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Use of Deep Learning in Transport Services for Maintaining Safety and Regulating Unauthorized Drivers

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ABSTRACT

Research from WHO shows in every 1.44 minutes a teenager is killed in road traffic crashes around the world. Our paper suggests the use of Deep Learning Algorithms in preventing such casualties through hardware and software implementation of the device in motor vehicles, also to overcome the potential limitation of Face Recognition to go that extra mile. In this paper we suggest using the integration of 4 models namely, Face Detection, Passive Liveness Detection (PLD), Face Recognition, Eye Detection. The Face Detection model consists of 2 versions which use Haar Cascades and Histogram of Oriented Gradients (HOG). PLD model is used for Presentation Attack Detection. The face recognition model is trained using the shape predictor 68 landmarks which are unique for each face. Using these landmarks, eye detection is also performed and the monitoring of sleepiness is carried out with the overall results of 98% accuracy with the face detection model, 94% accuracy with the face recognition model (limited to n=10 faces per model) with an Eye Aspect Ratio threshold of 0.3. Along with that, different current attack scenarios/ limitations of Facial Recognition that will be faced with these devices are described. Based on these scenarios, some of the preventive methods are elaborated to make the purpose of the device to its fullest performance.

Keywords: Deep Learning, Face Recognition, Face Detection, Haar Cascades, Histogram of Oriented Gradients, Passive Liveliness Detection, Facial Landmarks

1. INTRODUCTION

From the measurements of street mishaps, the quantity of deadly and handicapping street mishaps happening is expanding step by step one reason for these mishaps is because of the unapproved driving of vehicles. It's anything but an individual who isn't qualified to drive the proprietor's vehicle without his insight. Unapproved driving can be observed by utilizing application that keeps a mind the driver's authority, this however of monitoring the authority made us to develop the application that is a Deep learning model that incorporates biometrics of the drivers to check their power. By the check brings about the advancement of street wounds avoidance.

Biometrics alludes to the computerized Recognition of people dependent on their natural and conduct qualities[1]. One such Biometrics is Face Recognition frame-work, Face Recognition has a wide scope of utilizations in security and biometric. The PC innovation improvement, numerous facial Recognition techniques were created. Facial Recognition strategies are for the most part assembled into two classes: holistic matching and neighbourhood matching. Neighbourhood coordinating with utilizing subspaces of the face picture while holistic coordinating with utilizing the full-face picture[2]. At first, procedures, for example, 29 landmarks of face for acknowledgment were utilized in[3], later in the advancement 68 landmarks recognition has demonstrated the victories in[4]. Nonetheless, this calculation has its constraint on perceiving the genuine versus counterfeit data sources given to it. Current ways to deal with face recognition have the vital hindrance of being handily caricature where a sham can introduce a photo or recorded video of someone else to the camera. To defeat this restriction Passive Liveness Detection (PLD) is utilized. PLD is a sort of Face liveness identification, which is a basic pre-handling step in face recognition, for keeping away from face satirizing assaults, where a faker can imitate a legitimate client for verification[5]. Two unique kinds of liveness discovery exist: dynamic liveness and detached liveness location[6], however latent liveness recognition is easy to use. Another such Biometrics utilized in this application is the Eye Landmarks Detection framework. This is a vital perspective in numerous valuable applications going from face acknowledgment/recognition to human PC interface, driver conduct examination[7].By finding the location of the eyes, the look can be resolved. In this manner it is feasible to realize where individuals are taking a gander at and comprehend the

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practices to assess the interests (for interface purposes) and the consideration levels (for security controls). Utilizing Eye Landmarks Detection, Sleepiness levels of the driver are noticed.

