Literature Survey: Drowsiness Detection using Computer Vision Technology

Apurva Patil[1] Archies Patil[2] Siddhi Shenoy[3] SiddheshPedamkar[4] Prof. Suvarna Pansambal[5]
[1,2,3,4]Student [5]Assistant Professor
[1,2,3,4,5]Atharva College of Engineering, Mumbai

Abstract— The basic idea of drowsiness detection is based on four parts: Background elimination, Face detection, Eye detection, and Mouth movement detection. A Drowsy Driver Detection System has been developed, using a non-intrusive machine vision based concepts. This paper lists some of the algorithms and features regarding the same.

Key words: Drowsiness Detection**,** Computer Vision Technology

I. INTRODUCTION

Drivers fatigue is a significant factor in a large number of vehicle accidents. Recent statistics estimate that annually 1,200 deaths and 76,000 injuries can be attributed to fatigue related crashes. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Because of the hazard that drowsiness presents on the road, methods need to be developed for counteracting its effects. The focus will be placed on monitoring the open or closed state of the driver's eyes in real-time and the yawing state. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. Detection of fatigue involves a sequence of images of a face, and the observation of eye movements and blink patterns. Yawning is included to make the system more accurate by determining the movement of the mouth. Once the position of the eyes and mouth is located, the system is designed to determine and detect fatigue.

- Background Elimination
- Face Detection

Face detections concerned with finding whether or not there are any faces in gray scale images and if present then returns the image location and content of each face. Face detection module was developed for single images but its performance can be further improved if a video stream is available. Face detection from a long database of face images with different backgrounds is not an easy task [6].

Steve Lawrence et al [1] have discussed Real time visions modules. Real time visions modules have been facilitated due to advances in computing technologies. These modules interact with humans. The face detection is challenging as it needs account for all possible appearance variations caused by changes in illuminations, facial features, occlusions, etc. It also has to detect faces that appear at different scale pose with in-plane rotations.

The Face Detection can be of two types:

1) We want to find one particular person for a large database. In this type of search the system searches through the database and result is the most closely matched template. This operation may take time so it need not be done in real time.
2) We need to survey a particular area. Here we need rapid classification and identification i.e. the data needs to be identified in real time data. Here the continuous video stream is converted into frames for recognition.

Algorithms used for Face Detection are Geometrical features, Eigenfaces, Template Matching, Graph Matching, etc.

II. GEOMETRICAL FEATURES

V. Starovoitov and D. Samal [2] have discussed, Geometric feature learning methods extract distinctive geometric features from images. Geometric features are features of objects constructed by a set of geometric elements like points, lines, curves or surfaces. These features can be corner features, edge features, Blobs, Ridges, salient points image texture and so on, which can be detected byfeature detection methods.
Geometric features are:

A. Fiducial Points

For geometric approach a set of fiducial points or anthropometrical points are used. 37 such points are found out. Some points need to be extracted manually and some are detected automatically. After point detection these coordinates may be corrected manually to improve their location. These coordinates ay be stored with the corresponding image in the database.

B. Feature Choosing

Geometric features maybe presented by segments, perimeters and area of some figures formed by the detected points. 15 such segments are formed from the coordinates.

C. The Feature Set Optimization

Once feature set are obtained it is optimized by the presenting technique. The point is to find the feature space with the maximum distance between the clusters and minimum ones between the pattern of one cluster.

D. Face Recognition based on the Features

The features are stored together with a person identification photograph in database. When the tested image normalized on the rotation, scale and intensity levels fiducial points are detected and the values of the features are calculated. All the images stored in database are the patterns in the feature face.

III. EIGENFACES

The eigenfaces are the principal components of the original face images, obtained by the decomposition of PCA, forming the face space from these images. So any new face can be expressed as linear combination of these Eigenfaces [8].

The algorithm for the facial recognition using eigenfaces is basically described below.

1) First, the original images of the training set are transformed into a set of eigenfaces E.
2) Afterwards, the weights are calculated for each image of the training set and stored in the set W. Upon observing an unknown image X, the weights are calculated for that particular image and stored in the vector WX.
3) Afterwards, WX is compared with the weights of images, of which one knows for certain that they are faces (the weights of the training set W). One way to do it would be to regard each weight vector as a point in space and calculate an average distance D between the weight vectors from WX and the weight vector of the unknown image WX (the Euclidean distance described in appendix A would be a measure for that).
4) If this average distance exceeds some threshold value θ, then the weight vector of the unknown image WX lies too ”far apart” from the weights of the faces. In this case, the unknown X is considered to not a face.
5) Otherwise (if X is actually a face), its weight vector WX is stored for later classification. The optimal threshold value θ has to be determined empirically [7].

