Implementation Paper on Vehicle Drowsiness Detection System

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Abstract

Drowsiness is a process in which one level of consciousness is reduced due to lacking of sleep or exhaustion and it may cause the driver fall into sleep quietly. A Drowsy or sleepy driver is unable to determine when he/she will have an uncontrolled sleep. Fall asleep crushes are very serious in terms of injury. Recent statistics estimate that annually 1,200 deaths and 76,000 injuries can be caused to exhaustion or drowsiness related crashes. More than 25% of highway traffic accidents are caused as result of driver exhaustion. Reduce the risk of an accident by warning the driver of his/her drowsiness. This project is mainly based on four components 1) Face and Eye detection: Performs scale invariant detection using Haar Cascade Classifier perform through a webcam. 2) Eye feature extraction: Eye features are extracted using Hough Circle and 3) Extract single eye 4) Edge detection and perform drowsiness detection on it. In the proposed method, following the face detection step, the facial components those are more important and considered as the most effective for drowsiness, are extracted and tracked in video sequence frames. The system has been tested and implemented in a real environment. The contribution work is when drowsiness detected, after it will give alarm warning signal to the driver.

Keywords: Drowsiness, Haar Cascade Classifier, Hough Circle, Image Processing, Real Time Drowsiness Detection, OpenCV.

Introduction

Drowsy driving is quickly becoming a leading cause of accidents all over the world. Identifying drowsiness as the cause of an accident is also extremely difficult, as there are no available tests that can be run on the driver. Therefore, mitigation is the best way to reduce such accidents. The most accurate way to gauge driver drowsiness is to monitor physiological signals such as heart rate, skin conductance and brain activity. However, such measurements require the attachment of electrodes to the body of the driver, which may cause discomfort and distraction. Majority of the accidents caused today by cars are mainly due to the driver's sleep or exhaustion. Driving for a long period of time causes excessive sleep or exhaustion and tiredness which in turn makes the driver sleepy or loose awareness. With the rapid increase in the number of accidents seems to be increasing day to day. Therefore a need arises to design a system that keeps the driver focused on the road. The real time drowsiness behaviors are dangerous which are related to drowsiness in the form of the eye blinking, head movement and brain activity. The aim of this system is to detect the human behaviors and mood like eye blinking, yawing etc. There are mainly four parts in this system (1) Face detection (2) Facial feature extraction like detect the eye portion (3) Extract Single eye and (4) Edge detection of the open or closed eye. Face is detected in the real time in the OpenCV using the face detection algorithm and facial features like detect the eye portion and then detect the open or closed eye by self-developing algorithm and reduce the accidents caused by sleep or exhaustion related and also save the money and the reduced human suffering.

Related Work

Literature survey is the most important step in any kind of research. Before start developing we need to study the previous papers of our domain which we are working and on the basis of study we can predict or generate the drawback and start working with the reference of previous papers.
In this section, we briefly review the related work on Detecting the drowsiness with their different techniques.

The paper proposed WE in a sliding window (WES), PP-ApEn in a sliding window (PP-ApEnS), and PP-SampEn in a sliding window (PP-SampEnS) for real-time analysis of driver fatigue. The real-time features obtained by WE, PP-ApEn, and PP-SampEn with sliding window were applied to artificial neural network for training and testing the system, which gives four situations for the fatigue level of the subjects, namely, normal state, mild fatigue, mood swing, and excessive fatigue. Advantages are: The driver fatigue can be estimated better by using the method based on EEG, EOG, and EMG signals. [1]

The paper presents a nonintrusive drowsiness recognition method using eye-tracking and image processing. A robust eye detection algorithm is introduced to address the problems caused by changes in illumination and driver posture. Six measures are calculated with percentage of eyelid closure, maximum closure duration, blink frequency, average opening level of the eyes, opening velocity of the eyes, and closing velocity of the eyes. Advantages are: The video-based drowsiness recognition method that provided 86% accuracy. Disadvantages are: Need to improve accuracy. [2]

The paper presents visual analysis of eye state and head pose (HP) for continuous monitoring of alertness of a vehicle driver. 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. Advantages are: It gives highest classification accuracy. Minimize the number of errors. Disadvantages are: The SVM classifier shows a low Type-I error, which is more critical. [3]

The paper represents for enable the vehicle to detect drowsiness or discrepancies in the driver's behavior and alert the user when it occurs. The main function of drowsiness-/fatigue-detection (DFD) systems is to monitor the driver's condition and take action accordingly. Advantages are: The vision systems with better time response were the ones that analyzed the driver's physiological features. [4]

The paper focuses on a driver drowsiness detection system in Intelligent Transportation System, which focuses on abnormal behavior exhibited by the driver using Raspberry pi single board computer. In the proposed system a non-intrusive driver drowsiness monitoring system has been developed using computer vision techniques. Advantages are: This system detects the drowsiness of the driver when the eyes are closed for 4 frames or more (i.e., more than 2 seconds). The system is non- intrusive and can be easily equipped with any vehicle. Disadvantages are: This system is expensive. [5]