There has been broad exploration and various papers that have advanced potential systems to identify heedlessness and lethargy in a driver over the most recent twenty years. Driver Sleepiness Detection is a vehicle security advancement which hinders disasters when the driver is getting sleepy. Various examinations have suggested that around 20% of all road incidents are depletion related, up to half on explicit roads[8]. This Paper centers around settling the unapproved driving and furthermore to forestall mishaps caused because of Sleepiness of driver, by utilizing Deep Learning (DL) algorithms, for example, Face Detection, Face Recognition, Passive Liveness Detection, Eye Landmarks Detection. The fundamental targets of our work are to use the mix of DL algorithm that is relevant progressively with a standard camera, in a genuine setting, for example, individuals driving a vehicle. The fundamental programming necessities are Python, OpenCV.

2. OVERVIEW OF MODELS

Artificial Intelligence (AI) is changing pretty much every industry. Deep Learning (DL), an AI system, is impelling the innovative business to the future with an apparently unending rundown of utilizations. Deep learning licenses high computational models that comprise of various layers of preparing to gain proficiency with the portrayal of information at different degrees of deliberation layers. These procedures have limitlessly worked on the best in class in visual acknowledgment, voice acknowledgment, detection of item, thus numerous different regions. Since the time the achievement of the Alex Net neural organization model[9] dependent on convolutional neural networks (CNN) in the ImageNet rivalry in 2012, algorithms for object discovery and acknowledgment dependent on the alleged deep learning have accomplished huge enhancements in execution.

2.1 Face Detection

Face detection is a lively space of biometrics with dynamic examination and business endeavors throughout the most recent 20 years. The assignment of face identification is to look through faces in pictures, detailing their situations by a bounding box. Given a solitary picture or a video, an optimal face detector ought to have the option to distinguish and find every one of the current faces paying little mind to their position, scale, direction, age, and appearance[10]. Furthermore, the detection ought to be done independently of superfluous light conditions and the picture and video content

2.1.a Haar cascade classifier

Haar cascade classifier utilizes the Haar-like features to recognize a face in a picture. This further developed list of capabilities is known as two-square shape include. The regions encompassing the eyes are ordinarily discovered to be relatively more obscure than the cheeks[11]. An instance like Haar segment for identifying the face is a course of action of adjoining two rectangular zones over the cheek and eye locales.

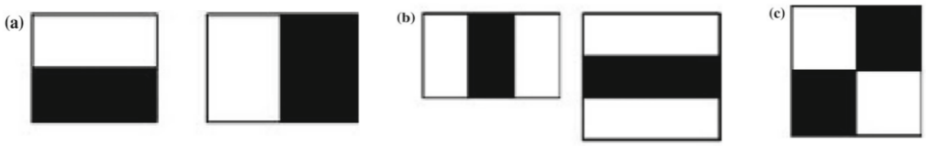

Fig. 1 Haar-like features from the OpenCV source distribution.
(a) Edge Features, (b) Line Features and (c) Rectangular Features[12]

2.1.b Histograms of Oriented Gradients

Histograms of Oriented Gradients (HOGs) are an element descriptor were effectively utilized for item and walker discovery, addressed an article as a solitary worth vector instead of a bunch of highlight vectors where each addresses an

area of the picture, figured by sliding window identifier over a picture. HOG detector is registered for each position, while the size of picture changed in accordance to get a HOGs highlight[13].

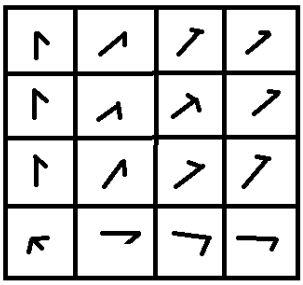

Fig. 2 Illustration of 8x8 fix size HOG descriptors. Direction of the inclinations is displayed in every cell

From[12-13], Haar Cascade estimation can recognize forward looking face very well in pictures, concerning of their appearance, beauty care products and edification, yet fairly difficult to distinguish the face who have impediments like utilizing eye glass, steerage, and veil. The HOGs more exact than Haar Cascade for face detection by and large, it can address nearby appearance quite well, in any case for Frontal Face Haar Cascade actually make a superior showing.

