School of Computer Science and Engineering

J Component report

Programme : **Integrated M.TECH(Software Engineering)**

Course Title : **Digital Image Processing**

Course Code : **SWE1010**

Slot : **F1+TF1**

Title : **Driver Drowsiness Detection**

Team Members :

Vignesh Sankar J - 20MIS1028

Harish R - 20MIS1070

Sathish Kumar V - 20MIS1080

Faculty: GEETHA S

ABSTRACT:

Drowsy driving highly contributes to a number of road accidents throughout the years. Car crashes or any unwanted incidents can be avoided by implementing a system with alarm output to alert drowsy drivers to focus on the road. An intelligent system is developed to detect driver drowsiness and trigger an alarm to alert drivers as one way to prevent accidents, save money and reduce losses and sufferings. However, due to high variability of surrounding parameters, current techniques have several limitations. Bad lightings may affect the camera ability to accurately measure the face and the eye of the driver. This will affect the analysis using image processing technique due to late detection or no detection hence decrease the accuracy and efficiency of the technique. Several techniques have been studied and analyzed to conclude the best technique with the highest accuracy to detect driver drowsiness. In this work, a real-time system that utilizes computerized camera to automatically track and process driver’s eye using Python, dlib and OpenCV is proposed. The eye region of the driver is measured and calculated continuously to determine the drowsiness of the driver before triggering an output alarm to alert the driver.

INTRODUCTION

The attention position of the driver degrades because of lower sleep, long nonstop driving or any other medical condition like brain diseases etc. Several checks on road accidents say that around 30 percent of accidents are caused by fatigue of the motorist. When a driver drives for further than normal period for mortals also inordinate fatigue is caused and also results in frazzle which drives the motorist to sleepy condition or loss of knowledge.

Drowsiness is a complex miracle which states that there's a drop in cautions and conscious situations of the driver. Though there's no direct measure to descry the drowsiness, several other indirect approaches can be used for this purpose.

Due to the increase in the amount of automobiles in recent years, problems created by accidents have become more complex as well. The official investigation reports of traffic accidents point out those dangerous driving behaviors, such as drunk and drowsy driving, have taken a high proportion among all the accidents, it is necessary to develop an appropriate driver drowsiness and alertness system that can directly improve driving safety. However, several complicated issues are involved with keeping an eye on drivers all the time to wipe out all possible hazards. Driver fatigue is a significant factor in a large number of vehicle accidents. Recent statistics estimate that annually 1,200 deaths and 76,000 injuries can be attributed to fatigue related crashes. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Because of the hazard that drowsiness presents on the road, methods need to be developed for counteracting its effects. The aim of this paper is to develop an algorithm for drowsiness or alertness detection systems. The focus will be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes in real-time . By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car

The research work about driving drowsiness detection algorithm has great significance to improve traffic safety. Presently, there are many fruits and literature about driving drowsiness detection However, most of them are devoted to nd a universal drowsiness detection method,

accident. Detection of fatigue involves a sequence of images of a face, and the observation of eye movements and blink patterns. The analysis of face images is a popular research area with applications such as face recognition, virtual tools, and human identification security systems. This paper work is focused on the localization of the eyes, which involves looking at the entire image of the face, and determining the position of the eyes, by a proposing well image processing algorithm. Once the position of the eyes is located, the system is designed to determine whether the eyes are opened or closed, and detect fatigue. This paper proposes a computer vision based driver drowsiness system, use of OpenCV in image processing, interfacing of webcam to OpenCV, Haar classifiers like feature based face detection methods, eyelid identification, and developing alertness system using eyelid status to warn the driver accordingly by providing an alarm. while ignore the individual driver differences. This paper proposes a real-time driving drowsiness detection algorithm that considers the individual differences of driver. A deep

Drowsy driving highly contributes to a number of road accidents throughout the years. Car crashes or any unwanted incidents can be avoided by implementing a system with alarm output to alert drowsy drivers to focus on the road. An intelligent system is developed to detect driver drowsiness and trigger alarm to alert drivers as one way to prevent accidents, save money and reduce losses and sufferings. However, due to high variability of surrounding parameters, current techniques have several limitations. Bad lightings may affect camera ability to accurately measure the face and the eye of the driver. This will affect the analysis using image processing technique due to late detection or no detection hence decrease the accuracy and efficiency of the technique. Several techniques have been studied and analyzed to conclude the best technique with the highest accuracy to detect driver drowsiness. In this work, a real-time system that utilizes computerized camera to automatically track and process driver's eye using Python, dlib and OpenCV is proposed. The eye region of the driver is measured and calculated continuously to determine the drowsiness of the driver before triggering an output alarm to alert the driver.

