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A GUI approach to Fatigue Detection System

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Abstract- Owing to majority of accidents happening on transport roads due to sheer carelessness of drivers, there arises a dire need to devise a mechanism which can monitor the drowsiness state of the driver and this paper represents a mechanism in the form of software application. Our application is implemented using PYTHON language and has been tested with different test cases by the approach of GUI like different light conditions, close-ups, and along with facial and non facial features. We present the results based on the experimental study conducted.

Index Terms- Fatigue Detection, Sleep Points, Drowsy Driver, Eye detection, facial features, and Python

I. Introduction

The innovations in the automobile industry over the last hundred years have made vehicles more powerful, easier to drive with safety mechanisms too. Vehicles now-a-days are more energy efficient, and environmental friendly. However, majority of the accidents these days are caused mainly due to driver fatigue. Today's fast life and long distance causes excessive fatigue and tiredness which in turn makes the driver sleepy or drowsy. With the rapid increase in the number of accidents over last few years, a need arises to design a system that alarms the driver focused on the road in case he/she feels sleepy or drowsy.

Studying the data on road accidents in India, as collected by Transport Research Wing of Ministry of Road Transport and Highways, we found that 57% of fatal truck accidents are due to driver fatigue in the trucking industry [3]. Many commercial drivers in hoard of more and more money do not care for their health consciousness and 90% of them end up in fatigue while driving.

It is the principal reason of heavy truck crashes. Seventy percent of American drivers agree to fatigue related driving. The National Highway Traffic Safety Administration (NHTSA) estimates that there are 1, 00,000 crashes that are caused by sleepy drivers and result in more than 1,500 fatalities and 71,000 injuries each year in U.S [6]. With the rising traffic conditions, this problem will further increase.

For this reason alerting the driver of any insecure driving conditions is essential for accident prevention or avoidance. In the last 10 years, many countries around the world have begun to pay attention to driver's safety problems, to investigate and monitor the mental state of driver which relates to driver safety. Therefore, there is a need to detect fatigue during driving. Thereby, efficiently preventing many accidents, and saving the lives of human beings.

The aim of this paper is to develop a prototype of fatigue detection warning system. Our whole focus and concentration will be placed on designing the system that will accurately monitor the open and closed states of the driver's eyes in real time. By constantly monitoring the eyes, it can be seen that the symptoms of driver fatigue can be detected early enough to avoid any accident. This detection can be done using the video input of drivers' eyes as well as face and head movement. The observation of eyes' movements and its edges for the detection will be used. Devices to detect if drivers are falling asleep and to provide them warnings of risk, or to even control the vehicle's movement, have been of interest to research community as well as trucking industry. Driver fatigue is a serious problem resulting in many thousands of road accidents each year. It is not currently possible to calculate the exact number of sleep related accidents because of the difficulties in detecting whether fatigue was a factor and in assessing the level of fatigue [6].

Our work involves developing a GUI application to detect eyes and head movements using Python language. The observations present in this paper are based on this application. The test cases have been devised by the authors of this paper while considering one of the authors as subject of the test cases. The rest of the paper is organized as: Section II presents a brief overview of the approach towards fatigue detection system followed by experimental study presented in Section –III. Section IV presents the observations from the experiments and the analysis results. Section V finally concludes the paper.

II. Fatigue Detection System

The common reasons for drowsiness come to light when the driver faces prolonged hours of seating on the vehicle seat resulting in fatigue. Various factors involving this can be quoted like sleep, work, physical, or time of day. While much travelling, overwork or not getting breaks or halts between consecutive drives is one reason, the time of the day holds much more prominence in the reasons of fatigue. Between 2 AM and 6 AM, the brain gets ample weariness and needs some rest. For physical reasons, some people are on medications, which are sedatives in nature and bring about sleepiness. As an effect, this proves much fatal to the driver himself. Not only this, but to other travelers on the road, inclusively posing threat to pedestrians too. [4]

A. Related Work: The Fatigue Detection System proposed by Sontakke [1] was implemented using Knowledge base (KB) model. Her KB Model included detection of facial features only. However, these features are not easy to compare. Secondly, her approach is based on the KB available that may not work with different skin tones and people from different ethnicity. The computational complexity of image comparison against the knowledge base in real- time is higher, therefore, it is not possible to compare the current driver's data against the KB while driving. The search algorithm applied by the author lacks the accuracy of exact determination of either open or closed eyes.