This paper, proposes a drowsiness and intrusion detection system based on driver behavior. The role of the system is to detect facial landmark from images that are collected while the person is driving the vehicle by a camera module attached to the vehicle and deliver the obtained data to the trained model to identify the driver's state. Once the collected data is detected to be showing signs of drowsiness the person will be alerted using the speakers in the vehicle so that the person can stop the vehicle to avoid any accidents due to his drowsy state. The system also includes GPS tracking of car and alerts on mobile app regarding car movement. [6]

The system design for the protection of commercial or personal vehicles from theft and other hostile condition and it is very important due to insecure environment around us. In this they have automatic locking of vehicles with the help of alcohol detection and other essential multitasking system for more secure driving as like drowsiness detection, accident awareness. With an efficient smart vehicle driving system the chances of accidents will become less an importantly the human nature is unpredictable so we provide a system which will work in all aspects. [7]

This paper, proposed low-cost and nonintrusive driver drowsiness detection solution which is based on face and eye tracking system for detecting the eye states in real time to identify the driver drowsiness state. The face region is detected based on the optimized Jones and Viola method. The eye area is obtained by a horizontal projection. Finally, a new complexity function with a dynamic threshold to identify the eye state. [8]

This paper, proposed Drowsy Driver Detection System, using a non-intrusive machine vision based concepts. The system uses a web camera that points directly towards the driver's face and monitors the driver's head movements in order to detect fatigue. In such a case when fatigue is detected, a warning signal is issued to alert the driver. The system deals with detecting eyes, nose and mouth within the specific segment of the image. If these are not found for 5 consecutive frames, the system draws the conclusion that the driver is falling asleep. [9]

This paper proposed a system for detection of driver drowsiness. They proposed the conception and implementation of a system for detecting driver drowsiness based on vision that aims to warn the driver if he is in drowsy state. [10]

This paper presented a system for automatic detection of driver drowsiness from video. Their system uses the Cb and Cr components of the YCbCr color space. This system locates the face with a vertical projection function, and the eyes with a horizontal projection function. Once the eyes are located the system calculates the eyes states using a function of complexity. [11]

This paper, proposed, Real Time Driver Identity and Alertness Monitoring. They used the Haar algorithm to detect objects and face classifier implemented by in OpenCV libraries. Eye regions are derived from the facial region with anthropometric factors. Then, they detect the eyelid to measure the level of eye closure and thereby analyse the alertness level of the driver and conclude whether he is drowsy or not. [12]

This paper, proposes a detection and prediction of drowsiness, Automatic classifiers for 30 facial actions from the Facial Action Coding system were developed using machine learning on a separate database of spontaneous expressions. These facial actions include blinking and yawn motions, as well as a number of other facial movements head motion was collected through automatic eye tracking and an accelerometer [13]

Problem Statement

Nowadays more accident occurs in trucks and cars than vehicles due to drowsiness. Nearly 97% of crashes of vehicles happen due to drowsiness of driver. It results into loss for e.g. human loss, money loss, and medical loss. The accident or crashes not only affect the internal system but also to outside world. 70% injury occurs in internal system and 30% injury happen to the external system. Environmental loss is one of the disadvantages of accident. Accidents results in human as well as non-human loss. Recently most of the accidents occur due to drowsiness of drivers in cars and trucks. Annually 1200 deaths and 76000 injured. This approach includes analysis of police reported crash data, in-depth on-site investigations immediately following a crash of the general driving population.

Proposed Method

The system starts with continuously capturing the video. The proposed system will generate the frames of driver's face and eye. Select one frame form the list of frames as known as image. The face and eye detection is based on the PCA algorithm. Detecting the face and eye with such method is proven to be a faster and efficient way of eye detection. This method stays good even under improper/extreme light conditions, as long as the data captured and provided for training includes these conditions. The image of drivers face will be processed and the eye images will be derived out of it. Then the eye region along with the boundary of iris will be detected in the frame using Circular Hough Transform. Circular Hough Transform helps in extracting the circles with a center point (xc; yc) and a radius r. The CHT will detect bright spots based on the circles.

The proposed system consists of three components:
1. Capturing: Camera mounted on the automotive dashboard captures the video of driver's face including eyes.
2. Processing: Captured video is converted in frames. Select every frame as facial image is used to determine driver's eye i.e. open or closed. The driver's current eye state can be determined using HARR classifier cascades and Circle Hough Transform in OpenCV.
3. **Detecting:** When system is to read images and detect drowsy condition when eye is closed.