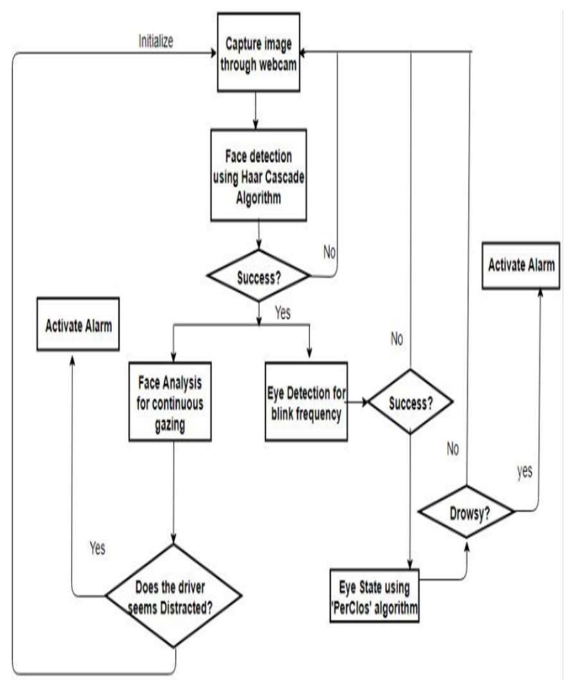
Deep learning approaches are steadily growing in popularity due to their ability to automate the feature selection and extraction process .Otherwise, it is done manually [39]–[42]. Also, models used in deep learning can not only extract features, but also learn from features with discernible quality that enable different purposes (i.e. classification, detection, segmentation). increase. Two examples of architectures used in Deep Learning are Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN). CNNs are typically trained for classification between images [43]–[46], consisting of convolutional layers to extract features from images, and finally a full conjunctive layers. So these models can be used to extract discriminative features between labels

In this study, we investigate the possibility of detecting the drowsy state in passive BCI from the drowsiness-induced hemodynamic response. Signals are measured from the prefrontal and dorsolateral prefrontal cortex brain regions. To do this, we use fNIRS to classify sleepy and sleepless states based on four windows. DNN and CNN deep learning architectures are used for feature extraction and evaluation. To our knowledge, this uses the right dorsolateral prefrontal cortex to classify the passive drowsiness and wakefulness states of drivers

using a deep learning architecture that provides very high real-time accuracy. First fNIRS study. In [49], a detailed review
of several algorithms of BCI was performed. The article mentions that deep learning algorithms such as recurrent neural network (RNN) and long short-term memory (LSTM)
may be more effective for BCI. Deep learning is suitable for detecting brain activity, such as detecting drowsiness, fatigue, etc. However, given the complexity of these algorithms, it is difficult to implement them for real-time scenarios.
From this point of view, the simpler methods DNN and CNN are used.
due to low computing power.

Methodology

This section describes a proposed approach to driver drowsiness detection that works on two levels. The application is installed on a device, a driver running the Android operating system (OS). The process starts by capturing a live image from your camera and sending it to your local server. On the server side, the Dlib library is used to detect facial features and a threshold is used to detect if the driver is drowsy. Then use these facial markers to calculate his EAR (Eye Aspect Ratio) and send it back to the driver.
In this context, his EAR value obtained at the end of the application is compared with a threshold of 0.52. If the EAR value is below the threshold, this indicates fatigue. When tired, the driver and his passengers are alerted by an alarm.



The following sections describe how each module works are

3.1. Data Procurement

To use the application, the driver registers the first time the application is used. After registration is complete, the driver adds her trip by entering the origin and destination of the trip. There is also an interface for passengers to connect to her ride added by the driver. Then the driver will start driving. The proposed application captures real-time images of drivers. Image is captured every time the application receives a response from the server. This process continues until the driver stops driving. A dataset of 50 volunteers was collected to test the efficiency of the proposed approach. Each participant was asked to blink intermittently while looked at the camera and obtained his EAR score. The resulting logs collected by the application were collected and analyzed using machine learning classifiers.

