Fatigue Surveillance and Shield

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Abstract - *Traveling has become our daily essentials, like oxygen, water, and food. Vehicles have evolved along with human needs and desires, as well as risk and danger. It is natural for a human to doze off while driving for a long time. Driver drowsiness or fatigue is one of the main reasons behind road accidents. Continued surveillance with the required preventive measures through an efficient model will be provided in this project. This project comprises two phases. In phase one, with the help of a camera module, a computer vision model can be used to monitor and detect the fatigue state. The proposed system incorporates a digital library. The Face Landmark Detection algorithm offered by the Digital Library is an implementation of the Ensemble of Regression Trees (ERT) and HOG descriptors for object detection. The EAR (Eye Aspect Ratio) value is determined, followed by the threshold frame count to endorse the fatigue state. Detection of drowsiness or fatigue: an alert is displayed on the screen along with an alert alarm. Simultaneously, the achieved value is uploaded in real-time to Firebase (cloud database storage). In phase two, a simulated car with a Raspberry Pi as its base control unit is established to take input from the firebase. For every specified threshold value, the actions of the car are subjected to certain changes. As a preventive measure, the motor slows down the vehicle's wheels as the fatigue threshold increases, and finally, the car is stopped. As an emergency measure, the car is integrated with a GSM and GPS module, which in turn sends an alert message and the location of the vehicle to the nearest hospital and one's respective emergency contact.*

Key Words: digital library, histogram of oriented gradients, eye-aspect ratio, ensemble of regression trees, GSM, GPS.

1.INTRODUCTION

The evolution and growth of the automobile industry in the present period are impeccable. Increases in vehicle automation and self-sustainability are witnessed every day. Despite all the innovations, the road safety and lives of the people on board a vehicle are still intriguing. Every year, thousands of people lose their lives due to road accidents. There are many causes of accidents, for example, speeding and being drunk.

driving, but still, the foremost factor, especially on rural roads, is the driver's fatigue and monotony. According to the data collected in 2017 from the World Health Organization, an approximate number of 1.25 million deaths have been recorded worldwide, i.e., approximately for every 25 seconds, an individual out there will experience a road crash.

The current evolved vehicle generation does not have the proper system to prevent accidents caused by drowsiness. A proper fatigue monitoring system should be implemented to prevent road crashes and save lives. A model that just detects fatigue and alerts the driver alone will not be sufficient to prevent road crashes from happening.

A shield system that simultaneously synchronizes with the fatigue monitoring phase to save lives and avoid road accidents must be incorporated. These phases together will form an efficient barrier to road accidents. Continuous surveillance with the help of computer vision and implementing the changes concerning the observed changes will enhance vehicle safety and ensure the prevention of road crashes.

Fatigue surveillance and shield systems lay driver protection and road safety as their foundation. This model aims to receive the facial landmarks of an individual as input, which is processed to generate a result that will indicate the state of fatigue. The further proceedings of the model depend on that state and execute the necessary actions to achieve its goal. If an individual is observed to be drowsy or inattentive while driving, the drowsiness is detected through the camera, and the alert system will be triggered, mentioning that the driver is drowsy. This result will be updated in cloud storage for later. If a condition prevails where the driver remains drowsy even after the alert alarm and the indication message goes on, the momentum of the vehicle will be reduced step by step with the help of the value attained from the cloud for every threshold frame until the car halts and is prevented from collapsing. Once the car is halted, a caution text and the location of the fatigued individual will be delivered to their respective emergency contact.

2. LITERARY SURVEY

The authors of [1] propose a fundamental algorithm that detects the individual differences of a driver while a deep cascaded convolutional neural network is constructed to detect the face region and also where the eye aspect ratio concept is introduced to evaluate the drowsiness of the individual in the present frame. The use of deep cascaded CNN avoids the problem of poor accuracy in artificial feature extraction.

The facial features monitoring model incorporates three phases for real-time facial monitoring and proposes efficient facial feature detection using Viola Jones, eye tracking, and yawning detection. It illuminates the skin part, and considering the chromatic components alone helps in rejecting most of the non-facial background. The implementation of a binary linear support vector machine classifies continuous frames into fatigue and non-fatigue states, thus making the system highly efficient. [2]

This paper [3] presents deep learning-based drowsiness detection for the brain-computer interface (BCI) using functional near-infrared spectroscopy (fNIRS), where the activities of the brain are measured with a continuous-wave fNIRS system. Deep neural networks (DNN) are implemented to classify the drowsy and alert states from the observed brain activities. The inclusion of the used CNN architecture attains an accuracy of 99.3%, making the system reliable, and it is also efficient in accessing the frame location for a passive BC.

A comprehensive Drowsiness Level Detection Model Combining Multimodal Information [4] can sense the entire range of stages of drowsiness. The approach behind this model makes use of sitting posture-related index values that can indicate weak drowsiness. The proposed system does not struggle to comprehend and differentiate various drowsiness states.