IV. EYE DETECTION

Robert Gabriel Lupu [3] has discussed that in the previous year’s many algorithms for eye pupil/iris detection have been developed. Depending upon the source light point of view there are two approaches namely based on ambient or infrared light. All of them search for characteristics of the eye. There are some algorithms that search for features like blackest pixels in the image, pixels that correspond to pupil or iris and are known as feature based algorithms. Other algorithms are trying to best fit a model to the pupil/iris contour and are known as model based algorithms.

In featured based algorithms the features required are isolated from the entire image. This has an advantage of low computing resources. On the other hand, model-based approaches do not explicitly detect features but rather find the best fitting model that is consistent with the image.

Dongheng Li, Derick J. Parkhrust [4] has discussed that Starburst algorithm is a robust eye-tracking algorithm that combines feature-based and model-based approaches to achieve a good trade-off between run-time performance and accuracy for dark-pupil infrared imagery. The goal of the algorithm is to extract the location of the pupil center and the corneal reflection so as to relate the vector difference between these measures to coordinates in the scene image. The algorithm begins by locating and removing the corneal reflection from the image. Then the pupil edge points are located using an iterative feature-based technique. An ellipse is fitted to a subset of the detected edge points using the Random Sample Consensus (RANSAC). The best fitting parameters from this feature-based approach are then used to initialize a local model-based search for the ellipse parameters that maximizes the fit to the image data.

Robert Gabriel Lupu [3] has discussed that, The ETAR algorithm has a feature based approaches. It starts by searching the region where the eye is located, using HaarCascadeFilter. The region is set as region so interest (ROI) and a mask image is constructed in order to eliminate the unwanted noise from the four corners of ROI. The algorithm continues with determination of an optimal binary segmentation threshold. The pupil centre is determined by applying the centre of mass to thegroup of pixels that correspond to the pupil from the segmented ROI image. The analysis of determined gaze direction reveals that the algorithm is not sensitive to the noise from the image.

V. MOUTH MOVEMENT DETECTION

A. Rule-based Face Detection Algorithm

Cheng-Chin Chiang et al [5] has discussed that in this algorithm finds not only the face regions, but also the precise locations of the facial components such as eyes and lips. The algorithm starts from the extraction of skin pixels based upon rules derived from a simple quadratic polynomial model. Interestingly, with a minor modification, this polynomial model is also applicable to the extraction of lips. The benefits of applying these two similar polynomial models are twofold. First, much computation time are saved. Second, both extraction processes can be performed simultaneously in one scan of the image or video frame. The eye components are then extracted after the extraction of skin pixels and lips. Afterwards, the algorithm removes the falsely extracted components by verifying with rules derived from the spatial and geometrical relationships of facial components. Finally, the precise face regions are determined accordingly. According to the experimental results, the proposed algorithm exhibits satisfactory performance in terms of both accuracy and speed for detecting faces with wide variations in size, scale, orientation, color and expressions.

According to the framework of the bottom-up detection approach, the proposed algorithm is designedto extract the facial components including lips and eyes. In order to reducing the searching areas in the input images, the proposed algorithm also performs the extraction of skin pixels. However, instead of using probabilistic models, we use a quadratic polynomial model for the color model of skin pixels to reduce the computation time. Moreover, we also extend this polynomial model to the extraction of lip components with a minor modification. Finally, the falsely extracted eye and lip components are removed based on a set of rules induced from the common spatial and geometrical relationships among normal facial components. The final precise face regions are then determined accordingly.

VI. CONCLUSION

In this paper the authors have proposed a method to determine various aspects of detecting drowsiness. This includes namely Background Elimination, Face Detection, Eye Detection, Detection of Lip Movement. We start with Background elimination. Then comes face detection using Geometric features. Then we do eye detection using Model Based Approach by using ETAR Algorithm or use Hybrid Approach by using Starburst Algorithm. Then we track lip movement using Rule Based Detection Algorithm. The proposed method detects yawning, alert fatigue earlier, and will facilitate to make drive safer. In future, the authors will capture more video clips to train and test the proposed method. The main goal is to develop a system to combine more features including mouth features, eye features to monitor driver fatigue

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