Drowsiness Detection Using Deep Neural Network

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Abstract:

One of the major reasons for road accidents is driver's drowsiness which causes several fatalities every year. Various studies on road accidents have proved that 20% of the accidents are caused mainly due to drowsiness among drivers while driving. In this paper, the system records the video and the NTHU Drowsiness Detection datasets for detecting the driver's drowsiness using Image processing techniques. The investigator has also implemented DNN in the both video and datasets to extract the 63 features of a face. These were used to evaluate three measures like yaw, pitch, roll, and eye aspect ratio in order to find the distance between every feature of the face to detect the drowsiness of the driver. Experimental outcomes shows that our framework is better than the existing drowsiness detection methods based on visual analysis

Keywords: —Driver drowsiness; eye detection, Eye Aspect Ratio

Introduction:

Road accidents are nowadays very common. In India, on average 1214 crashes appear every day (Give reference). In 2019 Central Government announced that approximately 1.5 lakh people died in road accidents. India is facing highest death rate in the world. According to(WHO) the reasons for increasing number of road accidents are due to drowsiness in driver, rash driving and worse road conditions. Recently mobile usage also has become a major factor which threats life while driving. If no longer it is focused and acted upon urgently the number of road may increase.

Generally for any normal human being every day a minimum of 6to7 hours of peaceful sleep especially in the night is required to work properly and to carry out their daily activities on the following day failing which may result in unnecessary problems. Most of the professional drivers do not get a good night rest. There are more possibilities for such drivers to get drowsy while driving. In such conditions if the drive's drowsiness is warned in time, several fatal accidents could be avoided.

.Various other factors that causes road accidents are environmental factors and road factors .The environmental factors includes weather conditions and lighting condition and road factors consists of potholes, damaged roads, illegal speed breakers etc. Some warning indications of the fatigued drivers are yawning or blinking frequently, drifting from the lane, and moving the head forward .Our objectives is to proposed a drowsiness detection method using eye state

Figure 1 shows the methods of detecting drowsiness.

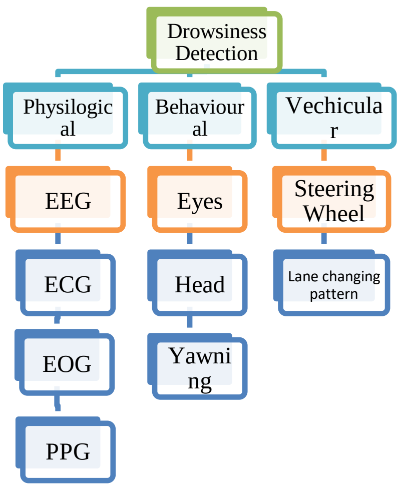


Fig1: Methods of Detecting Drowsiness

Physiological: The data acquired from physiological detection through, pulse rate, heartbeat provides the required information..The theta, delta, and alpha signals are the three main signals to assess drivers' drowsiness. When a driver is drowsy, theta and delta signals spike, whil e alpha signals increase slightly.

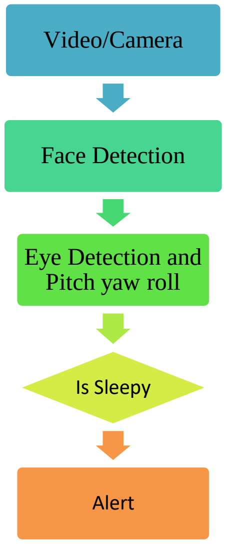
Vehicular: The assessment used for drowsiness detection is the threshold value. The threshold value is calculated and the alarm is generated when the vehicle crosses the lane

Behavioural: The third method is focused on the eye-blink duration, head pose, and yawning. Among the above methods, eye blink detection is the most reliable parameter for the detection of the drowsiness level. The pros and cons of the techniques employed in detecting drowsiness are given in Table 1

Table 1 Pros And Cons Of The Techniques Employed In Detecting Drowsiness

Techniques	Parameters	Pros	Cons
Vehicular Measures	Steering wheel behaviour, yaw angle, lane changing pattern	Non-intrusive	Affected by geometric characteristics of roads, Unreliable
Behavioural Measure	Head movement, Yawning, facial expression	Non -Intrusive Easy to use	Affected by illumination, Lightening conditions
Physiological Measure	Heart rate, pulse rate, brain activity, respiratory rate, body temperature	1)Efficient 2)Reliable	Intrusive

Behavioural Measures are adopted to detect driver's drowsiness in the proposed methodology. Figure 2 represents the general structure followed for driver drowsiness detection



2) Related Work

Venkata Rami Reddy Chirra1 et al suggested a new framework using deep learning was followed**.** The Haar classifier was used to discover the face and Viola Jones. was used to extort the eye location from the face and output is transferred to the next layer .The next layer is the stacked deep convolution neural networks and they are used to extract features. These features are passed to next layers and softmax layer was used to classify the extent of drowsiness. The study was evaluated with the collected datasets which acquired better accuracy of 96.42 per cent when compared to the existing system of ----- per cent. The author additionally planned to make use of transfer learning in the future to enhance the system's efficiency.