2.2 Face Recognition

Face Recognition is a technique for perceiving or checking the character of an individual using their face. Face recognition systems can be used to recognize people in photos, video, or in live[14]. This system is used to perceive appearances of individuals whose photos are saved in the dataset. Notwithstanding the point that various techniques for recognizing verification can be more precise, face recognition has reliably remained a basic point of convergence of assessment because of its non-interfering nature and considering the way that it is people's easy methodology for singular ID. Face recognition structures vary in their ability to recognize people under testing conditions like defenseless lighting, mediocre quality picture objective, and flawed perspective. The face recognition model used in our application is based on 68 landmarks detected by Dlib. The 68 landmarks are unique for each individual person. So, this model is better than many other face recognition models.

Facial landmarks are utilized to limit and address notable regions of the face, like eyes, eyebrows, nose, mouth, facial structure. Dlib is a landmark's facial finder with pre-prepared models, the dlib is utilized to gauge the area of 68 directions (x, y) that map the facial focuses on an individual's face like in the picture beneath[15].

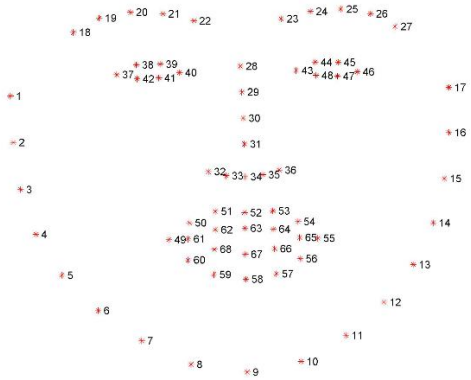

Fig 3 68 landmarks of Person's face

The device utilized for this application is dlib.face_recognition_model v1. This device maps a picture of a human face to a 128-dimensional vector space where pictures of similar individuals are close to one another and pictures from various individuals are far separated. Accordingly, you can perform face acknowledgment by planning appearances to the 128D space and afterward checking if their Euclidean distance is sufficiently little. As a rule, if two face descriptor vectors have an Euclidean distance between them under 0.6 then they are from a similar individual, else they are from various people[16].

$$d(\mathbf{p}, \mathbf{q}) = \sqrt{\sum_{i=1}^{n} (q_i - p_i)^2}$$

p, q = two points in Euclidean n-space

q_i, p_i = Euclidean vectors, starting from the origin of the space (initial point)

n = n-space

Fig 4. Formula for Euclidean Distance

2.3 Passive Liveness Detection

Facial liveness has arisen as an approach to battle misrepresentation and guarantee the respectability of face biometrics as a method for confirmation or character check. Though face acknowledgment can precisely respond to the inquiry "Is this the opportune individual?" it doesn't address the inquiry, "Is this a genuine individual?". This is the part of liveness identification.

While significant examination has been as of late done in working on the exactness of face liveness recognition, the best current methodologies utilize a two-venture cycle of first applying non-straight anisotropic dissemination to the approaching picture[27] and afterward utilizing a profound organization for definite liveness choice. Current ways to deal with face acknowledgment have the vital weakness of being effortlessly caricature where a faker can introduce a photo or recorded video of someone else to the camera. Consequently, face liveness discovery is an essential pre-preparing venture prior to playing out the face confirmation by means of face acknowledgment. Different methodologies have been proposed for face liveness identification on static pictures, for example, examination of surface contrasts among live and counterfeit appearances as in Reference[17], movement investigation, and deep Convolutional Neural Network (CNN) designs.
As a rule, aloof location procedures utilize biometric tests which were recorded through a biometric sensor. As indicated by this, further cooperation with the information subject is excessive. For this, an average model would be a temperature or heartbeat estimation occurring while the biometric test is gathered or checking the Micro Movements like Comparison between the muscle developments when talking happens and Blinking[18]. Another Computer Vision approach is making the classifier train between counterfeit information (commonly showing the photographs or recordings to the authenticator) and afterward utilize the Model to foresee among genuine and counterfeit.

