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Automated Detection of Eye Blink and Conversion to voice using ML Algorithms

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Abstract

The motive of the paper is to develop a real time method for the paralysed patients, which is the conversion of eye blinks to voice. The motive behind this research paper is to provide assistance for the disabled who always requires assistance for the interaction with hands. Hence we provide them help by fulfilling their requirement. We use certain algorithms for this need. For the facial and eye detection we use the Haar Cascade Classifier. It uses Haar like features for finding the axial positioning of the eyes. An efficient method for tracking the eye was developed which is used to detect the eye position. We also use the Eye Aspect Ratio (EAR) to find the state of the eye and estimate the opening and closing of the eyes. Basically, we use a live stream video in this project as the input and capture the Eye Blinks. This is further processed by the OpenCV Library and henceforth provides the required assistance.

Keywords: *paralysed patients, Haar cascade classifier, Eye aspect ratio (EAR), Eye blinking, OpenCV.*

1. Introduction

Paralysis is a condition found in most humans where the muscle function in our body is lost. Paralysis can be complete or partial. Due to a paralysed attack the human body communication ability is restricted. In such scenarios the patient is highly dependent on the muscle movement of the eye. Hence our prime motive behind this project is, we capture the eye blinks movements and convert these into voice there by fulfilling the need of the disabled.

For the detection of the axis of the face, we use simple features like the haar features for identifying the image in viola [1].

Many of the camera sources use an expensive method for the detection of the eye and its pupil and location of the eye. Avoiding specialized hardware and infrared emission sources, the proposed system uses aninexpensive webcam of a computer to take the input. We do not require any other equipment for communicating with the patient. We use OpenCv which is a library for taking the input as live stream video from the webcam. These videos captured is further being processed by applying the processing techniques of images on them . Begins with the Eye Tracking Process [2], it is considered to be the starting point. We obtain the video frame and then send it for the facial detection after which the face is detected. After the face is detected it sends that information for the eye detection. We do not use any lightening effect nor any medical equipment is needed for the communication. With the use of OpenCV library the video Stream and frames are taken by the webcam and it is than being processed by various techniques to obtain the appropriate output.

An effective approach was presented in [3] for the inter eye blink intervals. The goal was to develop a new method to productively track eyes of a person from the video frame and thereby analysing the state of the eyelids. For the tracking purpose we used the Haar Cascade Classifier (HCC) and the Camshift algorithm. Their results show that their approach works well in real time applications.

Eye tracking is used to provide us an interaction with the modern level interfaces which is a boon these days. We have various interfaces like the keyboard or the mouse etc which is used at the basic level or the primary level to take in the input for the interaction of the human with the computer. A System for tracking the eye was also proposed [4] for the blink detection and the human computer interaction. Their proposed system

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uses the pupil portion and hence with that it tracks the movement of eyes.

2. Related Work

[1]With reference to this paper an implementation of the eye tracking system was developed by removing the facial detecting method. By this it was proved that their was a very little loss in the accuracy.

[2] In this we see a gesture based system was developed for the interactions. An MFCC was developed which used signals for rotating the device and using that force they recorded their MFCCs. They used a classifier for this purpose which is the Hidden Markov Model(HMM).

In [3] authors have proposed a method using eye gaze to develop wheelchair that moves on the motion of the attention gaze. The disadvantage was that it Just works for gaze movement but not for blink movement.

In [4] an indication language interpreter system was proposed for reducing the communication barrier between the deaf-dumb people and also the normal ones. On the opposite hand, the majority of the currently used systems are based only on the American signing and also the English vocal language. Furthermore, these systems have a really limited signing database that can't be considered fully reliable. The disadvantage was that it was Gesture based method and human should be fit to do this

3. Proposed Methodologies

The stated system consists of two main modules namely Eye Blink Detection, and Eye Motion Detection. The slated algorithm first detects the face using facial landmark detector executed inside dlib and detect the eye region and draw a bounding box around the localized eye co-ordinates. Then the eye region is computed and changed into grayscale. While performing these algorithms, the assumption is made that the patient's head is stationary. The computer monitors the movement of an eye towards left or right or detects blinks. The contour lines are then detected through a blob around the iris of the eye. The output from these algorithms can be used as the input parameters for the required computer interface.