Sukrit Mehta et al.., has proposed a real time drowsiness detection system and it was implemented on android application. By using image processing technique the author has captured the image of the driver in every frame. Eye Aspect Ratio and Eye Closure Ratio was made use in the proposed technique with adaptive threshold to detect driver's drowsiness. To test the efficiency of the proposed approach machine learning techniques have been utilized. The proposed system was evaluated on the datasets and it showed a better accuracy of 84% . . The work can be further extended out for various other clients who drive trains , aeroplane , bike etc

Wanghua Deng1 Ruoxue Wu12
also has projected a system called Dricare.The author uses MC-KCF to define the detected facial area based on facial key points. In addition, the author also introduced a drowsiness method based on the state of the eyes .Therefore ,Dricare has a high operating speed .From the experimental results, it was found that Dricare is suitable for different situations and can also provide stable performance

Rukhsar Khan, Shruti Menon has suggested a drowsiness detection system. The author had observed various criterions like face detection, the position of the head, and eye blinking etc. The system was designed to record the videos and the video was converted into frames and the driver's face was detected in every frame .Once the drivers show the sign of drowsiness
the person will be alerted with an alarm .In this system additionally GPS tracking was installed in the cars . The vehicle movement will be detected and it will alert the driver on mobile apps. The movement of the drivers can be kept track by the admin of the system. In case if the driver ignores the warning signals the admin can take
right action according to the situation .
B. Mohana, C. M. Sheela Rani et al also has recommended a drowsiness detection system. Here the author had used Haar based classifier to detect the face and with the help of eye closure detection and yawning the drowsiness detection of the driver has been detected. The proposed system has accurately detected the required eye facial features in 85% of the test cases. It is observed that under better illumination condition the detection rate of the proposed system will increase. The author proposes a system that can detect drowsiness immediately. For future the author has suggested that the work could be extended to eliminate difficulties caused by poor lighting condition.

Toan H. VU†a), An DANG†b), et al...has referred a real time drowsiness detection. The author had provided a DNN model. DNN model consisted of three components i.e. - a convolutional neural network (CNN), a convolutional control gate-based recurrent neural network (ConvCGRNN), and a voting layer. To learn the facial representation from the input faces the CNN are used. The ConvCGRNN was fed with the output from the convolution neural network through which the temporal features such as yawning etc is detected. To predict drowsiness state the voting layer acts like an ensemble of sub-classifiers. The proposed method was executed on NTHU-DDD dataset The experimental results reveal that the proposed model, other than giving a result of 84.81% accuracy without any post processing in real-time also works with a speed of about 100 fps.

T.Edison1*, had endorsed a hybrid method of detecting the level of drowsiness detection. Driver's faces and eyes are extracted from video frames using e Viola and the Jones and taken as inputs and the face and eyes are detected. The hybrid technique is used to analyze the driver's drowsiness level.

Shivani Sheth, Aditya Singhal, V.V. Ramalingam proposed a drowsiness detection system. Haar based classifier was used by the author to recognize the face of the driver in his study.. Eye Aspect Ratio was administered to detect the state of drowsiness of the driver. The author in his study has used Raspberry Pi single-board computer. He had combined the computer with a camera and an alarm system. The alarm system by passing sound signals will alert the driver, which will effectively wake up the driver in real-time to avoid road accidents.

Rateb Jabbar∗†, Mohammed Shinoy also had scheduled **a** drowsiness detection system. Here the author has extracted the images from the video and the face landmarks have been extracted .CNN. It was used to classify whether the driver is in drowsiness state or not . The outcome of the experiment showed an accuracy of 84.81%. However, there is still a scope for improving the performance and detecting better facial feature even in poor lighting conditions. However this technology has a drawback, in detecting the facial features while wearing sunglasses and under poor lighting conditions.

S. Jansi Rani1 et al suggested a system which uses face and eye blinking detection formula based upon the Histogram of Oriented Gradients (HOG) image descriptor and a Linear Support Vector Machine (SVM) for detecting facial features .The author has used Eye Aspect Ratio to evaluate the state of drowsiness detection. Moreover, the results affirm that it's having a higher accuracy even within the low light conditions. The Figure shown below shows the existing methods followed in drowsiness detection.

