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Drowsiness Detection of a Driver using Advanced Machine Learning for Light Motor Vehicle Collision

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Abstract: Recently, in addition to autonomous vehicle technology research and development, machine learning methods have been used to predict a driver's condition and emotions in order to provide information that will improve road safety. A driver's condition can be estimated not only by basic characteristics such as gender, age, and driving experience, but also by a driver's facial expressions, bio-signals, and driving behavior. Recent developments in video processing using machine learning have enabled images obtained from cameras to be analyzed with high accuracy. Therefore, based on the relationship between facial features and a driver's drowsy state, variables that reflect facial features have been established. In this paper, we proposed a method for extracting detailed features of the eyes, the mouth, and positions of the head using Open CV and Dlib library in order to estimate a driver's level of drowsiness. The proposed system gives an alarm which represents vehicle tracking and accident detection when theft and accident identifying. Raspberry-pi is the heart of the system, which is connected to any moving vehicle which makes an easy option to track any moving vehicle for that it matters in real time on Google-maps. An alert will be received to the authorized person, the vehicle will be moved to stop mode through the GSM-GPRS or Wi-fi Module connected to the raspberry-pi kit which is kept on inside of the vehicle. This system helps find-out the exact location of an accident with the server and sent the information to an authorized person, give an alarm signal to save the human life. This system also detects the behavior of the driver through the sensors whether he/she drowsy/drunk, the speed vehicle is stopped. This system is more securable, reliable and economical.

***Index Terms* – Drowsiness detection, Machine learning, Open CV, Dlib.**

I. INTRODUCTION

Most of the road accidents are caused because of drowsiness and drunk driving and also working environments, reduced sleep and time factor. Driver drowsiness and fatigue drunk driving reduces the driver decision making capability and perception level. These two situations affect the ability to control the vehicle. There are some techniques which are used to detect drowsiness in drivers like by sensing of driver operation or physiological characteristics of driver like or vehicle movement etc. Traffic survey shows that driver fatigue may be a contributory factor in up to 20% and due to alcohol drinking it is about 31% of all road accidents. The primary purpose of this drowsiness and alcohol detection system is to develop a system that can reduce the number of accidents from drowsiness and drunk driving of vehicle.

To determine the condition of a driver, we can monitor the motion of a vehicle, driving patterns, a driver's vital signs, and a driver's face using a camera. As the latest machine learning capable data is released, a variety of professional algorithms are constantly being introduced. Also, as training speed is improving due to the use of graphics processing units (GPU), image analysis is receiving attention in many fields. Therefore, in this paper, possible driver condition estimation techniques will be explained using image feature extraction analyses.

II. OBJECTIVE

The main objective of this project is to develop a cost-effective device which integrates drowsy detection, alcohol detection, cell phone detection while driving to prevent accident rate. To Track/stop the vehicle when unauthorized person theft the car and capture the image of an unauthorized person when any pressure applied. To reduce the speed of the vehicle when the person is drowsy/drunk and To Reduce the death after the accident by using the alarm. Drowsiness is detected using camera and accident detection using tilt sensors. Intimating the concerned person through GSM-GPRS.

III. MOTIVATION

In a developing nation like India, with advancement in the transportation technology and rise in the total number of vehicles, road accident increases rapidly. The main cause behind these road accidents are the lack of training institutes, unskilled drivers, poor road conditions, use of cell phones during driving, consuming alcohol while driving, overloading and poor governmental plans in this regard. The proposed work is to alert the driver when he is drowsy or distracted away from normal alert mode to non-alert mode by means of buzzer or vibration mechanism. In this project real time data is collected by video camera and other micro electro mechanical system devices (MEMS). This data gives information about driving condition of the driver which acts as input to controller. The appropriate measures are taken by the controller to alert the driver.