A. Eye Blink Algorithms

There are four important steps
1) Detecting Face
2)Locating Region of Eye and Blob Creation
3)Eye Blink Detection
4)Eye Blink Classification

First, our algorithm uses OpenCV and dlib library to identify the face and it obtains the region of the eye in the face. The boundary region helps to detect the number of blinks. It also classifies the blinks based on classifiers present in the dlib.

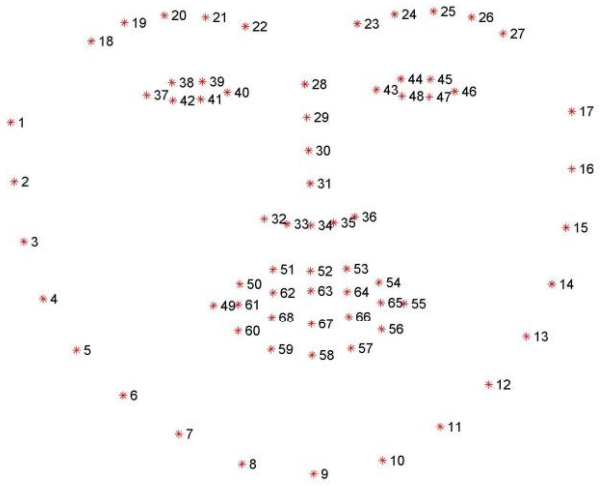

Diagram 1: Coordinates of Face -identified by dlib

Eyeblink detection algorithm is being implemented by several algorithms. They can be explained as below

1. Detection of Face

In this method, it detects face by making use of neural networks that instructs the computer using Haar-Cascades, facial landmark detector in the dlib. It is used to detect facial features like ear, nose, eye etc. The dlib library is actually used to plot 68 coordinate points on the face to define a particular feature.

$$\epsilon = \frac{100}{\kappa N} \sum_{i=1}^{N} ||x_i - \hat{x}_i||_2,$$

In this, the accuracy of landmark identification of face is estimated by the medium of the corresponding landmark localization error.

2. Localization of Eye Region

The Eye region is taken from live streaming video frames. By seeing the detected face, we can tell that the part of the eye is defined with the help of facial landmark. It is further taken to detect Eye blinks. The localised region can be shown as:

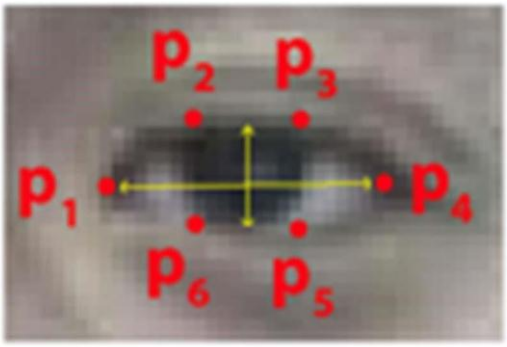

Diagram 2: The six coordinate points locating the Eye region

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3. Threshold

If we consider Thresholding, the white regions of the eye in the extricated Eye region. The white area of eye disappears for a time period, considered as eye blink can be determined with the help of a time library. detection of eye blink can be calculated by using EAR(Eye Aspect Ratio), which is achieved using the formula as follows.

$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

4. Classification of Eye Blink

In this system, the eye blink detection is classified into two types, voluntary eye blinks and involuntary eye blinks. The duration of voluntary eye blink is set greater than 200Ms. We used Eye aspect Ratio(EAR) as a parameter to detect the blinks. EAR is used to identify when the eye is shut and thereby calculating the threshold values. The change in EAR measured values is used to detect an Eyeblink. These type of Gestures helps the user/patient to monitor the interface.