3.2 Facial Landmark Marking

To extract facial landmarks from the driver, the Dlib library was imported and deployed in our application. The library uses a pre-trained face detector, based on the modification of the directional gradient histogram, and uses a SVM (support vector machine) linear method for object detection. The actual facial landmarks predictor was then initialized, and the facial landmarks recorded by the app were used to calculate the distance between the points. These distances are used to calculate the EAR value. The EAR is defined as the ratio between the height and width of the eyes and is calculated using Equation 1. The numerator indicates the height of eyes and the denominator gives the width of the eye and details of all landmarks. of the eye is shown in figure below.

$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

Open eye will have more EAR

Closed eye will have less EAR

Referring to Equation 1, the numerator calculates the distance between the upper and lower eyelids. The denominator represents the horizontal eye distance of
. When the eyes are open, the counter value increases, increasing the EAR value, and when the closes the eyes, the counter value decreases, decreasing the EAR value. In this context, EAR values

are used to detect driver fatigue. Calculate the EAR values of left and right eyes and take the average value. For drowsiness detectors, eye aspect ratio monitors whether the value falls below the threshold and does not exceed the threshold again in the next
frames. The above state means that the person is in a sleepy state with their eyes closed. On the other hand, if the EAR value he returned to
, it means that the person just blinked and was not sleepy. Figure 2 shows a block diagram of the proposed approach for detecting driver drowsiness.

3.3 Classification

After collecting facial recognition points, the EAR value calculated by the server is received by the driver's Android device and compared to a previously set threshold of 0.25 (T. Soukupova and J. Cech, 2016) . If the value is less than the threshold, the counter value
is incremented. Otherwise, the counter value is reset to zero. An alarm is triggered on Android devices when the counter value reaches 3. In addition, another variable (sleep counter) is maintained that counts how often the EAR value falls below the threshold of 0.52. A variable (Total Counter) stores the total number of responses from the server side and is used to calculate the ECR (Eye Closure Ratio). Defined as the ratio of the sleep count and the total frame count (captured by the camera). When the frame number reaches
-16, the total counter is 1 and the idle counter is 0. When the ECR value exceeds a threshold (set to 0.5 in
), the Android app generates a notification indicating driver drowsiness.

Description of tool used in the project

Following optimized tools and image processing libraries are used by author for implementation of presented algorithm.

Open CV:
OpenCV (Open-source Computer Vision) is the Swiss Army knife of computer vision. It has a wide range of modules that can help us with a lot of computer vision problems. But perhaps the most useful part of OpenCV is its architecture and memory management. It provides you with a framework in which you can work with images and video in any way you want, using OpenCV's algorithms or your own, without worrying about allocating and reallocating memory for your images.

Open CV libraries and functions are highly optimized and can be used for real time image and video processing. OPENCV's highly optimized image processing function are used by author for real time image processing of live video feed from camera.

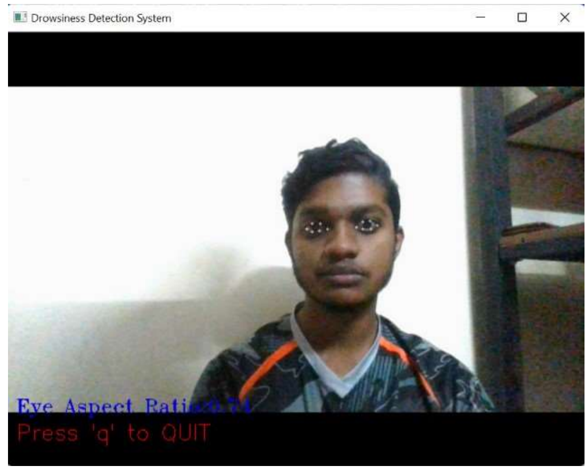
DLib:
Dlib is a modern C++ toolkit containing machine learning algorithms and tools for creating complex software in C++ to solve real world problems. It is used in both industry and academia in a wide range of domains including robotics, embedded devices, mobile phones, and large high performance computing environments. Dlib's open-source licensing allows you to use it in any application, free of charge. Open-Source Dib library is used by author for implementation of CNN (Neural Networks). Highly optimized pre-learned facial shape predictor and detectors functions are used by author for detection of facial landmarks. Facial landmarks were further used for extracting eye coordinates.