IV. LITERATURE REVIEW

Paper [1], this paper proposes a Real-Time Drowsiness Detection System (RT-DDS) applicable in motor vehicles with the help of conventional Computer Vision applications. The system employed various Computer Vision applications using blink rate, eye closure, yawning to effectively and quickly identify the drowsiness of a driver during driving the vehicle and alter the driver accordingly. The proposed work tried to contribute in reducing the increased number of road accidents while keeping the methodologies simple and intact.

In Paper [2], this paper works on the real time detection of car driver drowsiness and alcoholic intoxication. This detects large numbers of road accidents which takes place due to fatigue or alcohol drinking of driver. Computer vision and alcohol gas sensor application is combined to an embedded system to achieve this goal. This system consists of Drowsiness detection, alcoholic intoxication, Raspberry pi, Arduino UNO, Open CV and Embedded System.

In Paper [3], Authors have implemented a system using ARM 7 based microcontroller and open CV based machine. This is interfaced to USB camera for continuous images are captured and these images are processed with help of Open CV and compared with existing database. If the current images are matching with any of the existing images the system generates command to the output unit to perform the location identification using GPS and forward the necessary information about the identified person using GSM/GPRS to concern authorities.

Paper [4] proposes focuses on eye states tracking. Images are captured using a camera and used for tracking as input of the proposed method. In first step we use color space for driver’s face detection and crop the face from background. In the next step, we estimate the area of the eyes and crop image from this region. Then top and bottom coordinates of the eyes are located using retrench the face pixels from this area and canny operator for edge detection. In the last step we count the number of white and black pixels and compare the distance between these coordinates for recognition of the driver’s fatigue.

Paper [5] is based on computer vision and embedded system application principles. System work is a combination of face detection, eye region detection and eye closing rate detection in real time environment. The proposed system is realized with a digital camera supported by embedded system board Raspberry Pi loaded with Raspian-OS and Python-IDLE with Open CV installed. Also different vehicle control functions like center locking and unlocking, opening and closing of windows, bonnets etc. can be controlled by using Android mobile phone.

V. BLOCK DIAGRAM

The proposed block diagram (**Fig.1**) consists of a USB camera for capturing the images of driver. This image is stored on SD card of raspberry-pi, When the persons are drowsy/drunk, motor of the vehicle start to reduced and come to off state. The SMS (Short Messaging Services) sent to 9 preloaded number using GSM (Global System for Mobile Communication), location also shared by this message. Alcohol sensor is used to detect whether the driver is drunk or not.

VI. METHODOLOGY

When people start driving, they tend to gaze at the left or right sides of the road after setting a destination. However, as time passes by, the frequency of blinking decreases as a driver becomes fatigued. A reduced rate of blinking may result in drivers closing their eyes unconsciously, and their heads may flop. This temporal behaviour can be observed continuously. Therefore, temporal changes of facial features may be analysed to identify changes in a driver’s condition.

In the proposed system provides security and safety. During the normal operation of the vehicle, when the authorized person open door of vehicle, then motor of the vehicle starts to run. Here alcohol content is not detected, buzzer is on mode, there is no information are sent to authorized person. Hence the system is in sleeping mode or normal condition otherwise goes to active mode i.e. When the person is drowsy/drunk, motor of the vehicle starts to reduced and come to off state. The SMS sent to 9 preloaded number using GSM and location is also shared by this message.

Image is captured by the USB camera connected to raspberry-pi. This image is stored on SD card of raspberry-pi. If the door of the vehicle goes through any interruption, then the IR sensor senses and gives an information to raspberry-pi, to stop the vehicle and SMS is sent to authorized person or owner with the location. When pressure is applied by an unauthorized person on vehicle then vehicle tends to run slowly while message is sent. Another most important application is, when an accident occurred raspberry-pi gives an alarm using buzzer. This reduces the chances of death after an accident.

A. **Workflow:** High vision cameras are embedded to monitor and capture to extract frames one by one and generate the alerts accordingly. Each extracted frame is analysed at time to study the pattern of facial features; using Haar Cascade Classifiers and determined Eye Aspect Ratio(EAR) and Mouth Aspect Ratio(MAR) for each frame [12]. EAR and MAR values exceed their respective threshold values, a blink and a yawn is considered respectively. The system alerts the driver by playing an alarm if eye blinking rate and yawns are suspected for a certain number of consecutive frames. The alarm is activated to grab the driver’s attention and keep on ringing until driver wakes up.