2.4 Eye Landmarks

Utilizing eye aspect ratio, the model future identifies the Drowsiness of the driver for which eye landmarks are extricated from the 68 facial landmarks. To arrive at the objective of extricating the landmarks spots the accompanying explores had been alluded, Chen and Liu[19] applied the Haar wavelet and support vector machine (SVM) for quick arrangement. Sharma and Savakis[20] proposed learning histogram of oriented gradients (HOG) highlights in mix with SVM classifiers to get a proficient eye detector.

Leo et al.[21-22] utilized self-likeness data joined with shape investigation for eye center detection. Kim et al.[23] proposed producing eye competitor areas by utilizing multiscale iris shape highlights and afterward checking those applicant districts utilizing the HOG and cell mean force highlights. With the notoriety of deep learning algorithms[24], a few analysts utilized the convolution neural network to prepare eye locators, which shapes the subsequent subclass. A CNN-based pupil center detection method is suggested by Chinsatit and Saitoh[25]. Bin Li and Hong Fu[26] can at the same time distinguish left and right eye areas and focus in any event, when the face was impeded and is inhumane toward noticeable or infrared light pictures. Likewise, eye situating doesn't depend on the face detector.

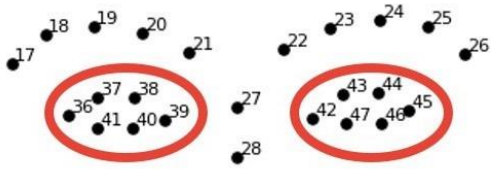

Fig 5. Eye Land marks of a person

By alluding the above investigates, our model uses the pre prepared facial landmarks identifier from dlib library, gauges the face by planning the face structure with the 68 directions the facial locales can be gotten to by basic python indexing. These mappings are encoded inside the facial_landmarks_idxs word reference inside face_utils of the imutils library. Using this word reference, we can undoubtedly extricate the lists into the facial landmarks cluster and concentrate different facial highlights.

3. IMPLEMENTATION

3.1 Application Overview

As the Application start when the driver switch on the Vehicle, it attempts to perceive the identified face from face recognition model, If the Person is recognized, it offers approval to the individual, else it prompts the individual to the principal screen where he will be given alternatives as follows

1. Driver Registration
2. Continue Un-Authorized Driving
3. Recognize once more
4. Send QR Code to the registered email for QR Verification

Driver Registration

On the off chance that the Driver is new to the application and might want to enroll with it, He will be approached to enter the License Number, If the number is related with the administrator information base, He will be continued with enlistment, there by taking the info preparing pictures which is a live video of 5 seconds gathering 10-15 facial pictures of driver utilizing face detection model, for training the face recognition model.

Continue Un-Authorized Driving

Driver can pick Un-Authorized Driving; this feature is incorporated for the crisis reason at the expense of the giving a feed to the administrator in regards to the un-approved driving action. Consequently, transferring the driver's picture in the class of un-approved drivers in the administrator's database.

Recognize again

On choosing this, the application attempts to perceive the individual again from the enrolled driver's data set. This component is added due to the constraint of the face recognition framework, where the acknowledgment probably won't perform as expected because of the reasons like impediment, absence of lighting, flimsy picture and so forth Thusly, for making the model take a stab at perceiving again we have added this component.

Send QR Code to the registered email for QR Verification

This element is a preventive solution for the edge instance of Face recognition model, this alternative empowers the clients to login with the driver license, which sends a QR code to the email enrolled with the license number, which they can examine on the application web cam. This component assists the application with effectively running in any event, when the facial recognition framework completely fizzles for the reasons like the user’s bewildered face, no lighting conditions, and so on

3.2 Process Flow

In this methodology, we partitioned the application in to 5 areas:
(a) Training Face Recognition Model
(b) Training Liveness Model
(c) Inclusion of Additional Features to the Application
(d) Database Management
(e) Testing Realtime Result

3.2.a Training Face Recognition Model

Face Recognition model requires the input picture of facial information. Henceforth, we for the most part utilize pre-trained face detection models to identify and crop the face image from the input image. In this application, we have utilized Haar Cascade Frontal Face Detection and Histograms of Oriented Gradients for Face detection and Cropping. From this facial information the Dlib's pretrained 68 landmarks shape predictor model gives us the landmark of the face. These landmarks are utilized in preparing the face recognition model as referenced in segment 2.2.