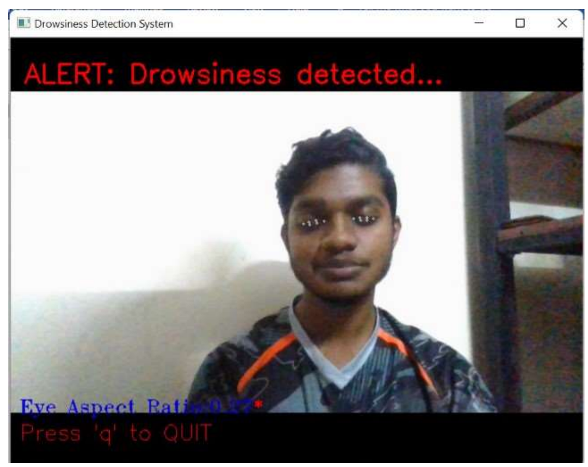
Python:
Python is an object-oriented programming language created by Guido Rossum in 1989. It is ideally designed for rapid prototyping of complex applications. It has interfaces to many Operating system calls and libraries and is extensible to C or C++. Many large companies use the Python programming language include NASA, Google, YouTube, BitTorrent, etc. Python is widely used in Artificial Intelligence, Natural Language Generation, Neural Networks and other advanced fields of Computer Science. Python had deep focus on code readability. Python language is used by author due to his cross-platform compatibility as main coding language for algorithm. OpenCV and Dlib libraries are integrated in python interpreter for using readymade optimized functions.

Comparison with state of art approach

We used EAR (Eye Aspect Ratio) and suggested how to calculate ECR (Eye Closed Ratio). Compared to other methods in the literature, our recommended
algorithm provides higher accuracy and reduced response time of EAR calculations on the server because the server is configured locally and, the returned EAR value is also checked locally in the driver's Android device, thus improving the resulting alertness whenever the

driver feels drowsy. Furthermore, in other penetration methods , certain machines and devices must be attached to the driver's body, making it impossible for the driver to concentrate on driving. Moreover, in the previous methods, the configuration has to be done every time, every time the driver starts a trip. However, these intrusive methods are expensive to measure pulse, heart rate. , etc. In our recommended measurement, we using only the Android device and the local server for drowsiness detection which eliminates machine costs and interruptions in the focus of the user driver.





Performance evaluation with Experimental Results and Discussion

The section presents the performance evaluation of the proposed approach by performing an empirical analysis of obtained results. First, the system collects the real-time data of the drivers depicted by Figures 4-a, 4-b and 4-c. It then determines drowsiness of the drivers based on the EAR values that are computed based on the images captured of the user and its response from the server. It also detects the drowsiness using ECR values.

SYSTEM CONFIGURATION

Software requirements:

These are the software requirements for running this project.

- Operating System: Windows 10/8/7 (incl. 64-bit), Mac OS, Linux
- Language: Python 3
- IDE: JetBrains PyCharm Community Edition 2019.1.3 x64

Hardware requirements

- Processor: 64 bit, quad-core, 2.5 GHz minimum per core
- RAM: 4 GB or more.
- HDD: 20 GB of available space or more.
- Display: Dual XGA (1024 x 768) or higher resolution monitors.
- Camera: A detachable webcam.
- Keyboard: A standard keyboard.

Conclusion: In this work, a real-time system that monitors and detects the loss of attention of vehicle drivers is proposed. The driver's face has been detected by capturing landmarks on the face, and the driver is alerted to avoid accidents in real time. Non-intrusive methods were preferred over intrusive methods to avoid driver distraction due to body-mounted sensors. The proposed approach uses eye aspect ratio and eye closure ratio with adaptive thresholding to detect driver drowsiness in real time. This is useful in situations where drivers are used to strenuous work and constantly drive long distances. The proposed system works with collected data sets under different conditions. Facial landmarks captured by the system are stored and machine learning algorithms were used for classification. The system provides a best case accuracy of 84% for a random forest classifier.

Future work may include integration of the proposed system with globally used applications such as Uber and Ola. If integrated, the system can reduce the number of fatalities and injuries that regularly occur as a result of these drowsy driver states. This experiment can be run as part of a pilot plan, i.e. for several days/months in different areas of the world where such incidents occur

regularly. So also our proposed
approach

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