the driver's eyes are not visible due to occlusion caused by large head movements. A support vector machine (SVM) classifies a sequence of video segments into alert or non alert driving events.

Overcoming drowsiness by inducing cardio respiratory phase synchronization proposed by issey takahashi et al. [6] presents drowsiness is one of the major factors leading to car accidents. Many automobile companies and institutions have been studying ways to monitor drowsiness and keep drivers awake. When drowsiness is detected during driving, audible sound, vibrations, or messages on a display are generally used to warn the driver to concentrate on driving or to take a rest. These methods help to prevent drowsiness-related crashes to some extent, but for greater safety, methods need to be developed to physiologically overcome drowsiness. The key to overcoming drowsiness is to keep the body constantly supplied with oxygen. They focused on cardio respiratory phase synchronization (CRPS) to recover from oxygen desaturation during drowsiness. This study found it possible to induce CRPS by paced breathing (PB) using pulse sound, which synchronized with heartbeats. The experiment results showed SpO2 measured from forehead increased during this PB. The increase in SpO2 was larger than that of yawns, deep breathing, or a period of drowsiness spontaneously reduced. In conclusion, inducing CRPS by PB using pulse sound synchronized with the heartbeat has the potential to reduce drowsiness physiologically.

Driver Assistance System with A Dual Control Scheme: Effectiveness of Identifying Driver Drowsiness and Preventing Lane Departure Accidents proposed by Yuichi Saito et al. [7], Driver drowsiness is a common cause of fatal traffic accidents. In this study, a driver assistance system with a dual control scheme is developed; it attempts to perform simultaneously the safety control of the vehicle and identification of the driver's state. The assistance system implements partial control in the event of lane departure and gives the driver the chance to voluntarily take the action needed. If the driver fails to implement the steering action needed within a limited time, the assistance system judges that "the driver's understanding of the given situation is incorrect" and executes the remaining control.

An Accurate ECG Based Transportation Safety Drowsiness Detection Scheme proposed by kwok tai chui et al. [8] presents many traffic injuries and deaths are caused by the drowsiness of drivers during driving. Existing drowsiness detection schemes are not accurate due to various reasons. To resolve this problem, an accurate driver drowsiness classifier (DDC) has been developed using an electrocardiogram genetic algorithm based support vector machine (ECG GA-SVM). In existing studies, a cross correlation kernel and a convolution kernel have both been applied for performing the classification. The DDC is designed by a Mercer kernel KDDC formed by commuting the cross correlation kernel (Kxcorr,ij) and the convolution kernel (Kconv,ij). Kxcorr,ij captures the symmetric information among ECG signals from different classes, while Kconv,ij captures the anti-symmetric information among ECG signals from the same class. The final KDDC (a pre-computed kernel) is obtained by a genetic mutation using a multi-objective genetic algorithm. The performance of KDDC is compared to the most prevailing kernels.

Vehicles Of The Future: A Survey of Research on Safety Issues proposed by cem bila et.al. [9] presents information and communication technologies (icts) have a profound impact on the current state and envisioned future of automobiles. Driver drowsiness is a serious hazard and major concern, which is identified as a direct or contributing cause in most of the road accidents. This paper presents an overview of research on ICT-based support and assistance services for the safety of future connected vehicles. A general classification and a brief description of the focus areas for research and development in this direction are given under the titles of vehicle detection road detection, lane detection, pedestrian detection, drowsiness detection, and collision avoidance. Following an overview and taxonomy of the reviewed research articles, a categorized literature survey of safety critical applications is presented in detail. Future research directions are also highlighted. The automotive industry has been continuously growing and transforming since its inception over two centuries ago. This transformation gained new ground in the last decade through significant developments in the information and communication technologies (ICT).

The use of ICT for novel vehicular applications causes disruptive changes in how automobiles are designed and used, which brought the automotive technology to the edge of fully autonomous driving. Indeed, some successful prototypes have already demonstrated hundreds of thousands of autonomously-driven miles. Nevertheless, putting aside the important law and regulation barriers in

their adoption, there are still important technological issues to be tackled by the driverless car technology to be able to operate smoothly in diverse environmental settings. Vision and sensor based safety mechanisms are the main enablers for automated or assisted driving, as we will cover in greater depth in this article.