B. Facial Features and Gesture Detection:

1) Frame Acquisition: A High end digital camera with nigh mode mounted in the car such that full view of the driver without disturbing the latter's view can be captured. Real time video has been captured, frames are extracted and analyzed in run time to identify the current state of the driver.

2) Face Detection: Histogram of Oriented Gradients (HOG) with Linear Support Vector Machine (SVM) detectors to localize the driver's face in a frame is implemented. The basic purpose for using HOG with Linear SVM detectors was to achieve higher accuracy rate with less false positives value.

3) Eye Detection and Yawn Detection: The pre-trained shape predictor in dlib library is used to obtain 68 pixels in (x,y) coordinates of facial landmarks of a face. This uses regression trees to determine facial landmarks using pixel intensities. The probability of distance between pixel pairs is used to detect eyes and mouth in a face region.

C. Blink Rate Calculation:

Eye Aspect Ratio (EAR) is used to detect a blink which is the ratio of vertical distance of the lower and upper eyelids to the horizontal length of an eye. During the eye blinks, the vertical distance of lower and upper eyelids decreases similarly in opened eye after a blink the distance between the respective eyelids tends to increases. Therefore, EAR decreases (approaching to zero) and increases simultaneously, the blink count is incremented. The EAR count less than the threshold value reports suspicion in driver's behaviour. Mathematically, EAR is calculated using:

$$EAR = \frac{||P2 - P6|| + ||P3 - P5||}{2\,||P1 - P4||}]$$

D. Yawn Counts: Mouth is represented by 8 -coordinates in dlib landmarks predictor function. The landmarks are marked starting from left corner of the mouth while moving in the clockwise direction as shown in Figure-3.It has been observed that the horizontal and vertical co-ordinates share some relation with each other. The ratio of vertical distance between lower and upper lips to the horizontal distance between the lip corners is calculated to determine MAR .When a person opens his mouth to yawn, the distance between lower and upper lips increases. Unlike EAR, the yawn count value gets incremented as soon as MAR value increases exceed a threshold value. MAR is calculated using:

$$MAR = \frac{||P1 - P5|| + ||P2 - P4||}{2\,||P6 - P3||}]$$

E. Alarm Activation: Blink rate and yawn counts exceed specified thresh old values respectively for a certain number of consecutive frames, the system will assume that the driver is dozing off and will activate an alarm to alert the driver until the driver wakes up.

Output:

The drowsiness is done successfully. The snapshot of the output is as shown **fig.4**. The image in the **fig.4** is the output of the drowsiness detection model, where the face is detected by the USB camera and buzzer is given when the driver is drowsy.

VII. HARDWARE IMPLEMENTATION

The proposed system consists of Arduino and Raspberry-pi, the USB camera is connected to Raspberry-pi and it captures the image of a driver and it is stored in SD card of Raspberry-pi. Buzzer is used to alert the driver. Alcohol sensors is used to detect the whether driver is drunk or not and IR sensors used to detect a near object, in contrast sensors to find a path or in counting sensors to count objects. GSM-GPRS is used to give information to the owner by messaging or calling to the preloaded number

VIII. ADVANTAGES

- It has fully automated operations, without any human intervention.
- No one can manipulate the data sent by the device to the owner.
- It is cost-effective and sensor free operation.

X. LIMITATIONS

- System failure may occur due to tampering
- System failure may also take place in the absence of power to the entire unit attached to the vehicle.

XI. FUTURE SCOPE

The cell phone detection enhanced by the hybrid system solution was possible with machine learning for movement detection and new features from Optical Flow as: horizontal movement, the area of connected components, and the dimensions of region movement detected. The increase of the frame per second processing and the image resolution.

