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DRIVER DROWSINESS MONITORING SYSTEM USING VISUAL BEHAVIOUR AND MACHINE LEARNING

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ABSTRACT

Driver fatigue is a significant cause of road accidents and fatalities, leading to ongoing research into methods of detecting and indicating drowsiness in drivers. Traditional approaches have included vehicle-based, behavioral-based, and physiological-based methods. However, some of these methods can be intrusive or distracting for the driver, while others require expensive sensors and complex data handling. To address these challenges, we have developed a low-cost, real- time system for actively monitoring driver drowsiness with a high degree of accuracy.

Our system utilizes a webcam to record video and employs image processing techniques to detect the driver's face in each frame. Facial landmarks are identified and used to compute eye aspect ratio, mouth opening ratio, and nose length ratio. Based on these ratios and developed adaptive thresholding methods, our system can detect drowsiness in real-time. In addition, we have implemented machine learning algorithms offline to enhance the system's accuracy. Our Support Vector Machine-based classification achieved a sensitivity of 95.58% and specificity of 100%.

INTRODUCTION

Drowsy driving has become a leading cause of fatalities in road accidents, particularly among truck drivers who work continuously for long hours, often at night, and bus drivers operating long-distance routes or overnight services. The problem of driver drowsiness poses a significant challenge for drivers and passengers in all countries. Fatigue and drowsiness are responsible for numerous injuries and fatalities resulting from road accidents each year. Therefore, identifying driver fatigue and detecting it has become an active area of research. The initial stage of the drowsiness detection system comprises three modules: acquisition, processing, and warning. In the acquisition module, a video of the driver's face is captured and transmitted to the processing module where it is analyzed online to identify drowsiness. If drowsiness is detected, a warning or alarm sound is issued to the driver via the warning module. Typically, the methods used to detect driver drowsiness fall into three categories: vehicle-based, behavioral-based, and physiological-based. In the vehicle-based method, a variety of metrics are continuously monitored, such as steering wheel movement, accelerator or brake pattern, vehicle speed, lateral acceleration, shift in engine speed, deviations from lane position, etc. Any abnormal change in these values is considered indicative of driver drowsiness. This method is non-intrusive because the sensors are not physically attached to the driver. The behavioral-based method analyzes the visual behavior of the driver's face, such as eye opening and closing, eye blinking, yawning, head bending, etc., to detect drowsiness. This approach is also non-intrusive because standard cameras are used to capture these features. The physiological-based method monitors physiological signals such as Electrocardiogram (ECG), Electrooculogram (EOG), Electroencephalogram (EEG), heartbeat, pulse rate, etc., to obtain a measure of drowsiness or fatigue level. This method is considered intrusive because the sensors are attached to the driver, which may cause distractions. The inclusion of additional parameters or features will increase the accuracy of the system to a certain extent but also lead to a larger and more costly system. Therefore, to create a low-cost and portable real-time driver's drowsiness detection system with acceptable and accurate results, we have proposed using a webcam-based system that relies on image processing and machine learning techniques to detect fatigue from facial images only.

EXISTING SYSTEM

In our study, we employed Support Vector Machine (SVM) to classify the components in the input video. However, the cropping of the regions of interest in the video may not always be accurate and may lead to erroneous regions. To detect the eyes, it is necessary to first create boundary boxes and apply a classification algorithm. It is important to note that the SVM algorithm may not be suitable for this purpose.

