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Efficient Eye Blink Detection for Disabled

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Abstract—This paper proposes the concept of Machine Learning to implement an eye blink detection system. It is used to first track the eyes on the patient and then detect its movements. Machine learning has experienced a boost in acceptance among many fields including the medical field. People suffering from speech impairment find it difficult to communicate their needs to the outside world. People with severe disabilities are confined in a state in which communication is virtually impossible, being reduced to communicating with their eyes or using sophisticated systems that translate thoughts into words.

The Eye Trackers are suitable systems for those people but the main disadvantage is the cost. More affordable devices are capable of detecting voluntary blinks and translating them into a binary signal that allows the selection. The method of voluntary blinking, the use of long or double blinks had no statistical influence on accuracy, excluding EOG, and the time taken to perform double blinks was shorter, resulting in a potentially much faster interface. Machine learning creates a platform to be precise in the measurement of any parameters using various algorithms.

In this paper, we propose to apply Haar cascade and shape predictor algorithms to map the eyes of the patient and detect various blink patterns. The preferred technology and blinking methods were Video-Oculography (VOG) and long blinks Implementation of this paper successfully bridges the communication gap between the outside world and the paralyzed/disabled patients.

Keywords— Open CV, eye aspect ratio, Ada boost classifier, face detection, EOG, VOG

I. INTRODUCTION

In these days electronic devices are improving day by day and their demand is also improving. Smart phones, tablets are example of this. The system detects the eye blink and differentiates between an intentional long blink and a normal eye blink. Tetraplegia is a condition where people cannot move parts below neck. The proposed system can be used to control and Communicate with other people. In the recent years due to the rapid advancement in the technology there has been a great demand of human computer or mobile interaction (HCI or HMI). [1]

Eye blink is a quick action of closing and opening of the eyelids. Blink detection is an important enabling component in various domains such as human computer interaction, mobile interaction, health care, and driving safety. For example, blink has been used as an input modality for people with disabilities to interact with computers and mobile phones. [2]

In Viola the chain of single-feature filters, Haar Cascade Classifier for identifying sub-region image is used. With the fast calculation of integral image technique, it can work in real time. Eye tracking provides an almost seamless form of interaction with the modern graphical user interface, representing the fastest non-invasive method of measuring user interest and attention. While the mouse, keyboard, and other touch-based interfaces

have long reigned as the primary mediums associated with the field of human computer interaction, as advances continue to improve the cost and accuracy of eye tracking systems, they stand poised to contend for this role. An open and close eye template for blink pattern decisions based on correlation measurement is used in. The method was specifically useful for people with severely paralyzed. A real-time eye blinking detection was proposed based on SIFT feature tracking with GPU based implementation. [3]

An efficient method is proposed and the method is based on image processing techniques for detecting human eye blinks and generating inter-eye-blink intervals. A Haar Cascade Classifier and Camshaft algorithms for face tracking and consequently are applied for getting facial axis information. [4]

Adaptive Haar Cascade Classifier from a cascade of boosted classifiers based on Haar-like features using the relationship between the eyes and the facial axis applied for positioning the eyes. The algorithm results show that the proposed method can work efficiently in real-time applications. An Eye Phone application which is developed in is a system that capable of driving mobile applications/functions using only the user's eyes movement and actions (e.g. Wink). Eye Phone tracks the user's eye movement across the phone's display using the camera mounted on the front of the phone. The results indicate that Eye Phone is a promising approach to driving mobile applications in a hand-free manner. [5]

An efficient eye tracking system is presented in having a feature of blink detection for controlling an interface that provides an alternative way of Communication for the people who are suffering from severe physical disabilities the proposed system uses pupil portion for tracking the movement of eyes. [6]

A literature review about different techniques employed to detect blinking are:

A. EOG

The EOG signal is derived from the polarization potential, also known as the Corneal-Retinal Potential (CRP), generated within the eyeball by the metabolically active retinal epithelium. The electrical activity associated to eye movement scan is measured by placing electrodes on the surface of the skin around the eye. When the eyes are looking straight forward, the position of the cornea and retina makes the electrodes measure a steady electric field. If the eyes move towards the periphery, the retina approaches one electrode whereas the cornea approaches the other. The EOG circuit amplifies the electrical ocular activity that, due to the electrode placement, is influenced more by vertical eye movements and blinks. This changes the orientation of the dipole and results in a variation in the measured EOG signal.

B. VOG

ETI's are especially appropriate for people with good control over ocular movements. They are mainly based on employing specific cameras according to the type of scene illumination: IR or natural. Some eye-tracking open-source hardware uses a small camera, which is placed close to the eye (the eye camera), capturing eye movements accurately. This scheme is very sensitive to head movements and needs frequent calibrations to correct the loss in accuracy. Other solutions have included a second camera, or field camera, which records the scene that the subject sees, and allows the software to correct the eye-gaze according to the head position. Other eye-trackers employ a Kinect, or a single webcam placed in front of the user, and do not need any additional mounting. The webcam-based ETI can achieve accuracy similar to the infrared counterparts when it uses reasonably sized images and avoids the periphery of the screen.