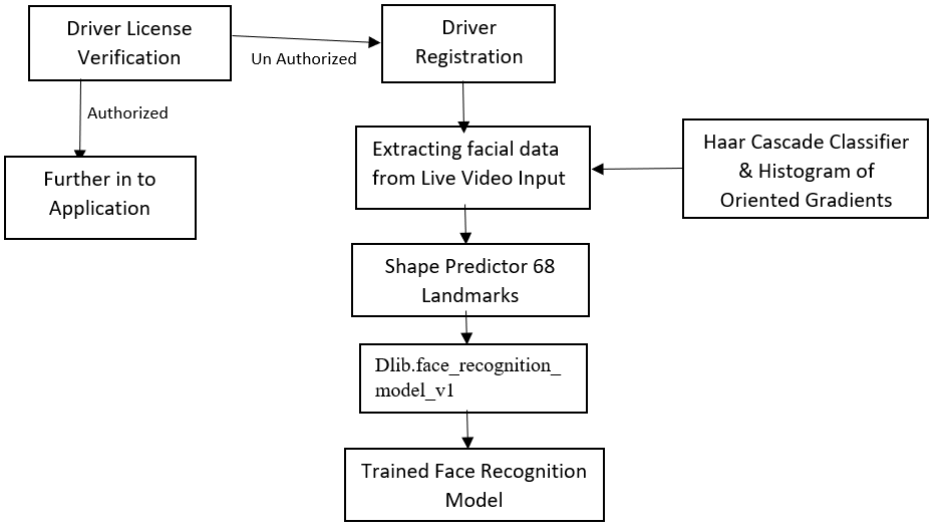

Fig 6. Training Face Recognition Model Flow Chart

3.2.b Training Liveness Model

The stored driver images are sent in to a pipeline where they are processed with Non-Linear Anisotropic Diffusion channels and stored in to a fake image's dataset, whereas the live input images are considered as genuine images. With the accompanying information, an image classifier is trained utilizing transfer learning from Resnet50 model additional dense-fully connected layers of 4 hidden layers and with the yield of 1 neuron and the activation function of Sigmoid.

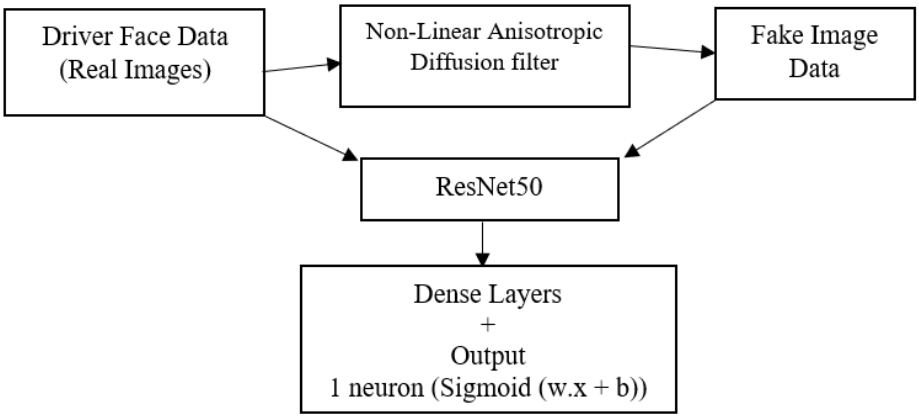

Fig 7. Training Liveness Model Flow chart

3.2.c Inclusion of Additional Features to the Application

Our application is appropriate for various edge cases one among them is, the point at which the approved driver is perceived and permits an unapproved driver to drive by spoofing the system while showing his face at the time of recognition and changing seats later. This limitation is incorporated while considering the transport services, who are providing transport services leads to a solution, that we came up by running our face recognition model for once in each 10 sec period, so that such shots at changing the drivers can be limited by bigger degree.