DESIGN IMPLEMENTATION OF DROWSINESS MONITORING SYSTEM

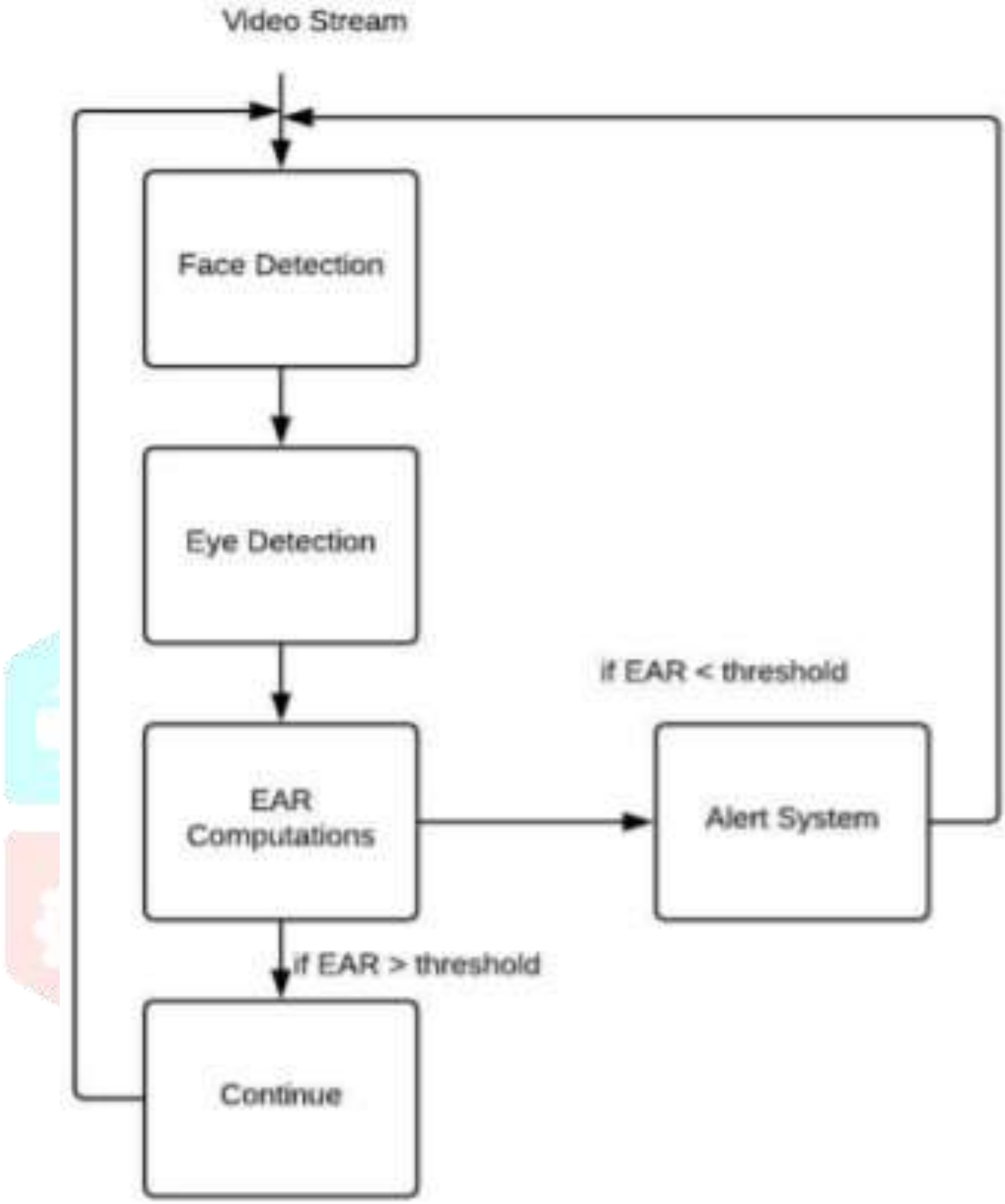


Fig.1 Block diagram of drowsiness monitoring system

SYSTEM DESIGN

The system design process involves transforming a user-oriented document into a format suitable for programmers or database personnel. This process is composed of multiple steps and provides the necessary understanding and procedural details for implementing the system. The design process includes both logical and physical stages of development. The logical design stage involves reviewing the current physical system, preparing input and output specifications, detailing the implementation plan, and conducting a logical design walkthrough.

