Drowsiness Detection in E-Learning

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Abstract: The paper presents a system to detect drowsiness among E-Learners which will help the learners enhance their knowledge efficiently and correctly. A system needs to be designed that would tweak according to the drowsiness of the learners. It analyses visual features from the learner's facial images having unique features such as Eye Blinks. The system detects for drowsiness by calculating the EAR ratio of both the eyes and also calculates the number of blinks done by the learner. If drowsy behavior is observed then appropriate steps to remove drowsiness, will be invoked by our system. The idea behind this system is to increase the level of concentration of the learner.

Index Terms **- Drowsiness, E-Learning, Face Detection, Eye Aspect Ratio (EAR) ratio, Eye Blinks, Alert System, Timeline extraction.**

I. INTRODUCTION

Education is most important aspect of a person's life. Nowadays in the era of smart devices, E-Learning technology is evolving day by day. Enthusiast learners prefer to enhance their knowledge by watching the online tutorials and videos along with the classroom learning. In the process of learning one can feel drowsy due to which concentration of learner decreases leading to lack of interest in learning. Feeling lethargic or tired during the day time is commonly known as drowsiness.

In a classroom, a professor can easily detect the drowsy nature of the learners and can quickly change the content of teaching or could make the content more engaging to grab the attentiveness of the learners. But while the learner is watching online tutorials it is difficult to judge whether a learner is feeling drowsy or not and to make the video more interesting. Our objective is to integrate the drowsiness detection system in E-Learning to enhance learner's performance.

So, we develop a system which can detect drowsy nature of the learner while watching the online tutorial by which the efficiency of the learning process will increase gradually. Our proposed system will use the concepts of facial landmarks detection, EAR ratio calculation to calculate the number of eye blinks which will help in detection of the drowsy nature of learner. If drowsy nature of learner is detected then an alert system will be invoked and the timeline will be captured by our system. In our alert system, the learner will perceive an alarm and a leisure activity consisting of a puzzle/game/questionnaire.

II. LITERATURE REVIEW

This section describes about our study of the existing systems which we have used as a reference for proposing our system. We referred different papers based on driver and learner drowsiness detection. From different papers we have measured different parameters viz techniques used, hardware components used, inference, etc. We have compared all the existing system and the results are shown in table. Refer TABLE I: Comparison Table of Existing Systems on the next page.

III. PROPOSED SYSTEM

The system inputs the video frames from the user. The video is pre-processed for enhancement. In this process the noise and the blurriness of the video is handled. The facail points are detected using the Dlib Library, followed by drowsiness detection and if learner is drowsy the alert system is invoked. In our alert system we have implemented that a questionnaire or puzzle would be displayed to make them attentive and the timeline would be recorded so that it could be made interesting later on. The outline of the system is shown in Fig. 2.

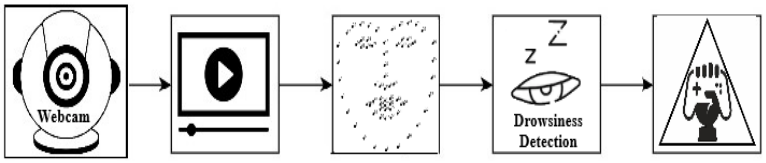

Fig. 2: System Outline.

