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Driver Safety System using Drowsiness and Emotion Detection Parameters

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Abstract: ***Driver fatigue and negligence has been a major reason for road accidents over the years and is growing every day. The driver safety system is an attempt at developing a framework or prototype application which uses drowsiness and emotional variance as factors for possible cause of accidents and attempts to inform the driver regarding the same. Driver negligence can occur due to various reasons ranging from fatigue, tiredness to extreme state of happiness or sadness. Emotional state can be identified with help of a person's facial expressions. Even though most faces look alike there are subtle changes which make face a good method of distinguishing people. We have implemented real time face detection, eye extraction and drowsiness detection. Viola Jones Haarcascade method is used. The eye aspect ratio and eye close time are taken as factors to detect driver drowsiness. The facial landmarks like mouth, eyes, nose, eyebrow positioning and movement have been considered for emotion detection. Successfully trained a Deep Neural Network model to detect emotions such as neutral, happy, sad, angry, surprised.***
Keywords: Driver safety, Face detection, Viola-Jones face and facial features detection, Emotion detection, Convolution neural network, Deep learning

I. INTRODUCTION

Road traffic injuries claim more than 1.35 million lives each year. It is one among the top 10 reasons of death as researched by WHO[1,2]. After alcohol related accidents, drowsiness is the second leading cause of the road accidents. People are conscious about the risk of drinking and driving but don't realize the dangers of drowsiness because no awareness or instruments exist to measure the driver drowsiness. Detection of driver's drowsiness is gaining importance in the field of Computer Vision and Machine Learning.

Another factor that is being neglected in driver safety system is the mental state of the driver. Certain emotions like anger, sadness and excitement will affect how the driver operates the vehicle. Emotions produce different physiological, behavioral and cognitive changes. Behavior is different from emotions but is very strongly influenced by them. One way that behavior is affected by emotions is through motivation, which drives a person's behaviour. When a person feels frustration, anger, tension or fear, they are more likely to act aggressively towards others[3]. Emotional state of driver can severely affect the reaction time, driving pattern, alertness of driver and several other factors. A driver needs to be alert and aware of road and surroundings to be affective in situations of possible accidents to avert the problem. The emotional state of driver directly has affect on the drivers awareness of various factors while driving and this small fractional delay in reaction time may be the line between life and death.

In this project, we propose a novel driver safety system method using HaarCascade methodology to extract facial information from live feed and use the same to detect drowsiness and emotional state of driver and alert the driver.

II. RELATED WORK

In 2015, there were about five lakh road accidents in India, which killed about 1.5 lakh people and injured about five lakh people. While highways (both national and state) comprise about 5% of the total road network, they witness 52% of the accidents. More accidents on highways may be attributed to higher vehicle speeds and higher volume of traffic on these roads[4].

The National Highway Traffic Safety Administration estimates that drowsy driving was responsible for 72,000 crashes, 44,000 injuries, and 800 deaths in 2013. However, these numbers are underestimated, and up to 6,000 fatal crashes each year may be caused by drowsy drivers. The need to monitor the driver behind the steering wheel is a challenge in the current industry.

Syed Imran Ali, Zohaib Khan and Sameer Jain have used the concept of Image processing and PERCLOS to detect drowsiness [5]. MATLAB and Sobel edge detection algorithm to extract facial feature.Eye closure and yawning were used as parameters.

In another paper drowsiness detection system was mentioned based on edge detection and exploiting the symmetry of facial features for extracting the eyes[6]. The state of the eyes is determined as open or closed by taking the Hough transform for circles and comparing the intersection of the Hough transform and the edge image with a threshold. The state of drowsiness is then determined by using Percentage of Eyelid Closure(PERCLOS)- a scientifically associated measure of drowsiness associated with slow eye closure.

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Eye is a prominent feature when it comes to drowsiness detection and various methodologies can be applied. Haar-like features were used to extract face region and region of interest (ROI) was found and drowsiness was detected[7].

Yap-jiunn chen ,Yen-chun Lin developed a system which uses facial geometry for feature recognition[8]. Geometric correlation between hair clusters and face is used as parameter for detecting face feature. Geometry-based approach extracts features using geometric information such as relative positions and sizes of the face component.