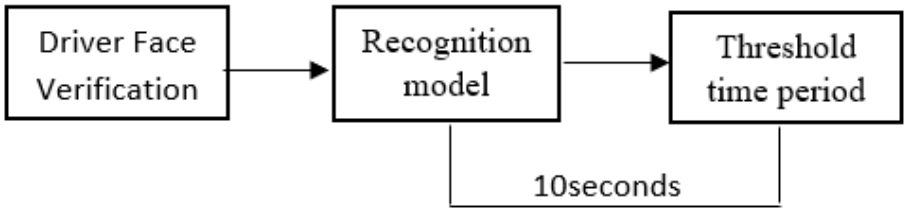

Fig 8. Periodic Driver Verification Check Flow Chart

The driver is provided with a process to register by their facial biometrics. That data is used to recognize him as an authorized driver, every time when the user is recognized as authorized driver, his data is stored back to training data. This results in a periodic updating and training of the model. In such a way, the training data is updated which in the future as the training data increases resulting in increase in the accuracy of the model.

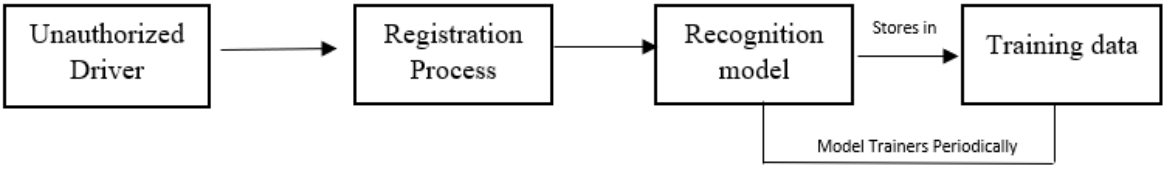

Fig 9. Training Data Updating Flow Chart

We likewise considered edge cases, for example, perplexed faces and low lighting conditions, and so on for the application, to address such limitations the utilization of QR code examining is executed in the application. In the event that the driver in the seat has a bewildered face or the driver is in the low lighting regions, or the driver is in a situation where he can't be perceived by the face acknowledgment model, the drives can pick an alternative, where a QR code is shipped off to the mail id connected to the individual driver on the off chance that he enters his license number. A message is shipped off the administrator as the driver is perceived utilizing the QR code

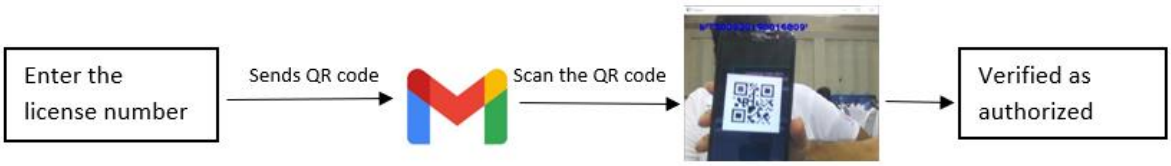

Fig 10. Authority Verification using QR code Flow Chart

Sleepiness detection is a security advancement that can prevent setbacks that are achieved by drivers who fell asleep while driving, this development is executed in the application. By utilizing pre-prepared facial landmarks detector, having 68 coordinates, addresses the significant areas of the face like nose, mouth, right eyebrow, left eyebrow, right eye, left eye and jaw. Of these, we use the co-ordinates of the right and left eye. In the wake of getting the co-ordinates we will figure the eye aspect ratio (EAR) to decide whether the eyes are shut or not. If the eye aspect ratio is less than the distance threshold, it indicates that the eyes have been closed. If it also exceeds the given time threshold, then an automatic alarm is raised to wake up the driver.