Drowsiness Detection By Bayesian-Copula Discriminant Classifier Based On EEG Signals during daytime short nap proposed by D Qian et al. [10] presents daytime short nap involves individual physiological states including alertness and drowsiness. In order to have a better understanding of the periodical rhymes of physiological states and then promote a good interpretability of alertness, the aim of this study is to detect drowsiness during daytime short nap.

A method of Bayesian-Copula Discriminant Classifier (BCDC) was introduced to detect individual drowsiness based on the physiological features extracted from electroencephalogram (EEG) signals. As an extension of traditional Bayesian decision theory, the BCDC method tries to construct the class-conditional probability density functions by exploiting the theory of copula and kernel density estimation.

The BCDC method was validated with experimental dataset for drowsiness detection. This method is likely to be a useful tool to improve the correctness of the estimated class-conditional probability density functions. Since features are extracted from spontaneous EEG recordings, the results can be further generalized to other experimental environment to detect vigilance level or driver drowsiness.

To, summarize, existing system are providing slightly less accuracy results due to low clarity image and videos, which results for variation in the camera position. To overcome these problems the proposed paper introduces drowsiness detection which are shape predictor algorithm detects the eyes of a person, and also counts the eye blink of the driver to avoid the accidents.

IV. PROPOSED SYSTEM

The Proposed System analyses visual based features, specifically eyes and mouth to detect drowsiness. It is due the less practicality of implementing the monitoring of physiological reactions. Also Monitoring of sleep and alarm triggering only leads to alert driver after accidents occurred. So Yawn detection is also implemented, it can be a early detection of drowsiness and alert the driver if he/she is yawning before the event occurring. The Shape predictor algorithm detects the eyes and mouth of a person, and also counts the eye blink, yawn detection's. Architecture diagram is shown in Fig. 4.

A. Image Pre-Processing

Video feed can be captured using Raspberry Pi Cam/ Webcam. 25 frames per second(fps) is the processing rate of the acquired video. These frames are then flipped and then Convert to gray-scale.

B. Face and Eye Detection

Face Detection is a vital step of drowsiness detection. Video frames from a camera are splitted into a series of images. For the face Detection, it uses Haar feature-based cascade classifiers, an efficient object detection method proposed by Paul Viola and Michael. It uses machine learning based approach and lot of positive and negative images trained for cascade function development. This cascade function can be used to detect objects in other images. Eye detection is the process of detecting eyes using facial landmarks. They have been also applied to detect face alignment, head pose estimation, face swapping, blink detection and much more techniques.

C. Facial mapping

In the context of facial mapping, our goal is to detect important facial structures on the face using shape prediction methods. Dlib python library is used to implement the facial mapping using a landmark's facial detector with pre-trained models. It uses the 68-point iBUG 300 dataset was used to train the dlib facial landmark predictor, the Source of the mapping. It is shown in Fig. 3.

D. Eye state and closure detection

In this step, the landmarks of eye points are detected for each frame in captured video. The eye aspect ratio (EAR) between height and width of the eye is calculated. Then calculated EAR for both eyes is averaged to get a mean value. Eye aspect ratio (EAR) is a parameter for measuring state of eye(closed or open). The equation (4.1) is given below.

$$EAR = (\|p2 - p6\| + \|p3 - p5\|) / 2\|p1 - p4\| \quad (4.1)$$

where p1, . . ., p6 are the 2D landmark locations. when an eye is in open state, the calculated EAR is some constant value and is getting near zero, when an eye is closed. Landmarks is shown in Fig.1 and Fig.2 for open eye and closed eye respectively. It is partially person and head pose insensitive. Eye Aspect ratio of the open eye encompasses a small variation among persons to persons, and it is fully invariant to a standardized scaling of the image and in-plane rotation of the face.