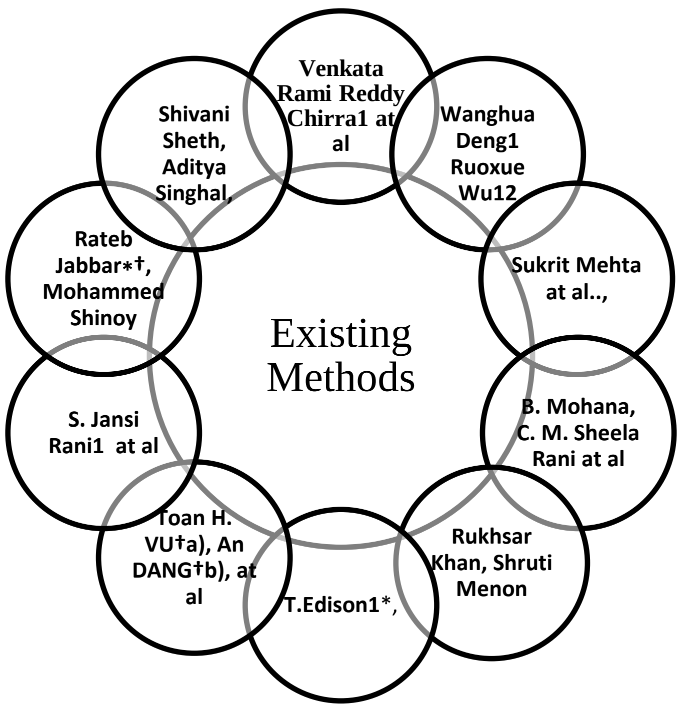


Figure 3 Existing Methods Followed in Detecting Drowsiness

METHDOLOGY:

3.1) Data Collection:

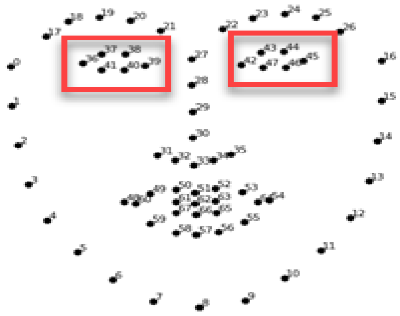
The NTHU Datasets consisted images of three subsets for training, evaluation, and test. . The training datasets involved 18 subjects with 5 different actions namely with a) bare face, b) with glasses, c)_bare face in the night d) with glasses in the night e) with sunglasses. All these subjects were recorded in a variety of simulated driving scenarios under day and night illumination conditions .It also included conventional driving model, yawning, slow blink rate, conscious laughter, and dizzy dozing. The evaluation and training datasets consisted of 90 videos (from the other 18 topics) with the state of drowsiness and non-drowsiness mixed under different conditions.

Fig. 4 Illustrations from the NTHU-DDD dataset from various participants in different scenarios

3.3) **Extracting the Features**

i) Face Features:

An extract of 63 features of the face was used to evaluate 3 measures which is a new contribution method namely yaw, pitch, roll and eye aspect ratio to a gray scale frame .Here we had marked the eyes with green colour



From the facial landmarks, left and right eye coordinates were extracted and the eye aspect ratio was calculated for each eye in three steps.
The vertical eye landmarks were taken in two pairs and the Euclidean distance between them is determined by:

A = dist.euclidean(eye[2], eye[6])
B = dist.euclidean(eye[3], eye[5])
The horizontal eye landmarks are taken and theλ Euclidean distance between them is computed by:
C = dist.euclidean (eye[1],eye[4])

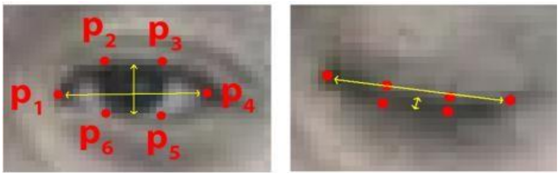


Figure 5. Calculation of the Eye Aspect Ratio

Eye Aspect Ratio = (A + B) / (2.0 * C)

Where eye[1]... eye[6] are 2D positions of facial landmarks..The distance between the vertical eye landmarks is calculated by the numerator in this equation and the distance between the horizontal eye is calculated in the denominator landmarks, There is only one set of horizontal points, but two sets of vertical points. The aspect rati o of the eye is roughly constant when the eye is open, but will rapidly fall to zero while blinking.. When the person blinks the eye aspect ratio decreases dramatically, approaching zero.