TABLE I: Comparison Table of Existing Systems

Reference	Techniques Used	Advantages	Disadvantages	Hardware Used	Inference
Student Emotion Recognition System (SERS) for e-learning improvement based on learner concentration metric.[1]	Implementation in MATLAB and face detection using Viola jones and LBP	To detect the concentration level of the student by continuously monitoring the head rotation and eye movement.	The quality could be achieved better based on the concentration level recognized using eye and head movement.	PC, Webcam	The system is efficient enough to detect the negative emotions like boredom or lack of interest of the student in e-learning environment.
Learner attending auto-monitor in distance learning using image recognition and Bayesian Networks.[2]	Image Recognition Techniques and Bayesian Network assessment.	The accuracy of the algorithm in detecting feature behaviours is quite high.	Under certain conditions, i.e. changes of illuminate, background complexity, and computer processing speed, the results might be affected to certain extent.	Pentium 2.4 MHz CPU, 256MB memory, Webcam (0.3-Megapixel).	An auto detection system is designed for defining facial expressions and behaviour when the learner is inattentive.
Automated Alertness and Emotion Detection for Empathic Feedback During E-Learning.[3]	Assessment of alertness level using ocular parameters such as PERCLOS and saccadic parameters,	intelligent assessment of alertness in the context of learning and an appropriate feedback generation method has been proposed	emotion recognition is associated with ambiguity and error while mapping emotional states to the factors that can be used to detect them.	scleral search coils, EOG, webcam	propose a stand-alone system that can be used in different learning contexts independent of the e-learning system.
Hey, Wake Up: Come Along with the Artificial Learning Companion to the e-Learner's Outcomes High![4]	Three-Stage Methods 1. Pilot test: 2. Prototype 3. Evaluation:	Android mobile applications capable of communicating with capturing systems	Under certain conditions, i.e. changes of illuminate, computer processing speed, the results might be affected to certain extent.	Webcam, pc	Two peer-to- peer analysis methods are used to compare the collected data with the three levels (0: Alert; 1: Slightly sleepy; 2: Very sleepy)
Real-Time Nonintrusive Monitoring and Detection of Eye Blinking in view of Accident Prevention due to Drowsiness.[5]	A. Face and eye detection B. Eye blinking detection (open/close) C. Warning system design	this paper approaches face detection using Viola-Jones object detection framework	the effects of poor detection due to insufficient light, night vision camera.	eye blink sensor, alcohol sensor and IR sensor. Charge-coupled-device cameras.	This system works by analysing the eye movement of the driver and alerting the driver by activating the buzzer when he/she is drowsy.
Driver Drowsiness Monitoring System using Visual Behaviour and Machine Learning.[6]	eye aspect ratio, mouth opening ratio and nose length ratio	Bayesian classifier, Fisher's linear discriminant analysis (FLDA) and Support Vector Machine (SVM) is used.	Depending on the sensors used in the system, system cost as well as size will increase.	Electrocardiogram (ECG), Electrooculogram (EOG), webcam	a low cost, real time driver drowsiness monitoring system has been proposed based on visual behaviour and machine learning.
Real Time Drowsiness Detection using Eye Blink Monitoring.[7]	A. Face Detection B. Eye Detection C Drowsiness Detection	Mandeep et al's algorithm which provides 99.4% accurate results with a negligible error rate. Glasses.	not support driver's wearing sun glasses. required high resolution camera.	Electrocardiogram (ECG), Electrooculogram (EOG), webcam	This technique gives highly accurate results when used under good illumination conditions and executed using a high-resolution camera
Real-time Driver Drowsiness Detection for Android Application Using Deep Neural Networks Techniques.[8]	1– Extracting NTHU Database: 2–Extracting Images from Video Frames: 3– Extracting landmark coordination from images: 4– Training the algorithm: 5– Model extraction:	to the experimental results, the size of the used model is small while having the accuracy rate of 81%.	wearing sunglass can decrease system performance. as well as the error rate increases by 6% with the rise in the luminosity.	Intel Core i7-7500U, 8 GB RAM, Intel GMA HD 2 GB.	The role of the system is to detect facial landmark from images and deliver the obtained data to the trained model to identify the driver's state.

A. System Overview

The procedure for drowsiness detection is as follows: -

1. Acquire the video through Webcam.
2. Extract the frames from the video.
3. Detect Facial landmark using Dlib library.
4. Calculate the Eye Aspect Ratio (EAR).
5. If EAR < THRESHOLD //where threshold=0.25
   - 5.1. If COUNTER >= 3 then increment number of blinks.
   - 5.2. If Number of drowsy frames >= 20
     - 5.2.1. Alert System/Leisure Activity will be executed.
     - 5.2.2. Respective Timeline will be captured.
6. Print the Number of blinks and show alert.