The authors in [6] propose a real-time system that can detect driver fatigue and distractions using machine vision approaches where face template matching and horizontal projection of the top-half face image are utilized to obtain hypervigilance symptoms from the face. The implementation of adaptive hypervigilance monitoring modules for standard inputs and a very short training phase makes this model robust and efficiently detects individuals with different facial and eyelid behaviors.

The author in [7] proposes a system named DriCare that modulates to detect the driver's fatigue status, such as yawning, blinking, and duration of eye closure, and introduces a new face algorithm to improve tracking accuracy. The non-contact method is cost-efficient and does not require computer vision technology or a sophisticated camera, which allows the model to be used in more cars.

The Small Faces Attention face detector [8] proposes a new scale-invariant face detector, which is called a Small Faces Attention (SFA) face detector. This model is built over the first-ever multi-branch face detection architecture and adopts multi-scale training and testing to make the model robust at various scales. It provides promising detection performance on challenging detection benchmarks like WIDER FACE and FDDB data sets. Having a multi-branch detection architecture, this model pays more attention to faces on a small scale.

The author of the paper [9] proposes a new module to detect an individual's eye closure and yawning for drowsiness analysis using an infrared camera. This module incorporates four steps, namely, face detection, eye detection, and eye closure and yawning detection. This method can detect eye closure or yawning even in low-light ambiance.

This paper [10] proposes a system that utilizes mathematical models like neural networks and image processing techniques to sense the environment, and it has been implemented as three major components, namely, curved road detection, road sign and signal detection, and obstacle detection. The proposed model is well-trained, efficient in obstacle and road sign detection, and can work efficiently in breaking down signs in both sunlight and night illumination.

The paper [11] presents a low-cost human-computer interaction device, represented by an Arduino glove, to control an RC car. The Arduino glove includes a gyro sensor to identify the angle of the hand, while the fingers' movements are identified by the flex sensor. It is a low-cost human-computer.

In this paper [12], we tackle the development of a robotic car with hardware control, lane detection, mapping, localization, and path planning capabilities. IT also introduced a generic map analysis system to increase the efficiency of certain paths on the track. It is completely robust.

3. ARCHITECTURE

The architecture diagram derives from the extraction of image frames and processing them with the Dlib to plot the facial features and detect the eyes. While the EAR value is calculated for each frame, the values and frame counts are passed to the cloud database, which in turn acts as the input for the Raspberry Pi, which acts as the vehicle's control unit. GSM and GPS are the key components of the recovery phase.

The architecture diagram of the project is shown below:

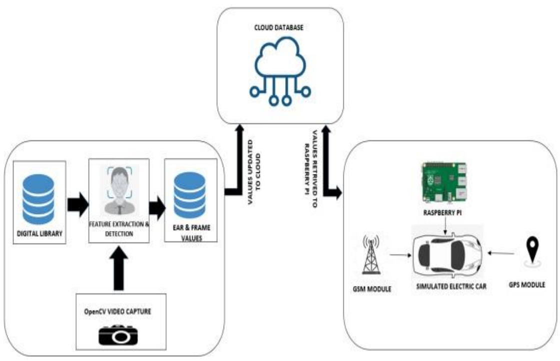

Fig -1:Fatigue Surveillance and Shield

4. PROPOSED SYSTEM AND WORKING MODUES

The fatigue surveillance and shield system lays driver protection and road safety as its foundation. This model extracts facial landmarks with the OpenCV of an individual as input, where it is processed to generate a result from facial landmarks. While the model is locating the eye region, the respective EAR value is calculated. With the EAR value, if it is less than the threshold value, then that will indicate the state of fatigue. The further proceedings of the model depend on that state and execute the necessary actions to achieve its goal. If an individual is observed to be drowsy or inattentive while driving, the drowsiness is detected, and the alert system will be triggered, mentioning that the driver is drowsy. This EAR and frame count value will be updated in cloud storage later. If a condition prevails where the driver remains drowsy even after the alert alarm and the indication message goes on, the momentum of the vehicle will be reduced gradually with the help of the EAR value attained from the cloud for every threshold frame until the car halts and is prevented from colliding. Once the car is halted, using GSM and GPS, a caution text and the location of the fatigued individual will be delivered to their respective emergency contact, suspecting that the driver might be in recoverable danger. The proposed model consists of four modules, namely image acquisition, face and eye detection, fatigue monitoring, and road crash recovery. The listed modules are explained here.

4.1 Image Acquisition

This module is used for capturing image frames of an individual with the camera attached. Using computer vision, the camera is accessed, and the face is captured live. These acquired frames are then converted to a grayscale for further processing. Being the initial module, the image acquisition never stops or changes.