B. Ji, Zhu and Lan [3] have considered several modifications with facial fatigue detection over existing operational techniques. However, these techniques need infrared (IR) eye detector, or clear pupils without any obstruction and well-lit illumination. They have further used the Kalman Filter method to track the eye movements. But, a Kalman Filter is linear system estimation methodology. In fatigue detection eye motion graph is highly nonlinear so standard Kalman filter is not very useful. Sun et al. [6] have resolved the linearity problem in Ji, Zhu and Lan's approach by using a nonlinear Kalman filter for fatigue detection. But, the limitation with their approach is that it requires application of IR-sensitive camera [5].

C. Our approach builds on Canny edge detection algorithm that has the advantage of detecting curved edges. We have further used the concept of hull convex in our proposed fatigue detection system.

III. Evaluation Study

We have coded the proposed algorithm of calculating the dark pixels with respect to the localization of other eye features like pupil, eye lashes, nose etc. The algorithm is fed with a video as input. Herein we have selected an AVI format (.avi) because of its better resolution quality and feasibility in terms of frame extraction at a better rate.

In order to validate In order to validate our approach, we designed our experimental study based for open and closed eyes in different illumination settings.

The experiments consider different scenarios of shadow conditions, whether the subject is wearing spectacles or not, and if the input video is gray-scale or colored. When the video is fed as input to our algorithm, we manually select a region of interest manually. The region of interest in our case is rectangular in shape and could be of any size. But on a practical note, we have taken a significant size though, but we are considering significant rectangular size close to the size of eye. The region of interest is selected for following three different cases:

- Focusing on single eye, with majority of frame covering only eye portion excluding other major eye features.
- Focussing on *both eyes* covering other facial features like parts of nose and eye brows
- Focusing *whole or partial face*, viz. major part of face inclusive of eyes, eye brows, skin

Our algorithm plots nonlinear continuous graph for the input video. The graph for each of the above-mentioned particular cases displays the troughs as when and what time the driver blinked for an unusual longer time intervals, variably different than usual rapid instant eye blinks. Those troughs designate the peculiar *sleep points* that are, in turn, manually validated.

The various cases undertaken for experimentation are enlisted below:

1. Colored video with Shadow over eyes.
2. Gray-Scale video in Darkness
3. Gray-Scale video with proper illumination (subject-1)
4. Gray-Scale video with proper illumination and much CLOSE-UP
5. Colored video with proper illumination
6. Gray-Scale video with proper illumination (subject-2)
7. Gray-Scale video in shadow and CLOSE-UP
8. Gray-Scale video having Spectacles with proper illumination
9. Gray-Scale video having Spectacles with proper illumination, but the subject gets out of frame.
10. Gray-Scale video with proper illumination, but subject is under Real-Drowsiness enactment.

We have considered ten different videos as test cases where each video comprises the above-mentioned three cases – single eye, both eyes and partial/whole face.

IV. Observations

A. As discussed in the previous section, the algorithmically detected sleep points are manually validated for their accuracy and, the accuracy is measured in terms of the number of manual counts of long blinks taken by the driver to the plotted sleep points.

B. Figure 1 presents observations for one of the test videos for single eye. Figure 2 presents observations for one of the test videos for both eye. Figure 3 presents observations for one of the test videos for whole/partial. Case.

C. The accuracy results are averages of three cases for each of the test videos. The results presenting average in each of the three cases are summarized in following points:

- Process Count (1) **-** A Single Eye (Lowest Accuracy with 54.2.26%)
- Process Count (2) **-** A pair of eyes (Best Accuracy with 69.98%)
- Process Count (3) **-** A pair of eyes with external facial features incorporated (Medium Accuracy with 67.7%)