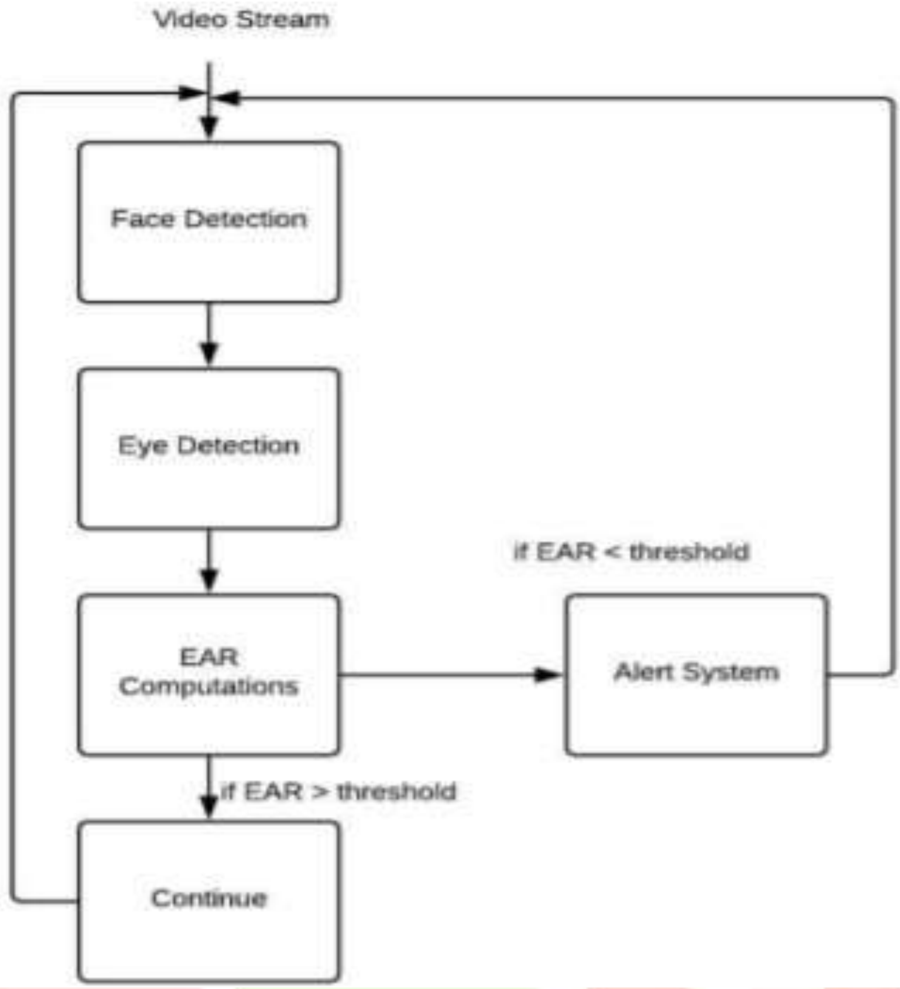
In the physical design stage, the database tables are designed by analyzing the system's functions and determining the appropriate format for the fields. Each field in the database tables should have a defined role in the system, and unnecessary fields should be avoided to prevent excessivestorage requirements.

During the input and output screen design, the user experience should be considered. The design should be user-friendly, with a precise and compact menu that is easy to navigate.

Face Detection

The face detection process is initiated after frame extraction, where several face detection algorithms are available online. In this study, Linear Support Vector Machine (SVM) and Histogram of Oriented Gradients (HOG) method is used. Initially, fixed window sizes of positive samples are chosen from the images, and HOG descriptors are calculated for them. Negative samples of the same size, which do not contain the object to be detected (i.e., human face), are also selected. The number of negative samples is generally higher than the positive ones. After acquiring features for both classes, a linear SVM is trained for classification. Hard negative mining is employed to enhance the accuracy of the SVM. In this technique, the classifier is tested on labelled data, and false-positive sample feature values are re-used for training purposes. A fixed-size window is moved over the image for a test image, and the classifier computes output for each window location. The highest output value is taken as the detected face, and a bounding box is drawn around it. Non-maximum suppression is applied to remove redundant and overlapping bounding boxes.

System architecture

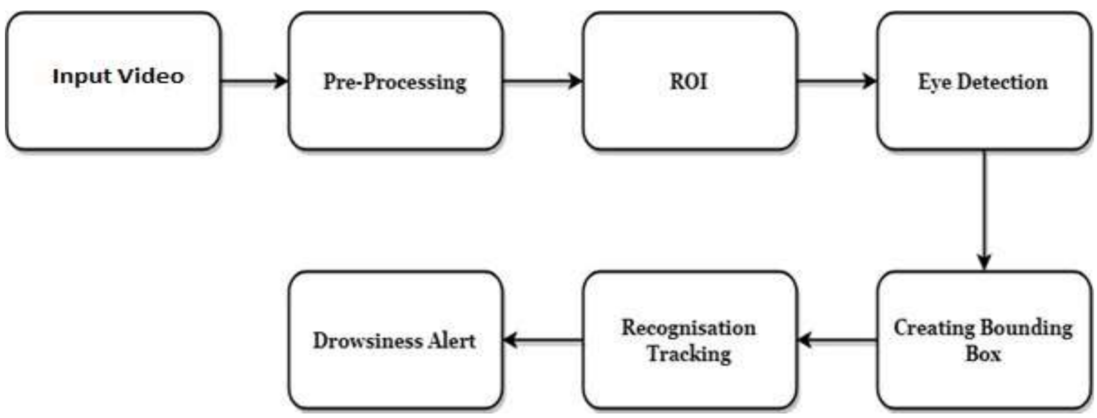


WORKING

Data Flow Diagram

Data Flow Diagrams (DFDs) are graphical representations used to display the movement of data within a business information system. These diagrams illustrate the processes involved in transferring data from input to file storage and report generation.