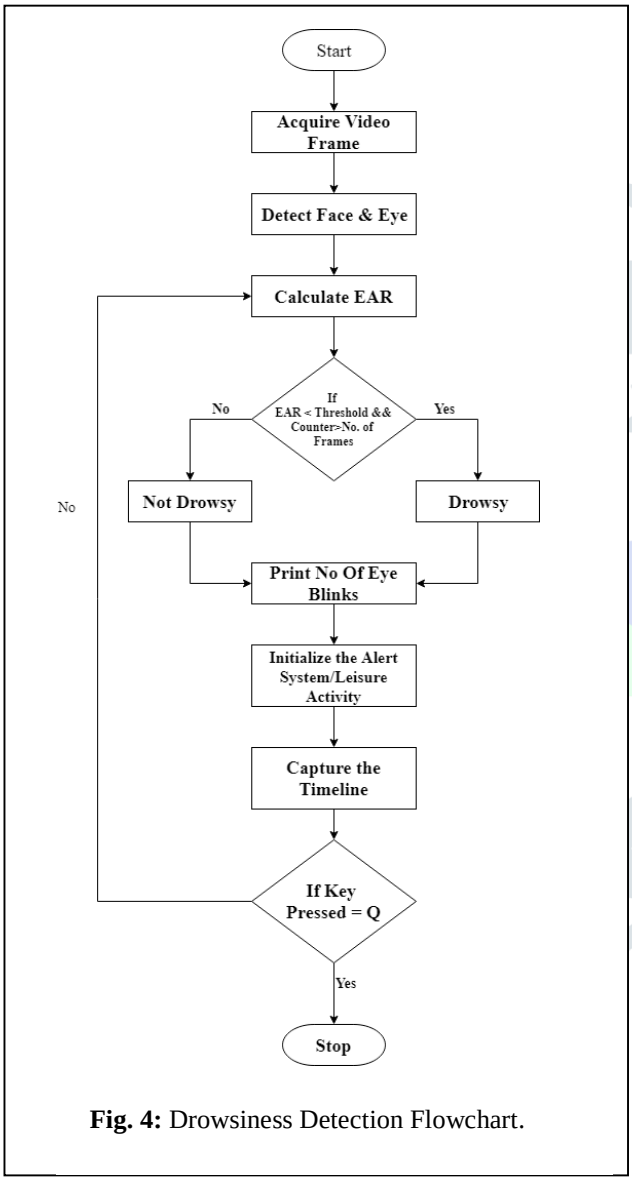

Fig. 4: Drowsiness Detection Flowchart.

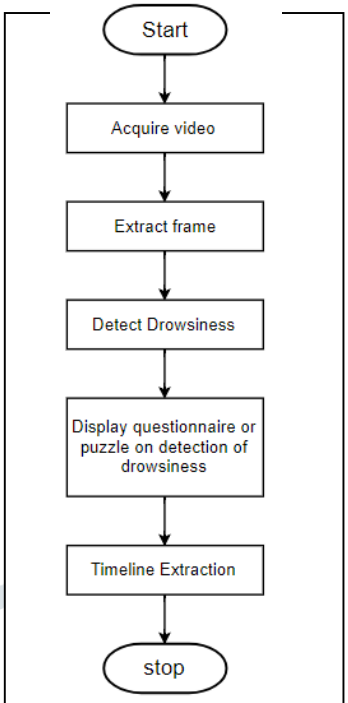

Fig. 3: System Flowchart.

The above Fig 3 shows System Flowchart and Fig. 4 shows the detailed workflow and procedure of the system.

B. Eye Aspect Ratio (EAR)

A person's eye can be represented using six points which will cover the entire eye as shown in Fig..5. We will use these six points to estimate whether a person's eye is open or closed by calculating the Eye Aspect Ratio. The value of Eye Aspect Ratio will decrease if the person's closes its eye and will increase if the eye is open.

There is a set of horizontal point (P0, P3) and two sets of vertical points (P1, P5) & (P2, P4).

By using these points, we can calculate the Eye Aspect Ratio.

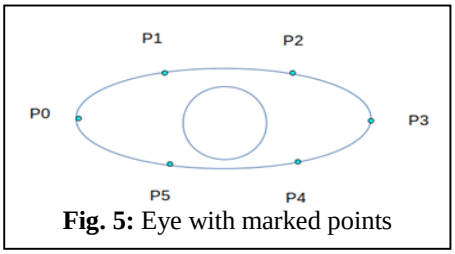

Fig. 5: Eye with marked points

In the given formula, we multiply the denominator by 2 to equate the outcome of adding two vertical points sets. Once we calculate Eye Aspect Ratio, we used it as a threshold value and made an action that a value higher than these means the eyes are open and any value lowed than these means the eyes are closed. A blink can be simply defined as an eye is closed for some time before it opens again. Further we added the condition that if for three continuous frames the Eye Aspect Ratio is lower than the threshold value, then, we can say that a blink has countered. Thus, we can keep a counter of the number of blinks.

$$EAR = \frac{||P1 - P5|| + ||P2 - P4||}{2\,||P0 - P3||}$$

C. Alert System

In our system, upon detection of drowsy behaviour of a learner respective timeline of the video will be captured and after that we have implemented an alert system which consists of an alarm sound followed by a game/puzzle which will be activated for few seconds for removal of drowsiness.

