Drowsy Driver Detection System

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Abstract— A Drowsy Driver Detection System has been developed, using a non-intrusive machine vision based concepts.A small monochrome security camera is used by the system that points directly towards the driver's face and monitors the driver's eyes in order to detect drowsy. In such a case when drowsiness is detected, to alert the driver a warning signal is issued. This report describes how to find the eyes, and also how to determine if the eyes are open or closed. A unique algorithm is developed, which was a primary objective of the project. The system deals with using information obtained for the binary version of the image to find the edges of the face, which narrows the area of where the eyes may exist. Once the face area is found, the eyes are found by computing the horizontal averages in the area.Taking into account the knowledge that eye regions in the face present great intensity changes, the eyes are located by finding the significant intensity changes in the face. Once the eyes are located, measuring the distances between the intensity changes in the eye area determine whether the eyes are open or closed. A large distance corresponds to eye closure. If the eyes are found closed for 5 consecutive frames, the system draws the conclusion that the driver is falling asleep and issues a warning signal.

Key words: Drowsy, warning signal

I. Introduction

Project is based on implementing Detection of drowsiness involves a sequence of images of a face, and the observation of eye movements and blink patterns. The analysis of face images is a popular research area with applications such as face recognition, virtual tools, and human identification security systems. This project is focused on the localization of the eyes, which involves looking at the entire image of the face, and determining the position of the eyes by a self developed image processing algorithm.Once the position of the eyes is located, the system is designed to determine whether the eyes are opened or closed, and detect drowsiness.

II. Proposed System

This system is well suited for real world driving conditions since it can be non-intrusive by using optical sensors of video cameras to detect changes. In this type of driver's drowsiness detection system we first capture the face image of the driver using a camera located inside the car. After that we have to segment only the face region and excluded the background portion. After the localization of the face we need to extract the eye region. We choose the eye region as our decision parameter because the eye region is very dynamic in nature and the drowsiness of a person can only be determined by looking at the eyes . If the eye is open, the situation is normal and if the eye is closed we should generate an alarm signal to alert the driver. The main idea behind this project is to develop a nonintrusive system which can detect drowsiness of the driver and issue a timely warning. Since a large number of road accidents occur due to the driver drowsiness, this system will be helpful in preventing many accidents, and consequently save money and reduce personal suffering. This system will monitor the drivers eyes using a camera and by developing an algorithm we can detect symptoms of driver drowsiness early enough to avoid an accident. So this project will be helpful in detecting driver drowsiness in advance and will gave warning output in form of sound. This will directly give an indication of drowsiness.

III. Modules

The project is basically divided into four main parts:-

- Face detection
- Eye detection
- Eye Ball Detection
- Drowsiness Detection

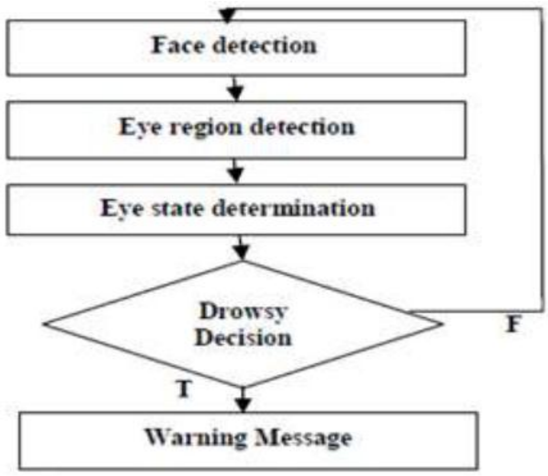

Fig. 1: Flow Chart of Drowsy Detection System

A. *Face Detection:*

Face detection is a computer technology that identifies human faces in digital images. It detects human faces which might then be used for recognizing a particular face.

1) Canny Edge Detection:

Canny algorithm is used to detect a live face in a scene of the image. Canny edge detector have advanced algorithm derived from the previous work of Marr and Hildreth. It is an optimal edge detection technique as provide good detection, clear response and good localization. It is widely used in current image processing techniques with further improvements.