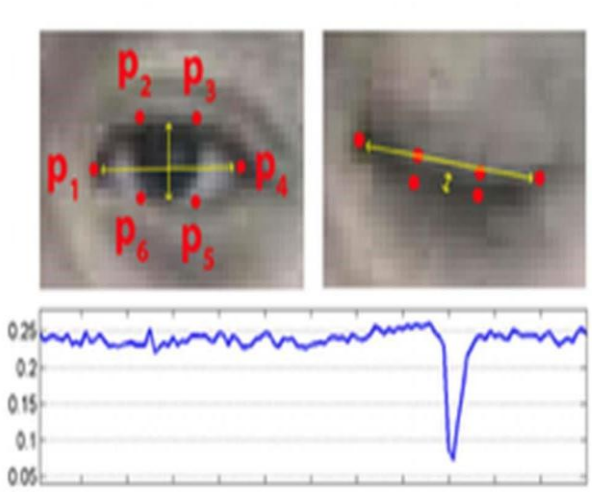

Diagram 3: Left-Picture: Landmarks of Eye when it is open
Right-Picture: Landmarks of eye when it is closed.
Bottom-Picture: To plot the EAR across Time. The drop in the EAR symbolizes a blink.

B. Detection of Eye Motion Algorithm

The boxes that are bounded across the eye region are computed using the identified right and left eye from the former stage. By using this, the algorithm crops off the left and right eye images into two separate sub-images. Using linear interpolation, the system produces a fixed size of eye images and it is based upon the size of the face detected. We consider here that the patient head is steady, and we also consider that there is no movement in the eye. Even if there is a slight change in the position of the head, it may result in either an error/fallacious eye motion. Hence, we can say that using this algorithm, the eye motion detection can be accurate.

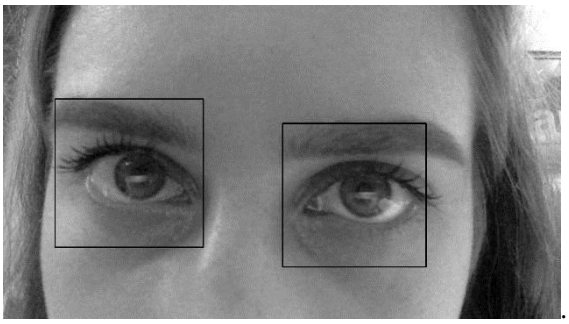

Diagram 4: Eye localization on both Eyes

1. Hough Circle Outline Around Pupil

Here, in this step we need to identify a pupil for movement detection. We know that the pupil is circular, so we need to draw a circular shape around the pupil by using Hough circle function in OpenCV. It is mainly used to draw a circle if it finds a circular object in video frames. With this help, we can draw a contour around the pupil and we can calculate the centre with that function

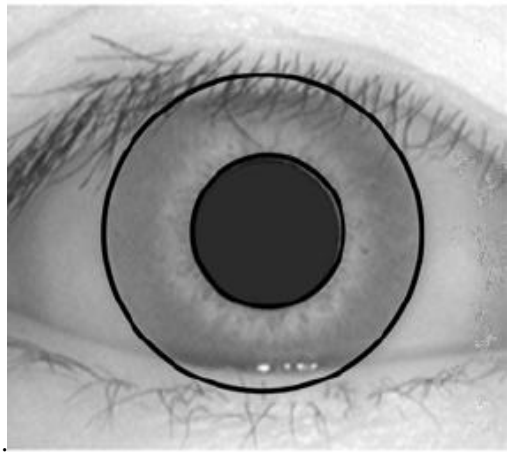

Diagram 5: Hough circle outline around the pupil

2. Tracking of Object

Here, in this step, we track the pupil motion by using object tracking function and it determines the direction of movement of the pupil. In this, we can track three possible movements of the eye

1) When the patient is looking towards the left side (Left eye motion).
2)When the patient is looking towards the right side (Right eye motion).
3)When the patient is looking towards the centre (No motion).