DFDs are classified into two types: logical and physical. A logical DFD depicts the data flow through a system to carry out specific business functions. On the contrary, a physical DFD represents the actual execution of the logical data flow.



PROPOSED SYSTEM

The system for monitoring driver drowsiness is presented in the figure below. A webcam is utilized to record a video of the driver's face in this system. The camera is positioned in front of the driver to capture a frontal view. The frames are extracted from the video to produce 2D images. Linear support vector machine (SVM) and Histogram of oriented gradients (HOG) are utilized for object detection to identify the face in the frames. Facial landmarks, including the locations of the eyes, nose, and mouth, are then marked on the images. The eye aspect ratio, mouth opening ratio, and head position are calculated using these facial landmarks. Machine learning algorithms are used to analyze these features and make a decision on the driver's drowsiness. If drowsiness is detected, an alarm is triggered to alert the driver

RESULT AND SNAPSHOTS

SCENARIO-1: Subject is in normal condition

Fig.1 Drowsiness detection in Normal conditions

In this scenario by recognizing the Eye Aspect Ratio and Count is calculated as the subject is not detected drowsy and the count=0 so no alarm is detected. In a well-lit environment and under optimal conditions, the initial evaluation of the program showed that it functioned effectively, with an accuracy rate ranging from 85% to 95%. Analysis of Figure 1 revealed that the program was better at detecting and identifying no drowsiness through eye movements.

SCENARIO-2: Subject is detected with drowsiness

Fig.2 Drowsiness detected in day light

Subject here is detected drowsy and the count value is increased by 17 where we can see in the Fig.2 and we can see the Eye Aspect Ratio (EAR) count varies as per the face. When the count value goes above the 20, we can hear the alarm goes on and which will automatically alert the driver right at the moment. In a proper daylight condition accuracy rate range from 90-95%.

