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# A Review of Fatigue Detection Techniques

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***Abstract* – Road accidents are increasing tremendously and accident causing factors include over speeding, violating traffic rules, fatigue driving etc. Fatigue driving is due to inadequate sleep or physical state of driver is not good. Many researches have been taken place for detecting fatigue while driving. This paper describes the methods that already implemented and analyse the best method that is much accurate compared to others. The methods include machine learning, deep learning algorithms. In the algorithms single facial features, multiple facial features, physiological features are used for detection.**

***Keywords* – Fatigue, Machine Learning, Deep Learning, Physiological**

## I.INTRODUCTION

The frenetic increase of vehicles all around the world thus increase the number of road accidents. Although fatigue driving is also one such factor for accidents to occur. Fatigue in driving scenario is of two types physical fatigue and mental fatigue, these both types reduces driver's capability to perform driving duty. Physical fatigue is due physical activities performed and mental fatigue is due to the physiological state, conditions that may decrease the mental capabilities. This mental fatigue reduce the driver's focus, alertness, attentiveness, decision- making ability thus it reduces driving functionality. The main factors affecting can be continuous hours of awake, sleep disorders, medication, stress and workload.

The detection need to be done at early stages of fatigue inorder to avoid accidents. The detection of fatigue can be subjective or objective as subjective methods require driver to check fatigue by physiological actions and objective methods include the parameters related to driving. Fatigue detection methods in real time are divided into four categories. These categories belong to both subjective and objective methods in which subjective methods has low accuracy and performance in real time is very poor .Objective method for detection is more reliable ,accurate as these use machine learning and deep learning algorithms for detection .

The first category include drivers physiological signals electroencephalogram (EEG), electrocardiograph(ECG), electrooculogram (EOG) [1] .The second category is methods related to driver behaviour such as the controlling of steering wheels and immediate action upon fatigue condition. Third category is based on vehicle condition like vehicle in lane and its information related to it and the fourth category is based on physiological reactions. It includes physiological behaviour like blinking, yawning. The most effective method of fatigue detection is by eye states as the duration of eye state remain closed is more than eye state is open in driver fatigue situation and so the frequency and effectiveness is more for closed eye state.

The factors related to fatigue driving are eye blink, PERCLOS, pupil diameter, head rotation , yawning ,gazing , ahead nod ,emotional action units, facial action units ,nasal electrodermal activity and physiological signals like pulse rate, heart rate, breathing rate, palm electrodermal activity in which visual sensors and physiological sensors are using for capturing respective factors.

The algorithm used for fatigue detection Facial Action Coding System (FACS) ,Support Vector Machines (SVM) ,Hidden Markov Model(HMM) ,Convolution Neural Network (CNN), Long Short Term Memory(LSTM) , Deep Learning Architectures, Fuzzy Expert Systems, Dynamic Bayesian Network, You Only Look Once(YOLO) . Along with fatigue detection face detection is one of the important factor and the algorithms and techniques used for face detection include Haar Cascade Face Detection, Ada Boost Algorithm , Viola Jones, Eigen Faces, Edge detection ,Hough Transform ,Template Matching. In this paper, we study about the detection methods and can analyse how effective each algorithm.

## II. LITERATURE SURVEY

In this section the different fatigue detection techniques used in previous studies and the overall outline of each method is defined and also the face detection method for each technique is marked.

### 1. Facial Movement Analysis

Ersa Vural and Mujat Cetin [2] anlyzed that apart from focus on eye closure and blinking the machine learning is used for determining actual human behaviour during drowsy or fatigue state. Automatic classifiers for 30 facial actions from Facial Action Coding System was developed with the help of machine learning and a database is created for facial expression storage. The facial expression can include blinking, yawning and also a number of facial movements .The head motion was collected during automatic eye tracking ,and an accelerometer. These measures will pass to classifiers like Adaboost and multinominal ridge regression . The drowsy prediction was done basis of these two classifiers. Yawn feature is also predicted in this and thus the system predicts falling sleep and avoids accidents to be caused.It is a long back technique.

**2. Machine Vision**

This paper by Wanzeng Kong, Lingxiao Zhou YizhiWang, Jianhai Zhang, Jianhui Liu,and Shenyong Gao [ 3] proposed a practical system to detect fatigue by machine vision and adaboost algorithm. The eye and face classifiers are trained by Adaboost algorithms.The strategy of proposed techniques was to detect face effectively from face classifiers of front face and deflected face.Then the eye region of the specified face is determined according to the geometric distribution of facial organs. Lastly the trained classifiers of open and closed eyes are used to detect the eyes in the specified region quickly and accurately . The index which include PERCLOS and duration of closed state of eye are extracted from the real time video frames. After that the system has been shifted to a smart device,it can be a smart phone, tablet that have its own camera and thus it shows high performance .In its practical application it results high accuracy and it is implemented in smart device that use daily.