4.2 Face And Eye Detection

In this module, the base of face detection, i.e., facial feature extraction of the individual, is carried over. Dlib's shape predictor is trained with the 300W–IBUG training dataset. The 300W-bug dataset consists of 11 columns and 1786 rows. It standardizes multiple alignments. databases with 68 landmarks. The goal of 300W-IBUG is to train a shape predictor capable of localizing each facial structure. With the help of trained Dlib, it will be efficient to mark the facial feature landmarks and identify the eye region. The data points for the eye region will be extracted.

4.3 Fatigue Monitor

This module helps in monitoring the fatigue state of an individual. HOG (Histogram of Oriented Gradients) is a feature descriptor generally used for object detection. The converted grayscale frame from the image acquisition module is then passed to HOG, and the coordinates of the facial features are extracted from the five face landmarks defined in the dataset. The EAR is defined as the ratio of the vertical to the horizontal Euclidean distance of the landmarks in the eye. The EAR value determines whether the eye is in an open or closed state while continuously monitoring the closure angle of the eyes. The EAR (Eye Aspect Ratio) for the left and right eyes is calculated with the attained coordinates. Once the EAR value drops below the threshold value, it is considered to be in a fatigue state.

4.4 Road Crash Recovery

The attained EAR value will be simultaneously uploaded to the cloud database. From the cloud, the values are taken as input by the Raspberry Pi control unit. Based on the input EAR value being received, the motor reduces the speed or rpm of the car for every threshold frame value, and finally, the vehicle attains the rest. Once the car is in a stopped position, with the help of GSM and GPS modules, the location and alert message are sent to the emergency contact for recovery. This module innovates road safety by preventing road crashes by ceasing the vehicle's motion.

5. RESULT

The fatigue surveillance and shield have been completed with the help of OpenCV. and the Face Landmark Detection algorithm.

In Figure 2, once the program is executed, OpenCV accesses the camera and starts the capture. The face is captured frame by frame continuously without any halts. Thus, OpenCV acts as the entry point.

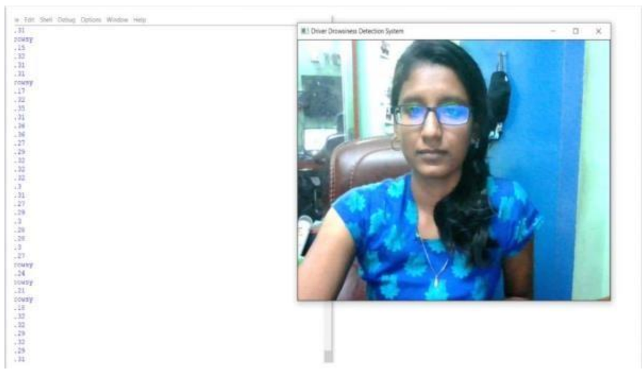

Fig -2: Camera Admission

After the detection phase, with the use of Dlib and HOG face descriptors, the facial landmarks for the eyes are marked, and their respective EAR values are calculated. The distance between each eye coordinate is taken as input, and the EAR is based on that value. On the serial monitor, the EAR value calculated for each frame is printed as output. Once the value drops below the threshold EAR value, drowsiness will be displayed.

In Figure 3, after successful detection of the eye closure, the EAR value drops below the threshold value, and the fatigue alert message is triggered on the Computer Vision window. Along with the alert message, an alarm sound is flashed to bring the driver back to consciousness. This process continues relentlessly in a loop without any hindrance.

Fig -3: Fatigue Alert

The emergency text, along with the location received by the emergency contact, is displayed. Once the vehicle comes to a complete rest position, the alert message indicating the need for help along with the location to track down the individual will be delivered without any interruption.

Fig -4: Emergency Alert Message

The EAR value calculated while detecting is passed to the cloud repository and stored. The data is secured from being tampered with. The graph represents the value's rise and fall during the fatigue monitoring phase.

Chart -1: Cloud Repository

The simulated car of a real-time vehicle is in a rest position to prevent a crash once the fatigue monitor reaches the threshold EAR value.

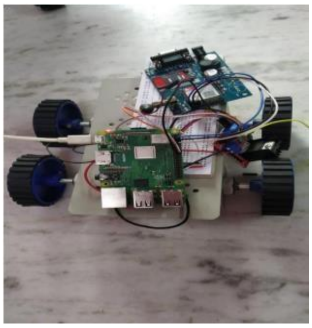

Fig -5: Simulated Car Model

6. CONCLUSIONS

The fatigue surveillance and shield system perform and provides the necessary road safety by preventing accidents with the system's enhanced capability of being agile to the result for every single second. During the recovery phase, the model takes over the control on the road and does not just wind up with the detection and alert phases. Speed reduction and location sharing are the apex features that ensure Z-grade safety in this practical world. The model can be further enhanced by incorporating AI into the vehicle's driving mode.

When detecting drowsiness, the accident can be further prevented with a self-parking feature and a wide alarm sound for causality recognition. Different approaches for detecting drowsiness can be handled, such as body postures and linking smartwatches with vehicle driving mode. Whenever an indication of cardiac arrest arises, the shield system can be activated.

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