XII.CONCLUSION

A driver's alertness detection system was proposed based on fatigue detection in real-time. The proposed method easily detects the eye blink and the drowsiness. Information about the eyes position was obtained through image processing algorithms. Image processing offers a noninvasive approach to detect drowsiness without any annoyance and interference. An algorithm for performing face recognition was used. Results, unaffected by lack of brightness will be obtained. Safe driving will be ensured by indicating the driver using a buzzer indicator.

Drunk and driving accidents are one of the major problems now-a-days. This paper provides much advanced facility in now as it can easily be implemented in vehicles with multi stage testing such a way that we can avoid accidents caused by drunken driving. Thus by this we can reduce the alcohol related road accidents and hence these kinds of detectors have great importance in the future which we are going to implement with IOT. Through this project we present hardware programming of IOT device to facilitate as alcohol detector and preventive device. The system's output could be a warning that can regain the driver's attention exclusively to the vehicle and the road or a warning for a transport company or enable a buzzer. We are using the alcohol sensors to sense the consumption of the alcohol up to the preset percentage.

XIII. Figures

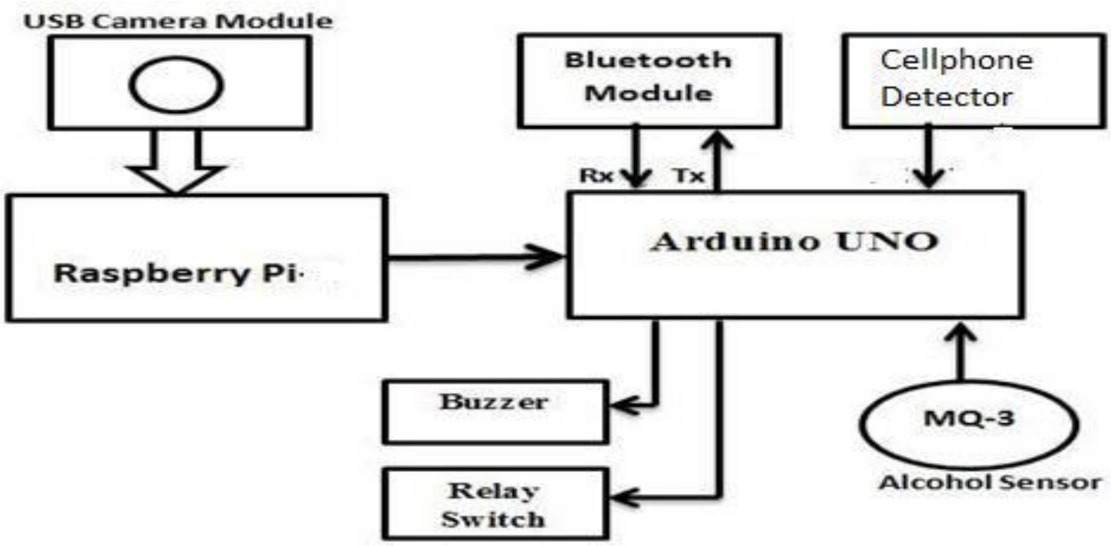
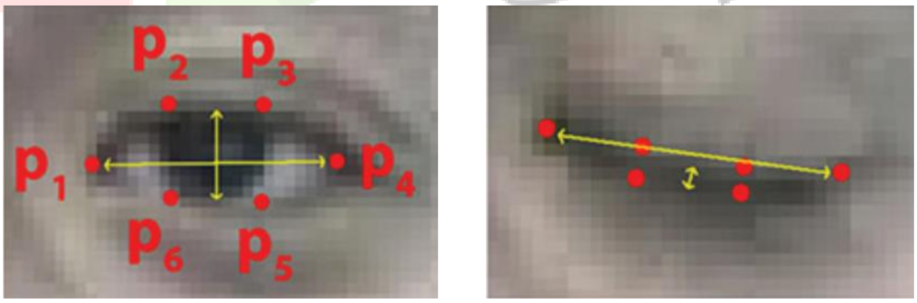
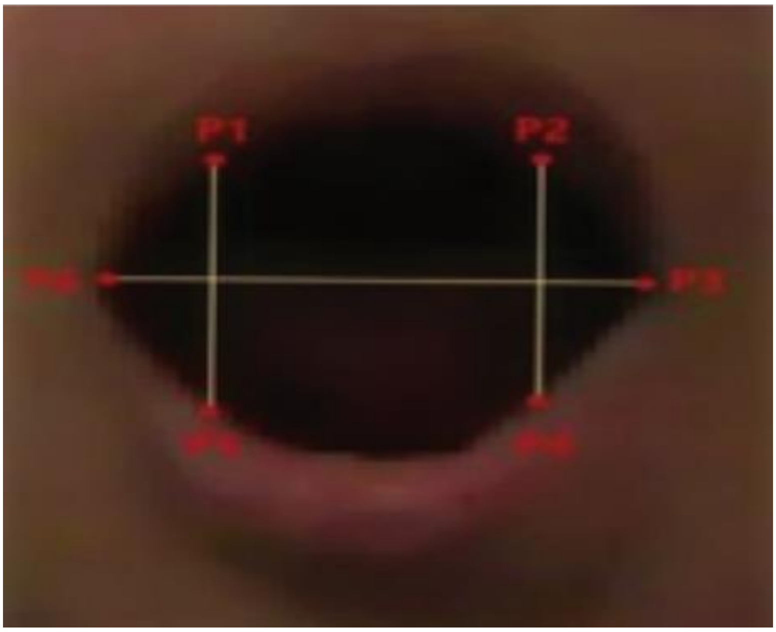