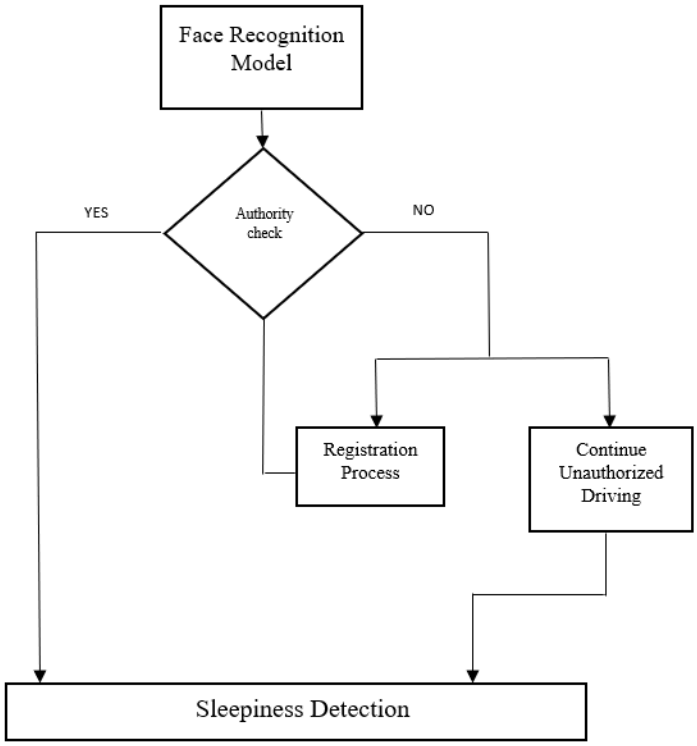

Fig 11. Sleepiness Detection Flow Chart

3.2.d Database Management

Local Database:

- Driver Face images for individual driver
- Non-Linear Anisotropic Diffusion filtered Images (Fake Faces)
- 68 Landmarks shape predictor model
- Face Recognition Model

- Face Detection Models
- PLD Model
- Python Scripts
- Alarm files
- Encrypted Information sheet (for periodic refreshing to cloud)

Cloud Database (Admin Access):

- Drivers Authorization Information Sheet (License, Mail ID, Name, Age)
- Unauthorized Driving, PLD Detection, Sleepiness Detection Notification sheet
- Unauthorized, Sleepy, Fake Driver Images

3.2.e Testing Realtime Result

Using the application created, real time tests are performed. Different tests are performed for individual cases. For face recognition model, an input of 10-15 images per user is given for testing and has been tested with 10 individuals per model for 58 individuals. The model trained on 10 persons' faces was able to produce 94% accuracy. Even when the face is not recognized, the face detection model was able to detect with an accuracy of 98% overall. The above test cases were performed from the pictures taken from the mobile.

The passive liveness detection is tested using various methods. During face recognition instead of using real person feed, a picture/video from a phone screen is fed and the model is able to detect the difference between real face and fake, this information is sent to the admin database, as there is fraud happening during face recognition. When a real person feed was given, the model was able to determine that the biometric sample being captured is from a living subject, thereby successfully detecting liveness, with a F1-Score of 82% conducted on 300 sample test data.

Further, tests were performed to check the performance of the sleepiness detection model, the user is asked to close his eye, and after a given threshold time and eye aspect ratio, the model was able to raise an alarm to alert the user to wake up. These tests were performed under various lighting conditions and occlusions and our model was able to yield about 84% accuracy.

4. CONCLUSION

We have introduced a practical structure for face recognition, in which various parts are recognized. By carrying out this application in transport administrations, mishaps caused because of unapproved driving and languor of a driver can be forestalled. In this paper, we have portrayed a face detection model carried out utilizing a mix of Haar Cascade Classifier and Histogram of Oriented Gradients descriptor, a face recognition model utilizing 68 landmarks detected by Dlib and sleepiness detection framework which helps in keeping drivers attentive and safe. This application created amazing outcomes with less training data, and end up being powerful. To keep away from any impediment in future, numerous prudent steps are taken and additional features are added to foster the application.

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