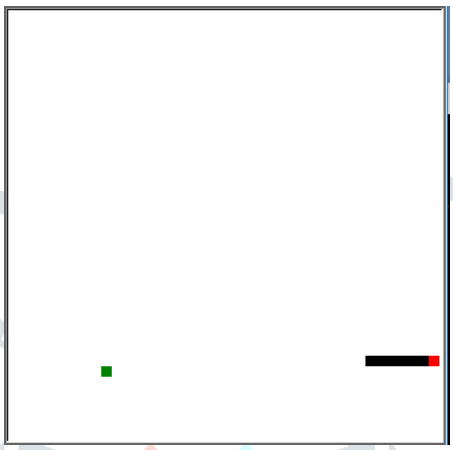

Fig. 6: Game (Snake Game) Invoked.

D. System Requirement

In this section we describe the requirements for an effective drowsy learner detection system.

1. Hardware Requirements
   - 1.1. CPU: Any Intel CPU (64-bit processor)
   - 1.2. RAM: 4GB Recommended
   - 1.3. GPU: Graphic card (2GB recommended)
2. Software Requirements
   - 2.1. Editor: Any editor which supports python.
   - 2.2. Libraries: NumPy, SciPy, Imutils, OpenCV.
   - 2.3. Environment: Python, Dlib.

E. Expected Outcome

In this section Fig. 7 shows the output for implementation of the system which clearly portray that the learner is drowsy.

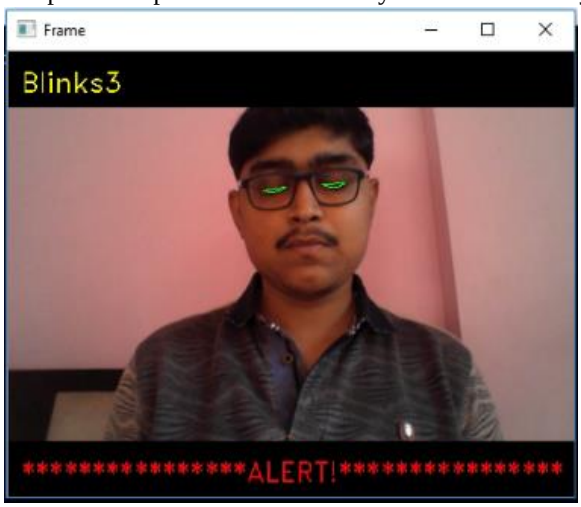

Fig. 7: Output.

Fig. 8 shows the output of the alert system which clearly describes the absolute working of our system.

Fig. 8: Working of System.

F. Analysis

We have tested our system on many individuals and it is detecting the eye blinks and drowsiness successfully. As soon as the drowsiness is detected the alert system gets activated and the log file that contains the timeline of the video is generated. Below are the details of results found after considering various situations/test cases.
Refer Table 2: Analysis Table.

TABLE II: Analysis Table of Various Situations.

Test Case ID	Test Case	Eye Detection	Blink Detection	Drowsiness Detection	Alert System activated	Log file generated
1	With Spectacles	Yes	Yes	Yes	Yes	Yes
2	Without Spectacles	Yes	Yes	Yes	Yes	Yes
3	Saccadic Condition	Yes	Yes	Yes	Yes	Yes
4	Dead Eye	No	No	No	No	No
5	Watery Eyes	Yes	Yes	Yes	Yes	Yes

IV. Conclusion and Future Scope

The system works on the principle of facial landmark detection using Dlib Library and by calculating the EAR ratio. The system can be useful for drowsiness detection for drowsy learners. This system shall be useful for the usage of a personal computer for all those who prefer E-Learning. Our low-cost based system aims to be affordable for the majority of the enthusiast learners.

The future scope for this system will be, to be used for monitoring and detecting drowsiness for online training platforms, self-learning portals, etc. This system can efficiently help such people who prefer computer or a laptop to learn instead of reading books. In future we tend to add more support for both trainer as well as learner.

V. ACKNOWLEDEGEMENT

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