Fig.1



Coordinate to calculate EAR

Fig.2



Coordinate to calculate MAR

Fig.3

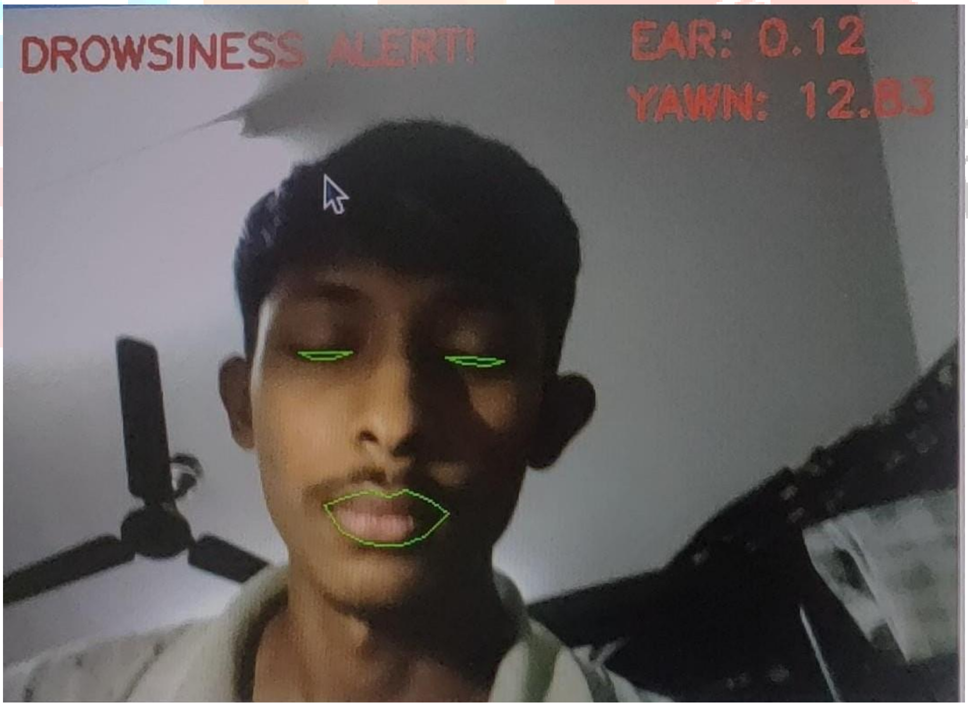


Fig.4

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