Viola Jones method is the most famous algorithm that is used for real time face detection[9]. 4916 images were trained using the Adaboost training procedure to obtain 38 layered cascade filter. It is proved by many research persons that it is one of the best methods to detect face even when the contrast difference between background and object is huge[10].

Emotion detections are also achieved in similar ways. Philip Michel, Rana El Kaliouby used the SVM algorithm for emotion detection[11].Though the system gave high accuracy it could not perform well when the head was rotated or in motion.

Nithyaroopa.S. has used deep learning and transfer learning of InceptionNet v3 to develop a model for emotion detection. Kaggle's Facial Expression Recognition Challenge and Karolinska Directed Emotional Faces (KDEF) datasets were used[12].

III.METHODOLOGY

In this project, we propose a novel driver drowsiness detection method using Haar Cascade methodology to extract facial information from live feed and use the same to detect drowsiness and emotional state of driver.

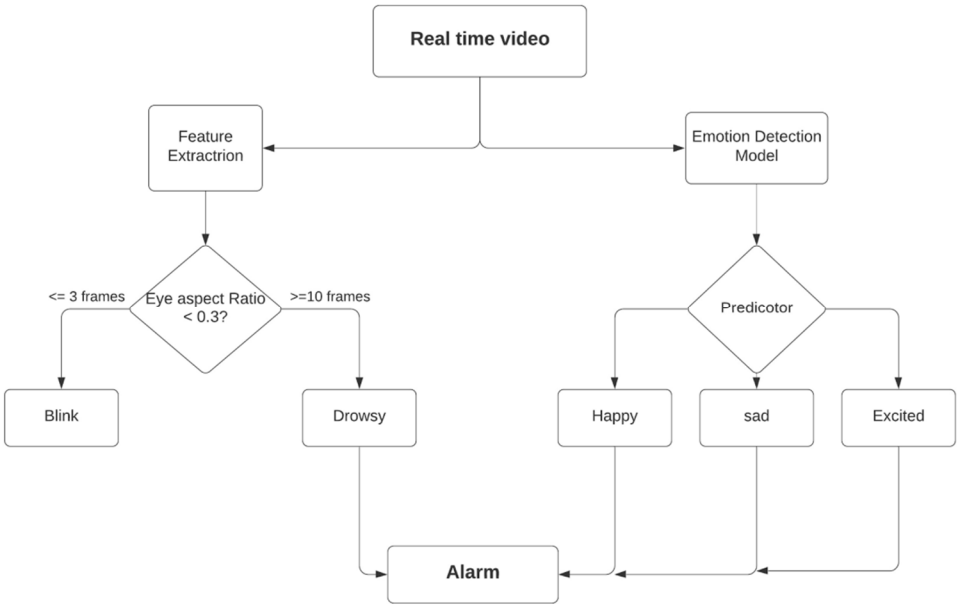

Fig.1 System Design

1) Detect face from live feed using haar cascade method.
2) Mark the face region with a rectangle and captured as an image.
3) Detect facial feature indicator from the image and mark them.
4) Face features are recognized with help of 68 available facial feature points.
5) Features like eye, mouth, nose, ear, eyebrow ,etc are recognized and required features extracted.
6) Extracted features are passed to functions for drowsiness and emotion detection.

A. Proposed solution for Drowsiness Detection

1) Detects face and eyes in a webcam feed by user(real time video) using Haar Cascade methodology.
2) Continuously determine the EAR(eye aspect ratio) of the user's eye.
3) EAR can be determined by the following equation,

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

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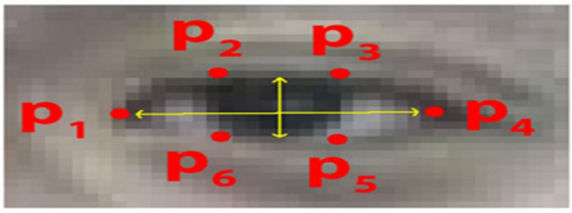

Fig.2 The 6 facial landmarks associated with the eye.