By obtaining a result from this, we can determine the direction and can be used to monitor. It not only tracks the eye movement but also can distinguish between voluntary and involuntary blinks of an eye thereby increasing the efficiency of an algorithm.

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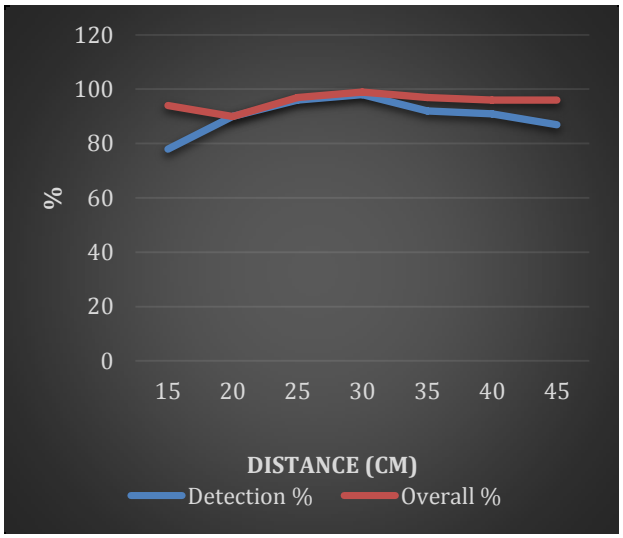

Graph: % (overall & detection accuracy) vs Distance in cm

4. User Interface

The User Interface is designed in such a way that, any untrained patient can also use this at an ease. In this, first, the user/patient is given with a simple and interactive user interface and it is designed in such a way that it can be used easily by any age group person ranging from kid to old person. Through which they can communicate using their eyes. It works on two algorithms:

1) Eye Blink detection
2) Eye motion detection.

The user is provided with a keypad consisting of numbers. This system uses the above mentioned two algorithms to detect the eye blinks and their motion. If the user is trying to blink voluntarily then the algorithm counts the number of blinks and delivers the voice message corresponding to that number of blinks. In this way, the paralyzed patient or any disabled person can communicate through the system. It is mainly intended to assist the disabled and paralyzed people.

5. Result

Upon Completing the project, We found that the Eye Blinks of a paralysed person was recorded through the Live Stream Video and the necessary Output Commands to perform their needs was delivered. These commands was outputted through voice. As we are using the webcam of the computer it is there by necessary to keep the computer close enough to the patient to take in the input. A threshold was used so that when the input is being taken from the person no other action or motion is found. After this threshold, it again takes input from the patient. Hence thereby providing the assistance to the paralysed. In our project we have given commands like food, water, washroom, turning on the fan etc.

Our project obtained an accuracy of 87.21% for detecting the eye blinks. With respect to the user Interface we obtained a accuracy of about 91%.A table below represents the calculation and the accuracy percentages obtained along with the error calculations.

Table I: Eye Motion Algo -Error Calculation

USER	TOTAL READINGS	CORRECT READINGS	WRONG READINGS	%ERROR
USER 1	25	23	2	8
USER 2	25	22	3	12
USER 3	25	21	4	16
USER 4	25	23	2	18
USER 5	25	22	3	12

Table II: Eye Blink Algo -Error Calculation

USER	TOTAL READINGS	CORRECT	WRONG	%ERROR
User 1	25	21	4	16
User 2	25	22	2	8
User 3	25	22	3	12
User 4	25	22	3	12
User 5	25	21	4	16

6. Conclusion

The Motive behind this project was proved through the experiments conducted and the desired output was obtained. Our proposed System has come up with 8% of improvement in accuracy of Eye detection and also Eye blinking.

The project was developed basically to help the paralysed. The method is also cost efficient. In this approach we don't need a labour as well. Thus the project developed is a real assistance to the paralysed.

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