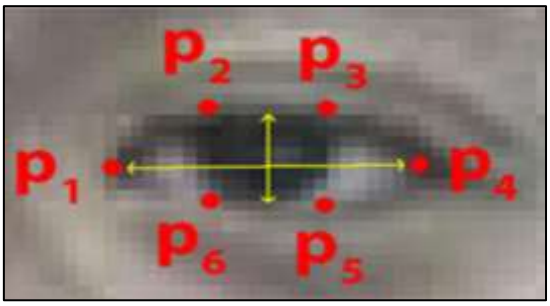

Fig. 1: Open Eyes with landmarks

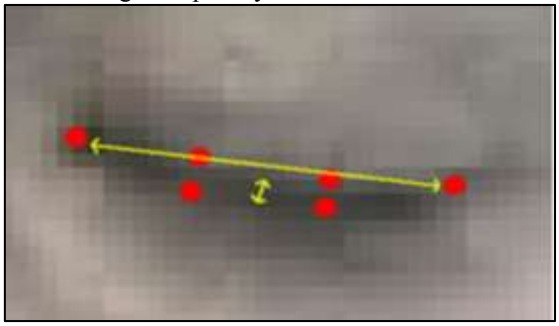

Fig. 2: Closed Eyes with landmarks

Fig. 3: Landmarks as depicted by dlib facial predictor

Recognition of Eyes State is very extremely necessary and crucial step in this system. The eye area can be estimated from video, by sparse tracking or by differencing and adaptive thresholding.

Finally, Eye State Determination is made based on EAR calculated in the previous step. If the distance is zero or near to zero, the eye state is classified as "closed" otherwise the eye state is classified as "open". The classifiers by support vector machine algorithm on this stage that help in decision making with respect to drowsiness. It detects drowsiness with the aid of parameters weighting. The eye-image is first converted into grey-scale and then the eye-image will be classified using a machine learning classifier to detect whether it was opened or closed. The normal blinking per minute of a person is roughly 10 times.

E. Yawn Detection

The facial landmarks are also used to detect an open mouth of driver. Lip distance is the parameter to evaluate yawning. It is calculated taking absolute of mean of euclidean distance between top lip points and low lip points. If calculated Lip distance is above lip distance threshold, yawning detected.

F. Drowsiness Detection

The algorithm's last step is to find out the person's condition based on a preset condition for drowsiness. 100-400 milliseconds is the average blink duration of person in general. So to say a person is drowsy, if his/her eye closure must be beyond this interval. If the eyes stays in closed state for presetted time frame value, drowsiness is detected and alarm regarding this is triggered. An alarm is also raised when subject has yawned more than a threshold. In real life, there are small openings that are created as a result of talking, eating are ignored.

V. IMPLEMENTATION

The drowsiness detection implemented using machine learning algorithms. Support Vector Machine (classification), Facial Action Coding System(FACS),Hidden Markov Model(HMM),Convolution Neural Network(CNN).

The Haar feature algorithm is used for face detection.

There is a Haar feature classifier to classify each feature. The input of this classifiers are captured face from video, output will be detected face. It also detects eyes area from this detected face. This eye area is sent to the machine learning algorithms for further machine learning processes.

SVM is used to identify whether the eyes are closed or open, and trigger the alarm when required. Facial Action Coding System (FACS) used to code facial expressions.

In FACS, 46 component movements are created by decomposing the facial expressions. These are corresponded to the number of an person's facial muscles. It can also capable of discovering new patterns based on emotional states.

Hidden Markov Model is a statistical model which makes predictions about hidden states and techniques for eye tracking based on color and geometrical features.

Convolutional Neural Networks provides more accurate results when compare with SVMs and HMMs. Voila and Jones algorithm can be used to detect faces Images are cropped to square images Fed to the first layer of the network that has filters. The output is passed further for classification. We only need one eye blinking information because we blink both the eyes together (Average of both eyes). So single eye closure are not considered. Similarly small openings of mouth are also ignored. This will save the memory usage only for required frames. All the method's programming is done in OpenCV Inbuilt, pre-trained classifiers for features like face, eyes and smiles.

In Setup, the driver is placed in front of the camera so that the face is in focus. The window displays the face and his eye and yawn rates and a message of the subject's state. An alarm is produced when the yawn count exceeds the set boundary parameter. Alarm is also sounded if the eyes are found to be closed. The testing of this technique is carried out on 25 persons. In all cases except for 5, the facial features(eyes, mouth, calculations) are accurately detected.