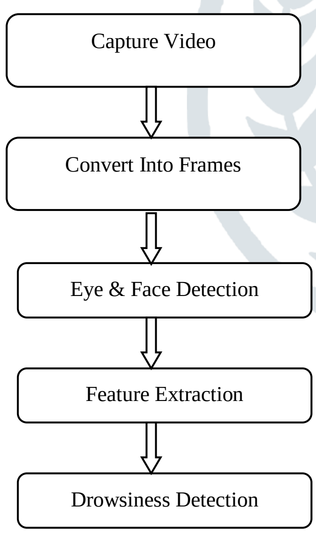

Fig.1 Flow diagram

Architecture

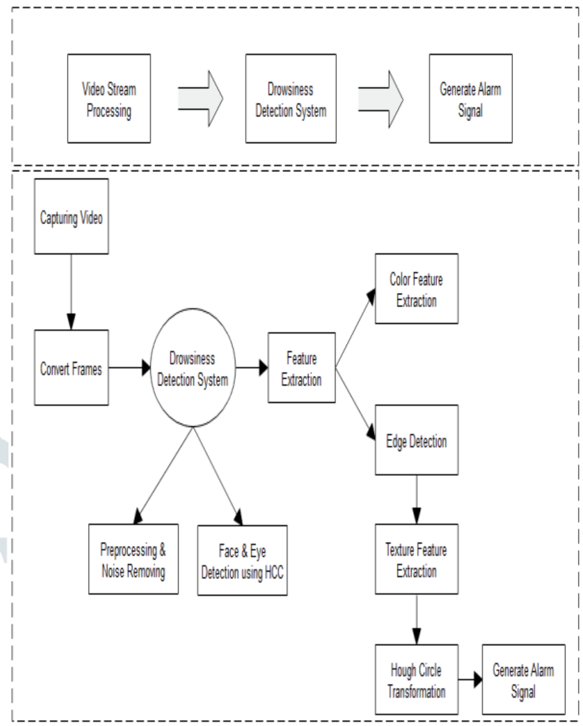

Fig.2 System Architecture

Algorithms

1. E Algorithm using HAAR Cascaded File

Step1: A Hough Transform function is used to automatically detect circular objects in the image.

Step 2: Horizontal test is applied, since eyes are present along the axis i.e. they lay horizontally. Threshold (distance between two eyes i.e. difference between x axis of centers) <=10.

Step 3: Apply Upper half test, where the length of the face is divided into two equal halves and upper half is where the eyes are present.

Step 4: Dark pixel test is applied, since iris is dark, this test calculates the average of dark pixels.

Radius = constant value

first1 = [x-radius: x+radius, y-radius: y+radius]

First = im2bw (first1)

Step 5: Eye Pair Distance Test, distance between the eyes are found manually

mu=0.468

cu=15.864

ml=0.418

cl=-7.853

y1= (mu*w) +cu

y2= (ml*w) +cl

Where mu, ml are the threshold values of the slope and cu, cl are the threshold values of the intercept.

If y1<= distance between 2 eyes <=y2 Then the left out pair of circles are eyes.

2. Face Recognition using Principle Component Analysis

STEP 1: Prepare the Data

The first step is to obtain a set S with M face images. Each image is transformed into a vector of size N and place into the set.

$$S = \{\Gamma_1, \Gamma_2, \ldots, \Gamma_M\}$$

STEP 2: Obtain the Mean

After obtaining the set, the mean image ψ has to be obtained as,

$$\psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma_n$$

STEP 3: Subtract the Mean from Original Image

The difference between the input image and the mean image has to be calculated and the result is stored inΦ.

$$\Phi_i = \Gamma_i - \psi$$

STEP 4: Calculate the Covariance Matrix

The covariance matrix C is calculated in the following manner

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi_n\Phi_n^J$$

$$= AA^J$$

$$A = \{\Phi_1, \Phi_2, \ldots, \Phi_n\}$$

STEP 5: Calculate the Eigenvectors and Eigenvalues of the Covariance Matrix and Select the Principal Components

In this step, the eigenvectors (Eigen faces) i and the corresponding eigenvalues ** should be calculated. From M eigenvectors, only M' should be chosen, which have the highest eigenvalues. The higher the eigenvalue, the more characteristic features of a face does the particular eigenvector describe. Eigen faces with low eigenvalues can be omitted, as they explain only a small part of the characteristic features of the faces. After M' Eigen faces are determined, the "training" phase of the

Results And Discussions

Experiments are done by a personal computer with a configuration: Intel (R) Core (TM) i3- 2120 CPU @ 3.30GHz, 4GB memory, Windows 7, MySQL 5.1 backend database and jdk 1.8. This application is desktop application used tool for design code in Eclipse and execute. Some functions used in the algorithm are provided by list of libraries like OpenCV jar and JavaCV jar for video capture as well as face and eye detection purpose. The objective here is to capture the video after generate video frames and after read images and drowsiness detect condition when eye is closed. The very first step in this system is to detect the Face, Eye region and the Eye through OpenCV libraries, live video as a input to the system and get output as frame with face and region of interest, simulating the estimated result before actually implementing it to the hardware.

Conclusion

When we analyze the drowsy videos, we realized that drowsiness has stages and the situation is the same in alert videos, as well. The real time drowsiness detection system here to locate driver eyes and monitor them for fatigue is capable of detecting drowsiness in a rapid manner. Thus we have implementing an effective drowsiness detection system using OpenCV software and Haar Classifiers. The system can be further improved and used in the automotive commercially.

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