**3.Bayesian Network Framework**

The paper by Q. He, Z. Fei, X. Fan, and W. Li [4] proposed that the Electroencephalogram (EEG) data are used for fatigue detection. Head nodding in a day at frequent times is a factor for detection .An EEG based indicator has established by Artificial Neural Network based on the samples of EEG. 50 drivers were included the driving experiment. The signals such as temperature, anxiety, mood and personalities are not examined and studied. Head position sensor is used to monitor head pose and rotation, but it is much expensive. Dynamic Bayesian Network model is established and it is much accurate with results obtained but DBN is computationally complex.

**4. Physiological Parameter Based Detection**

In this study , J. A. Healey and R.W. Picard stated that [5] when a driver is in fatigue state the physiological response will be slow the body response will be delayed and the physiological indicators deviate. Physiological sensors are used for collecting physiological features. The detection methods, are based on EEG EMG, ECG , and pulse beat and respiratory frequency. This physiological signal information was used by adaptive system automatically and it helps the driver to know about the stress levels and thus can be reduced. The change of band signal and degree of fatigue is a common relation in which the detection algorithm is able to use the real-time EEG signals to make accurate judgments. EEG signals are common and reliable index feature for fatigue detection. It has high reliability ,sensitivity and anti interference ability, expensive cost.

**5. Fuzzy Based Method**

Omar Rigane, Karim Abbes, Chokri Abdelmoula and Mohamed Masmoudi [6] propose an intelligent method for detection of fatigue by visual behaviour of driver. The view of driver is made by facial and eye symptoms use fuzzy logic controller. The experiment results was done in MATLAB and shows high reliability and robustness in the result. The drivers face and eyes are localized and the related behaviour are extracted by Viola Jones detection methods.The fuzzy system is used to combine the symptoms and moniter drivers attentions.

**6. Computer Vision Method**

Hitendra Garg proposed [7] a Real-Time Drowsiness Detection System (RTDDS) which can be used in all types of smart vehicles with the assistance of computer vision applications. For this method he uses features like blink rate, eye closure, yawning. The facial keypoints is obtained initially and by using Viola Jones face detection method the facial features is extracted. The eye region ,mouth region are localized by keypoints. Eye Aspect Ratio and Mouth Aspect Ratio is obtained from the respective classifiers and also blink ratio and yawn frequency is also noted. After exceeding a predefined threshold value the fatigue can be determined and driver is make awake by alerting through an alarm or buzzer .

**7. Artificial Neural Network Method**

Charlotte Jacobe de Naurois, Christophe Bourdin , Anca Stratulat , Emmanuelle Diaz , Jean-Louis Vercher [9] proposed that including the data like driving time and participant details can improve the accuracy of detecting and predicting the accidents due to fatigue or drowsiness. All the physiological and behavioural factors of 21 drivers were recorded in the experiment. Also the driving behaviour was also noted like the time of lane change ,crossing, speed etc. Combining all these features were tested with a real driver that is by video recordings compared with the trained samples. Here two models of ANN were developed as one is for detection and other one is for prediction.Thus ,it was resulted effectively.

**8. Support Vector Machines**

Minho Choi, Sang Woo Kim [10] implement a new method by SVM as Online Support Vector Machine to

solve inter driver variation problems.It mainly focuses on drowsiness .It is done by selecting important data from the previous training and retains itself by new feedback data. For faster adaptation and for low error rates two OSVM is used in the proposed system.The experiment was done by using wearable gears and thus system shows high accuracy nearly 95% compared to others.

**9. Conventional Neural Network**

Kening Li, Yunbo Gong, Ziliang Ren [11] proposes a method with multiple features and it also used YOLO algorithm for fatigue detection. This algorithm captures face region from complex backgrounds thus it reduces the inaccuracy .The eyes and mouth features are marked by keypoints and it stores in separate classifiers.The driver's biometric is stored in information library and verification for fatigue is done by online assessment. Large dataset is needed for implementation and so, it is computationally complexing.

## III. PROPOSED SYSTEM

Various types of fatigue detection technique is discussed in litersture survey section and some of the techniques has its own drawback some others cover up other methods .One of efficient as well as accurate method for detection is Haar Cascade Method. In this method, the face and eyes are detected by Haar Cascade Face Detector and Eye Detector and also we can calculate the blink frequency and eye aspect ratio very effectively thus fatigue can be predicted easily.

## IV. CONCLUSION

In this paper fatigue detection techniques have been discussed .Each technique has separate face detection algorithm .The face and eye detecting and segmenting is the common process and keypoints are obtained in each one . Fatigue detection is an ongoing research and methods are implementing .Some techniques can be effectively used by combining two methods like SVM method and Viola Jones algorithm.By combining the result shows much accurate one. For each keypoints there is a certain values which can be predefined and by comparing the values state of the driver is marked and determined.

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