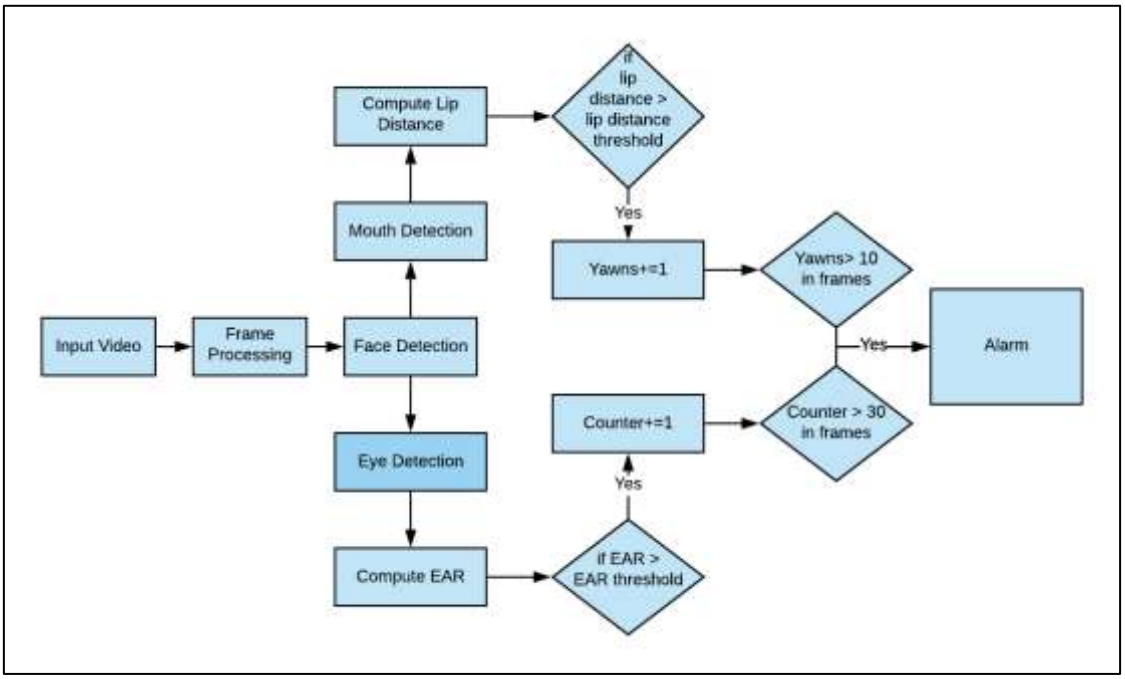

Fig. 4: Architecture diagram

VI. RESULT

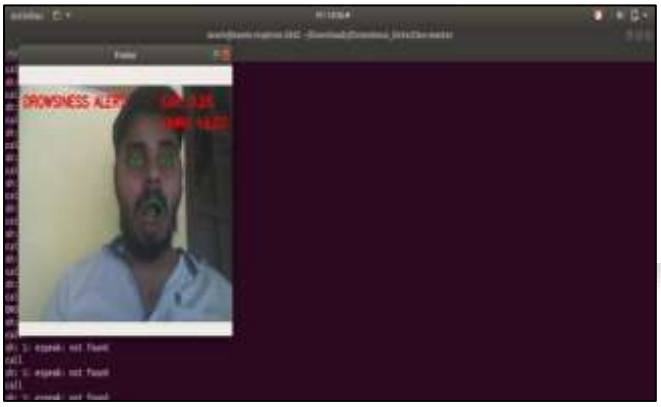

Fig. 5: Drowsiness Detected, With Eye and Yawn rates

Fig. 6: Yawn Alert, With Eye and Yawn rates.

The results are shown above Fig.5 shows drowsiness detection with eye and yawn rates and Fig.6 shows Yawn alert with eye and yawn rates.

VII. CONCLUSION

This paper introduces a drowsiness detection framework based on shape predictor algorithm that detects the eyes, mouths, and also counts the eye blink rate, yawn rate followed by drowsiness detection at real time. In the proposed system, the details about the eye status and mouth are obtained through image processing algorithms, which offer a non-invasive approach to detect drowsiness without any annoyance and interference. In future, the slowing the movement of vehicles can be also be implemented using same frame work for reducing accidents.

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