4) The eye aspect ratio is approximately constant while the eye is open, but will rapidly fall to zero when a blink is taking place, this technique is used to detect drowsiness of the driver.
5) If the eye aspect ratio falls below a certain threshold and then rises above the threshold, then we'll register a "blink".
6) There will be a counter (threshold value) which indicates the certain number of frames(3) with an EAR less than the threshold value to register a blink.
7) If the EAR value of the user's eye is less than 0.3 and exceeds certain fixed threshold frames(10),then alarm the user as drowsy.

B. Proposed solution For Emotion Detection

To classify the emotion on a person's face into one of seven categories, we used deep convolutional neural networks.The model is trained on the FER-2013 dataset.This dataset consists of 35887 grayscale, 48x48 sized face images with seven emotions - angry, disgusted, fearful, happy, neutral, sad and surprised[13].The architecture of this neural network model consists of 3 layers- one input layer, one hidden layer (consisting of 3 sets of convolution layers) and an output layer of 7 nodes each corresponding to one emotion.

C. Hardware Requirement

1) *Processor:* Quad core Intel Core i7 Skylake or higher(Dual core is manageable)
2) *RAM:* Minimum 6GB of RAM(16GB RAM is preferable)
3) *Storage:* Minimum 500GB HDD(SDD is preferable for better performance)
4) *GPU:* Premium Graphic cards like Nvidia 9x or 10x series(preferable to use graphic card that supports CUDA toolkit)
5) Webcam

D. Software Requirement

1) *Operating System:* Windows / Linux / MacOS
2) *Python 3+ :* Programming language
3) *Keras 2.0+ :* Library for neural network which uses TensorFlow as its backend
4) *TensorFlow 2.0+ :* Deep learning library in python
5) *NumPy 1.18.2 :* NumPy is the fundamental package for scientific computing with python

IV. RESULTS AND ANALYSIS

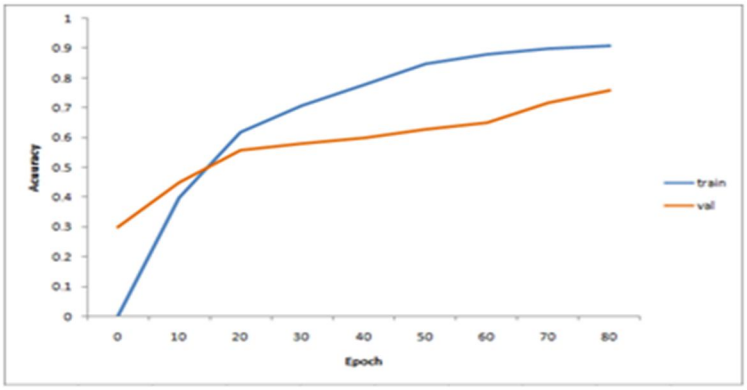

Fig.3 Final Testing Result

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Drowsiness detection has shown a good result. The neural network model for emotion detection has gained training accuracy of 91% and validation accuracy of 76% with 80 epochs. The combined interface works without any delay and is a real time system that can be deployed.

Eye is a good parameter to consider while detecting drowsiness. Several different approaches have been tried and yet there are few pitfalls among them. Because the other parameters such as mouth, whether the mouth is closed or open might be misleading, since the driver might be talking or singing. But the system would predict that case as yawning and hence will lead to a bad result.

Analysing the existing systems for detection of facial features, Haar Cascade approach is the optimal for real time application. Kriti Dang and Shanu Sharma have tried four different methods such that are Viola-Jones, SMQT features & SNOW Classifier, Neural Network-Based Face Detection and Support Vector Machine-Based face detection[14]. Their conclusion holds true with our outcome.

With respect to emotion detection using face images most existing systems have used machine learning and deep learning. Our model has gained higher validation accuracy of 76 percentage than few of the existing systems[12],[13],[15].