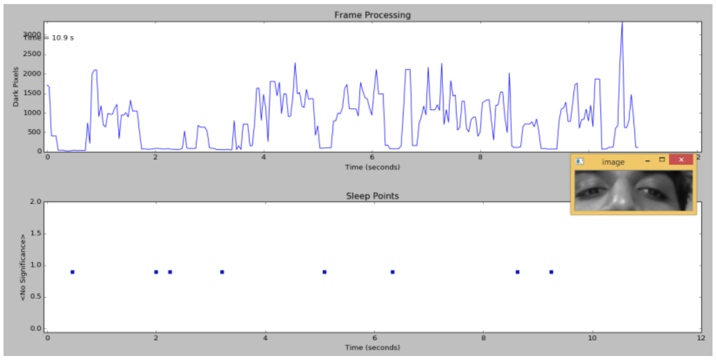

Figure 1: Process Count-2, Case-3

Manual Count: 7
Process Count: 08
Accuracy: 87.5%

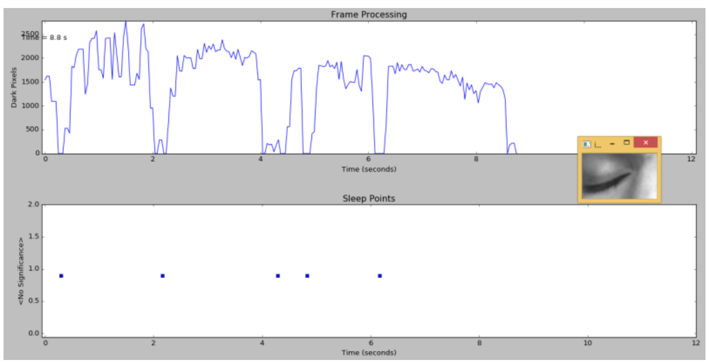

Figure 2: Process Count-1, Case-4

Manual Count: 5
Process Count: 05
Accuracy: 100%

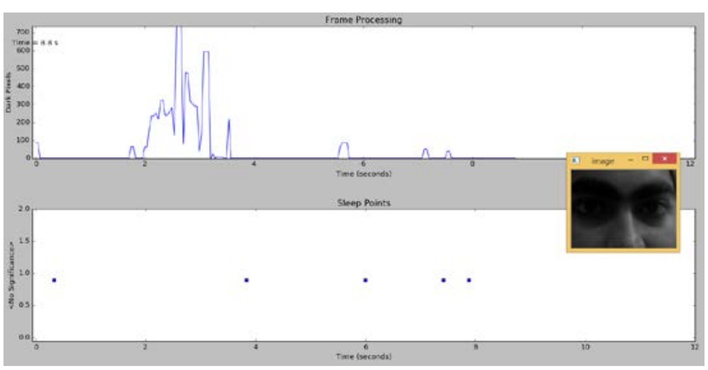

Figure 3: Process Count-3, Case-7

Manual Count: 5
Process Count: 5
Accuracy: 100%

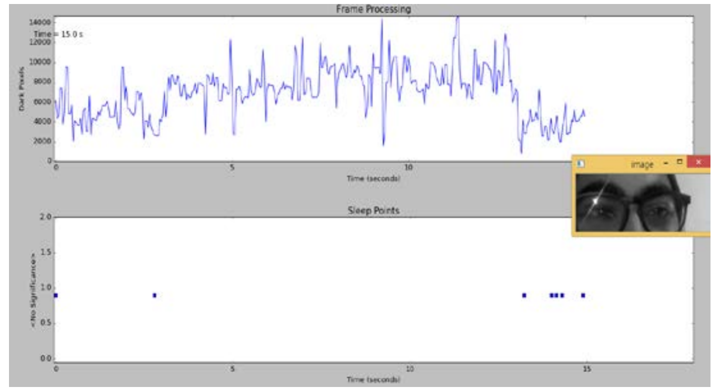

Figure 4: Process Count-9, Case-2

Manual Count: 8
Process Count: 07
Accuracy: 87.5%

Table 1 below presents accuracy chart for the test cases considered in our evaluation study:

Table 1: Accuracy Chart

Case	**Manual Count**	**Process Count- (1)**	**%age**	**Process Count- (2)**	**%age**	**Process Count- (3)**	**%age**
1.	3	0	0	0	0	0	0
2.	4	0	0	5	80	5	80
3.	7	7	100	8	87.5	5	71.4
4.	5	5	100	5	100	5	100
5.	4	7	57.1	4	100	4	100
6.	8	8	100	5	62.5	9	88.8
7.	5	0	0	5	100	5	100
8.	6	3	50	3	50	1	16.6
9.	8	11	72.7	7	87.5	2	25
10.	6	5	83.3	2	33	7	85.2
∑=			**54.26**		**69.98**		**67.7**

As evident from Table 1, we have got best, worst and average accuracies under following conditions:

A. The Table of Statistical Analysis shows the accuracy of 100% in the case where the Best Case comes out to be Gray-Scale Video with Close Up and well Illumination.

B. While the worst scenario comes out to be, when the video input of the subject is observed in Colour and ill-lit area, i.e. much darker region of interest. With accuracy of 0%.

V. Conclusion

Table 1 shows the accuracies calculated in all cases. The best case with 100% accuracy comes out to be Gray-Scale Video in Close Up and well illumination while the worst case scenario is observed in colored video with darker region of interest having accuracy of 0%. In total, thirty cases are observed on the basis of Color/Gray Scale, Dark/Light conditions, Spectacles/without spectacles and also head movement. The method above described lacks, where manually the video is to be fed as input to the analyzing system. Its future scope can be extended for increasing the accuracy in colored videos as well. Currently best results are showing up in Gray-Scale video input.

Furthermore, it can be extended to the automatic selection of region of interest of pair of eyes within the input video. The idea proposed in the system can be a base for devising an efficient fatigue detection system, which can be beneficial for avoiding accidents, and eventually improving the lives of people.

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