Head Movement

Definition of Tilt Angle:

The head actions are utilized as the input by the device. The tilted angles of the head are used more accurately here .
The proportion of rotation of the top along an axis is defined by head tilt angles. Three possible head tilt movements are shown in Figure 5 and are listed as:
Pitch, the vertical movement of head (as in, looking up or down).
Roll, the rotation of the head by swaying the head towards the shoulders.
Yaw, the horizontal movement of head rotation (looking left or right as in•)

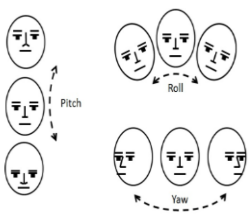
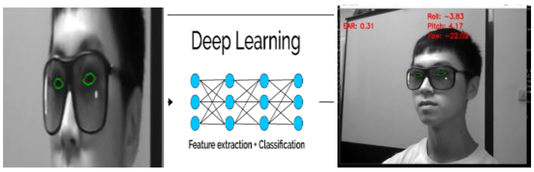


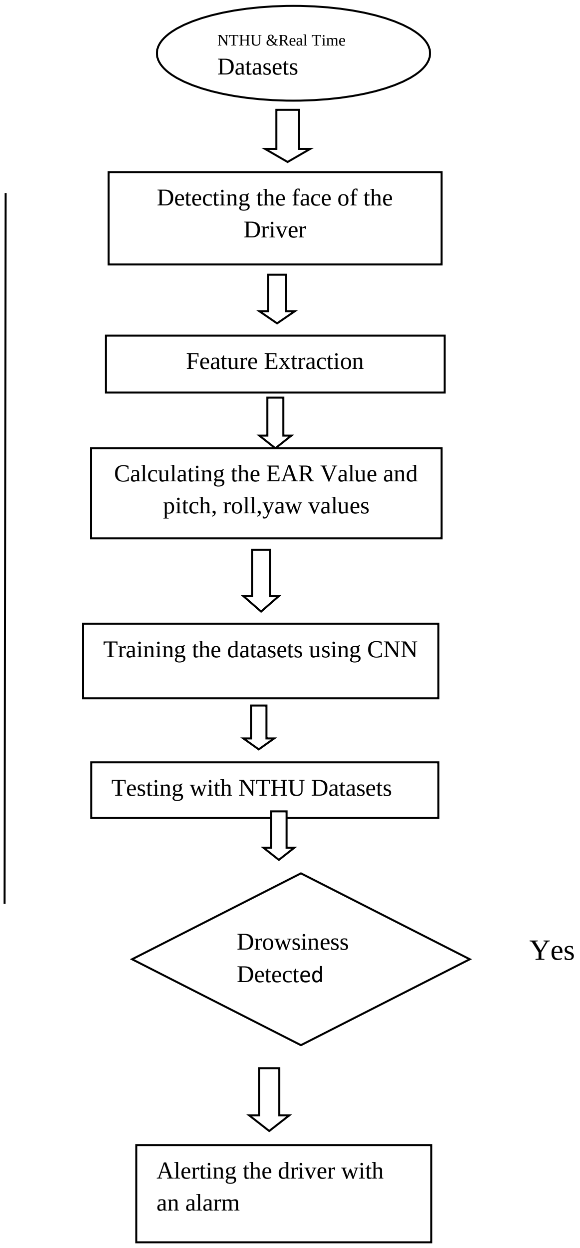
Figure 6: Head Tilt Movements

Algorithm

For detecting the driver's drowsiness, improved deep neural network was used .The proposed system used facial landmarks and head movements. To evaluate the driver's downiness level this was fed into the DNN network



DNN Architecture



Flow Diagram

4. Experimental Results

Here the Drowsiness detection using DNN was successfully implemented on the NTHU datasets. The NTHU datasets consisted of images of three subsets for training, evaluation, and test. . The training dataset consisted of 18 subjects with 5 different action as mentioned before (BareFace,Glasses, Night_BareFace, Night_Glasses, Sunglasses).This part of the study focused on the efficiency of the proposed method