V. CONCLUSIONS

We have considered drowsiness and the emotional state of driver as a possible cause for on road accidents. A prototype Driver Safety System has been developed to continually record the driver face and detect any sign of fatigue, drowsiness or emotional trouble and alert the driver in the suitable scenario. Along with detection of symptoms the systems capability to send a text alert has also been tested and verified. We believe that the system prototype can go a long way in preventing a number of road accidents.

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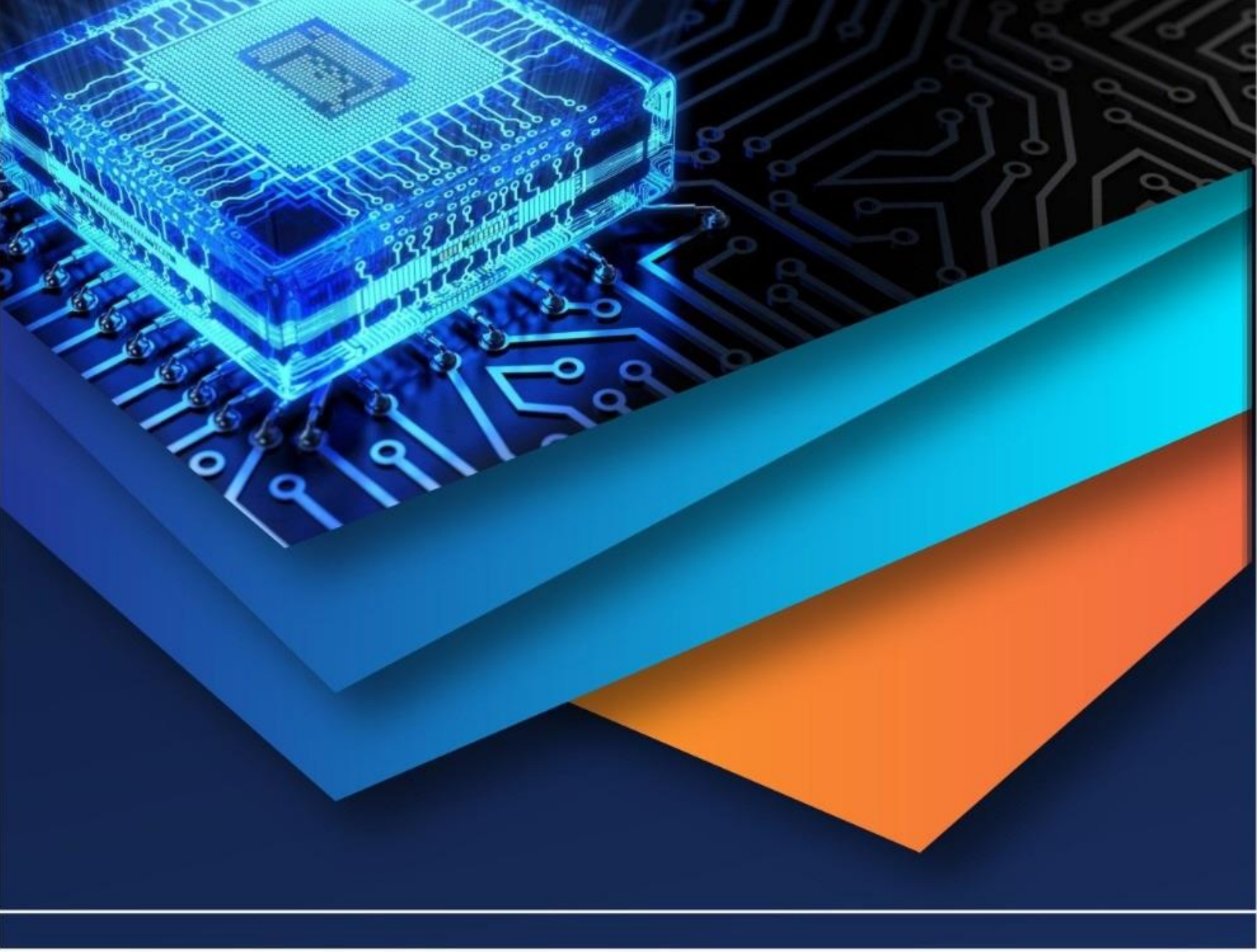

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