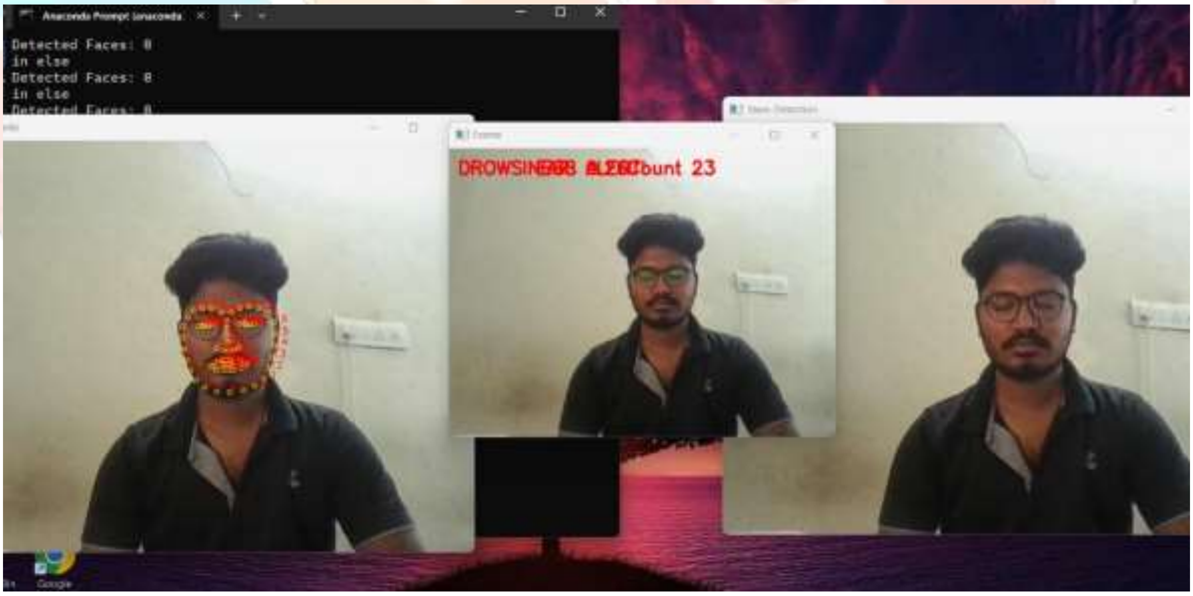


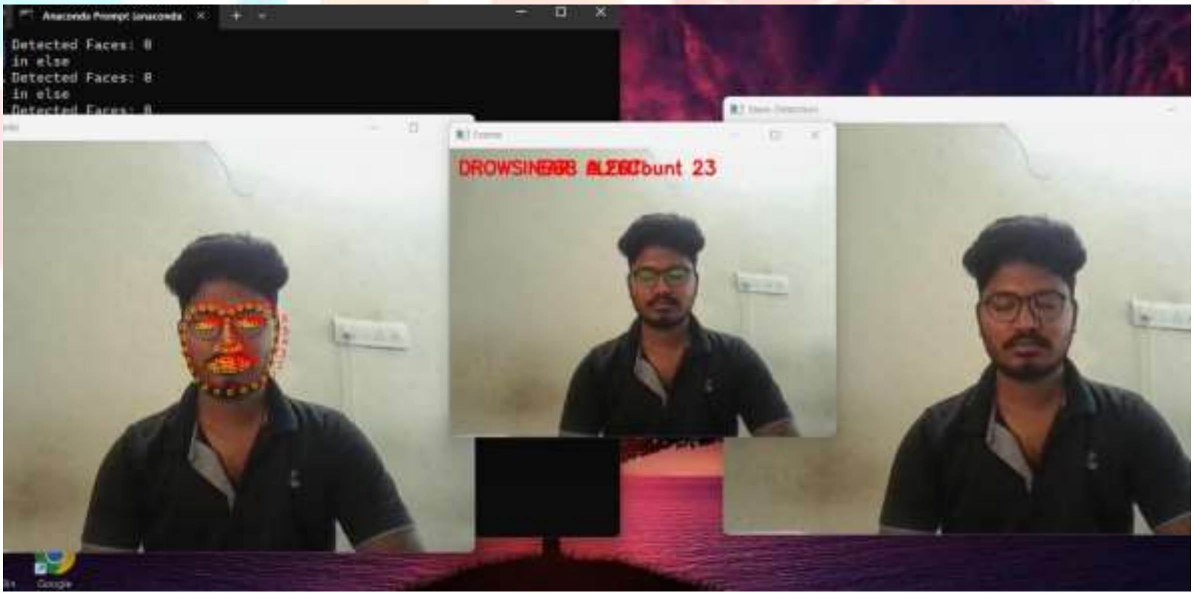
Fig. 3 Drowsiness detection in dim light

Scenario-3: Subject is detected yawning

Fig.4 Yawn detection

In scenario 3 subject is detected yawning and as soon as the yawn is detected, yawn detectionsystem shows on the screen as "subject is yawning" which is shown in the above figure.

Fig.5 Drowsiness detected when subject is wearing spectacles



CONCLUSION

The present study proposes a low-cost, real-time system for monitoring driver drowsiness based on visual behaviour and machine learning. The system computes visual behaviour features such as eye aspect ratio, mouth opening ratio, and nose length ratio from a streaming video captured by a webcam. An adaptive thresholding technique has been developed to detect driver drowsiness in real-time, which is accurate when tested with synthetic data.

The feature values obtained are stored and machine learning algorithms, including Bayesian classifier, FLDA, and SVM, have been used for classification. The study found that FLDA and SVM outperform the Bayesian classifier, with sensitivity values of 0.896 and 0.956 respectively, and a specificity of 1 for both. Based on these results, the study plans to implement FLDA and SVM in the developed system to perform online classification of drowsiness detection.

Additionally, the developed system will be implemented in hardware to make it portable for car systems. A pilot study will be conducted on drivers to validate the system's effectiveness.

FUTURE SCOPE

In the future, the scope of driver drowsiness detection may expand to include external factors such as vehicle conditions, mechanical data, sleep patterns, and weather conditions for fatigue measurement. Fatigue poses a significant threat to highway safety, particularly for commercial motor vehicle operators who face long work hours, challenging environmental conditions, and high annual mileage. To address this safety issue, it is crucial to monitor drivers' drowsiness and alertness and provide them with feedback so that they can take appropriate action. Currently, the camera does not adjust its zoom or direction during operation, but future developments may allow it to automatically zoom in on the driver's eyes once they are detected.

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