2) Canny Edge Detection Algorithm:

a) Step I:

Noise reduction by smoothing Noise contained in image is smoothed by convolving the input image I (i, j) with Gaussian filter G. Mathematically, the smooth resultant image is given by F(i,j)=G*I(i,j) Prewitt operators are simpler to operator as compared to sobel operator but more sensitive to noise in comparison with sobel operator.

b) Step II:

Finding gradients In this step we detect the edges where the change in grayscale intensity is maximum. Required areas are determined with the help of gradient of images. Sobel operator is used to determine the gradient at each pixel of smoothened image. Sobel operators in i and j directions are:

$$D_i = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} \text{ And } D_j = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

These sobel masks are convolved with smoothed image and giving gradients in i and j directions.

$$G_i = D_i * F(i,j) \quad \text{And} \quad G_j = D_j * F(i,j)$$

Therefore edge strength or magnitude of gradient of a pixel is given by

$$G = \sqrt{G_i^2 + G_j^2}$$

The direction of gradient is given by

$$\theta = \arctan\left(\frac{G_j}{G_i}\right)$$

c) Step III:

Non maximum suppressions:

Non maximum suppression is carried out to preserves all local maxima in the gradient image, and deleting everything else this results in thin edges. For a pixel M (i, j):

1) Firstly round the gradient direction nearest45° ,then compare the gradient magnitude of the pixels in positive and negative gradient directions i.e. If gradient direction is east then compare with gradient of the pixels in east and west directions say E (i, j) and W (i, j) respectively.
2) If the edge strength of pixel M (i, j) is largest than that of E (i, j) and W (i, j), then preserve the value of gradient and mark M (i, j) as edge pixel, if not then suppress or remove.

d) Step IV:

Hysteresis thresholding

The output of non-maxima suppression still contains the local maxima created by noise. Instead choosing a single threshold, for avoiding the problem of streaking two thresholds t_{high} and t_{low} are used. For a pixel M (i, j) having gradient magnitude G following conditions exists to detect pixel as edge: $G < t_{low}$ than discard the edge.

1) $G >$ than t_{high} keep the edge.
2) $t_{low} < G <$ and t_{high} and any of its neighbours in a 3 ×3 region around it have gradient magnitudes greater than t_{high}, keep the edge.
3) If none of pixel (x, y)'s neighbors have high gradient magnitudes but at least one falls between t_{low} and, t_{high} search the 5 × 5 region to see if any of these pixels have a magnitude greater than thigh. If so, keep the edge.
4) Else, discard the edge.

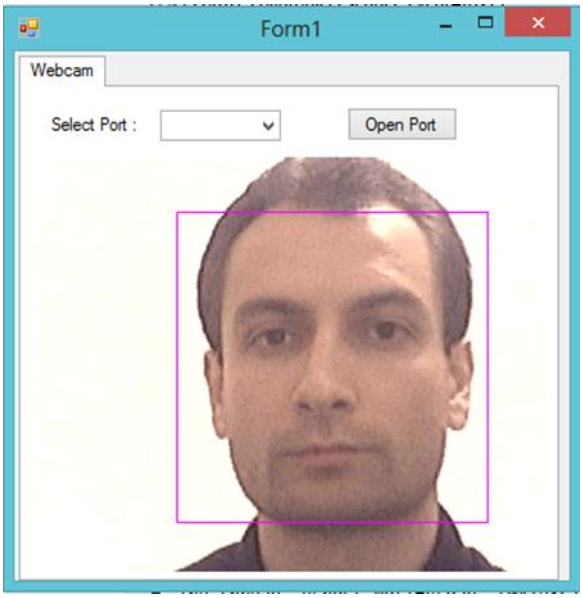

Fig. 2: Face Detection

B. Eye Detection:

After detecting the face, the next step is to detect the eyes, this can be achieved by making use of Haar Cascade Classifier. However, to reduce the amount of processing, we mark the region of interest before trying to detect eyes.

1) Haar Casacade Classifier:

It is also known as eye detector. Eye detection is achieved by making use of Haar Casacade. It is machine learning algorithm that are included in OpenCV. Haar Cascade file contains number of features of eyes. It is constructed using number of positive and negative samples. First load the Casacade file and then pass the acquired frame to Edge detector and then compare with cascade file to detect eyes. Using Eye-Haar Classifier eyes are detected and rectangles are drawn around the left and right eye.