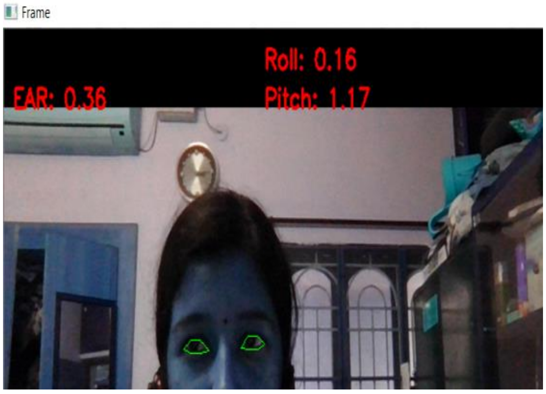


Figure 7. Person with drowsiness detection output

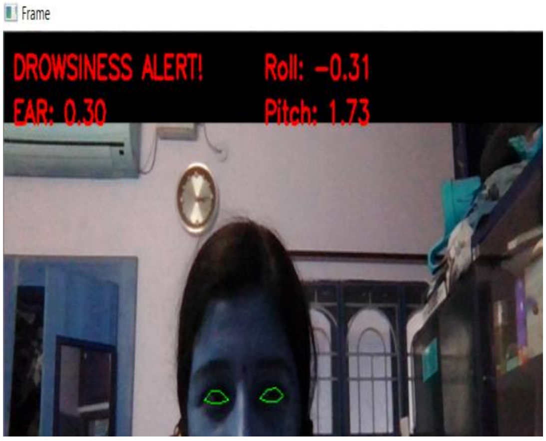


Fig 8 . Person with drowsiness detection output

Subjects	EAR during eyes	EAR during eyes closed
1	0.33	0.081
2	0.28	0.083
3	0.362	0.154
4	0.343	0.182
5	0.31	0.177
6	0.29	0.171
7	0.28	0.11
8	0.35	0.19
9	0.27	0.154
10	0.32	0.182
11	0.4	0.177
12	0.35	0.171

Table 2: Threshold Value for EAR for Eyes Open and Eyes Closed

Training Samples	Testing Samples	Validation Samples	Training Accuracy (%	Validation Accuracy (%)	Testing Accuracy (%)
60%	10%	30%	99.7	96	96.42

From the NTHU Datasets 60 percent of the total datasets have been taken for the training samples and 30 percent have been taken for the validating the dataset and 10% have been taken for testing the samples and we acquire 96.42 accuracy on the datasets

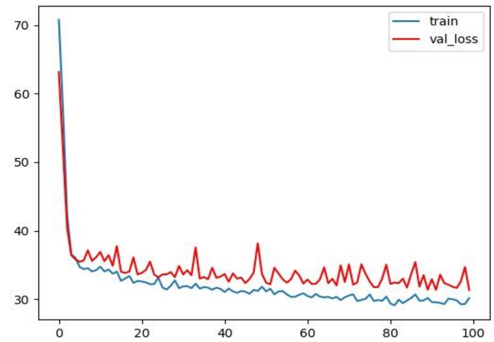


Figure7: Validation Loss Vs Training

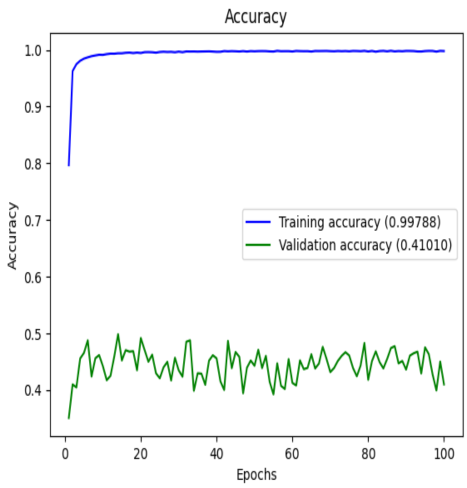


Figure 8: Accuracy

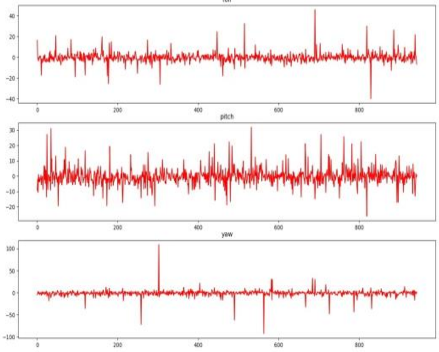


Figure 9: Values of Pitch roll yaw of Datasets

Conclusion

In conclusion, all objectives that were set in the beginning of the research were successfully achieved. The researcher have implemented Eye Aspect Ratio and Pitch, Raw,Roll value and DNN is used to Detect the Drowsiness Detection. In this paper the author have implemented this technique on both video and images and have recorded a greater accuracy when compared with the existing methods The researcher had made an attempt to use this novel method to detect the drowsiness.

5 .Future work

The future work can be improvised by using an efficient grid camera and night vision camera in order to achieve a clear and better resolution of images during adverse climatic conditions like fog, rainfall, and at night times and during other such undesirable environmental conditions. By employing a real time system which has the ability to detect multiple road symbols and which can respond accordingly better results could be obtained. Such initiatives in research may help the public to avoid accidents and assure safe driving in future.

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