2) Open CV:

It includes statistical machine learning library that contain Haar Cascade.Open CV is a library for implementing Haar training.We have used Haar training application to detect eyes.

C. Eye Ball Detection:

Eye ball detection is the major phase in drowsiness detection. So this phase must have appreciable accuracy. Here we choose circular Hough transform for this purpose. Hough transform is a feature extraction technique used.

1) Hough Transform:

In Digital Image Processing,Hough Transform is use for feature extraction.The purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform. The purpose of the Hough transform is to perform groupings of edge points into object candidates by performing an explicit voting procedure over a set of parameterized image objects.

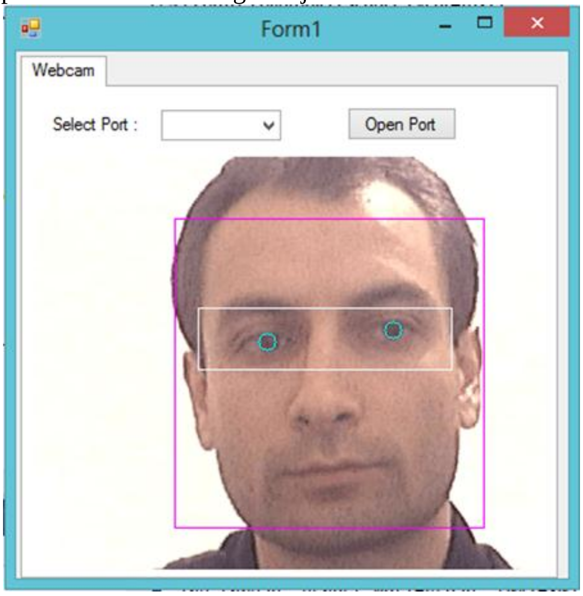

Fig. 3:Eyeball Detection

2) Drowsiness Detection:

The simplest symptom to detect drowsiness is eye closure.Drowsiness detection is the final step of system implementeion. In this state we get the final result.

3) Emgu.CV Engine:

It is a cross platform .Net wrapper to the Open CV image processing library. Allows Open CV function to be called by .Net compatible language such as C#,VB,Python. To detect the human facial features. Intel developed an open source library used for implementation of computer vision related program called Open CV.

The output of eye ball detector will be continuously compared with eye samples from Emgu.CV library. If the real time frames match with the closed eye samples from the library then it will generate an alarm.

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V. CONCLUSION

A non-invasive system to localize the eyes and monitor fatigue was developed. Information about the head and eyes position is obtained though various self-developed image processing algorithms. During the monitoring, the system is able to decide if the eyes are opened or closed. When the eyes have been closed for too long, a warning signal is issued. In addition,during monitoring, the system is able to automatically detect any eye localizing error that might have occurred. In case of this type of error, the system is able to recover and properly localize the eyes. The following conclusions were made:

1) Image processing achieves highly accurate and reliable detection of drowsiness.
2) Image processing offers a non-invasive approach to detect drowsiness without the annoyance and interference.
3) A drowsiness detection system developed around the principle of image processing judges the driver's alertness level on the basis of continuous eye closures

VI. FUTURE SCOPE

Future work may be to automatically zoom in on the eyes once they are localized. This would avoid the trade-off between having a wide field of view in order to locate the eyes, and a narrow view in order to detect drowsiness.This system only looks at the number of consecutive frames where the eyes are closed. At that point it may be too late to issue the warning. By studying eye movement patterns, it is possible to find a method to generate the warning sooner. Using 3D images is another possibility in finding the eyes. The eyes are the deepest part of a 3D image, and this maybe a more robust way of localizing the eyes. Adaptive binarization is an addition that can help make the system more robust. This may also eliminate the need for the noise removal function, cutting down the computations needed to find the eyes. This will also allow adaptability to changes in ambient light. The system does not work for dark skinned individuals. This can be corrected by having an adaptive light source. The adaptive light source would measure the amount of light being reflected back. If little light is being reflected, the intensity of the light is increased. Darker skinned individual need much more light, so that when the binary image is constructed, the face is white, and the background is black.

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