II. RELATED WORK

The Patient who had this major problem became Scientist Dr. Stephen Hawking. All his speeches are pre-recorded. He used to communicate with the arena the use of fast keys approach and prediction software program for phrases. This method includes a display which has all of the alphabets from A to Z in order. Whenever he thinks of communicating, all the letters from A to Z pops out from the screen one after the other. He used to tweak his cheek when the display pops out the starting letter of the word which he desired to say. He had to put on eye glasses, which has a sensor embedded to it. Whenever he tweaks his cheek, it activates the sensor that's embedded along with his eye glasses. Thus the letter is selected with the assist of speedy key technique. Then, with the help of prediction software program for words, the anticipated phrases with the selected letter pop out from the display screen. The gadget is attached to the wheelchair.

Fig. 1 Dr. Stephen Hawking using swift keys technique for communication

For instance, if he wishes to say WELCOME, then he has to look forward to the letter W to pop out. Once it is done he moves his cheek and selects the letter, then the words which start from letter W pops out like WE, WELCOME. Thus, once more shifting his cheek he used to choose the desired words and complete the sentence. This tool turned into added by using IBM Company, which prices round 2 million USD, which is too big for the common humans to manage to pay for.

There are numerous techniques which are brought for the paralyzed patients with low value to communicate with the outside global. They are Brain wave detection and electro-oculography method. These techniques contain the usage of electrodes. The electrodes have to be pierced via the epidermis this is first layer of the skin. Thus this approach is too painful and the sufferers want to be conscious and he could be uncomfortable all the time. Thus the video oculography (VOD) entails the camera connected to the wheel chair of the affected person which data the attention blinks of the patient and is converted into a meaningful sentence which the character notion of conveying to the outside world. Thus it makes the patient to without difficulty communicate and is less expensive to not unusual people.

III. METHODOLOGY

Blink-To-Speak offers a form of independence to paralyzed people. The software platform converts the eye blinks to voice. Every feature of the software can be controlled by eye movement. Thus, the software can be independently operated by paralyzed people. Using the software, patients can record messages, recite those messages aloud and send the messages to others.

The software can be run on any low-end computer, from a Raspberry Pi to an IBM ThinkPad. The software uses computer vision and Haar cascades to detect eye blinking and convert the motion into text. The program uses language modeling to predict the next words that the user might blink.

The software can be easily customized for each patient as well. Blink to Text is free open source software. It is distributed under the MIT Permissive Free Software License.

Hence, the proposed system is free of any kind of gadgets and makes it easy for the patient to communicate with the outside world to express their basic everyday needs.

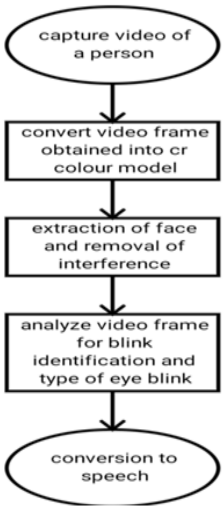


Fig 2: Process

A. HAAR CASCADE

Haar Cascade is a machine learning object detection algorithm used to identify objects in an image or video based on the concept of features. Cascade Classifier training requires a set of positive and negative samples. It is used to detect objects in other images. It is well known for being able to detect faces and body parts in an image but can be trained to identify almost any object. Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. Then we need to extract features from it. For this, haar features shown in below image are used. Each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black rectangle. After each classification, weights of misclassified images are increased. Then again same process is done. New error rates are calculated. The process is continued until required accuracy or error rate is achieved

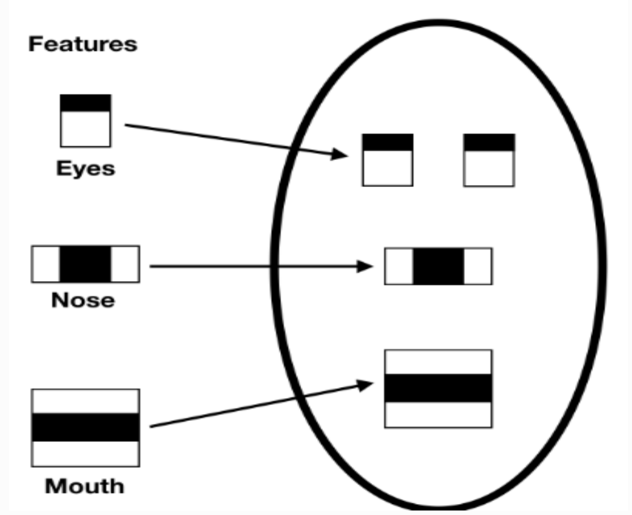


Fig. 3

B. ADAPTIVE BOOSTING (ADABOOST)

Ada Boost short for adaptive boosting is a machine learning meta algorithm. Boosting is a general ensemble method that creates a strong classifier from a number of weak classifiers.

This is done by building a model from the training data, then creating a second model that attempts to correct the errors from the first model. Models are added until the training set is predicted perfectly. It can be used in conjunction with many other types of learning algorithms to improve performance. The output of other algorithms is combined into a weighted sum that represents final output of boosted classifier. This is best used to boost performance of Decision Trees on Binary classification problems. Ada Boost can be used to boost the performance of any machine learning algorithm

Pseudo code :

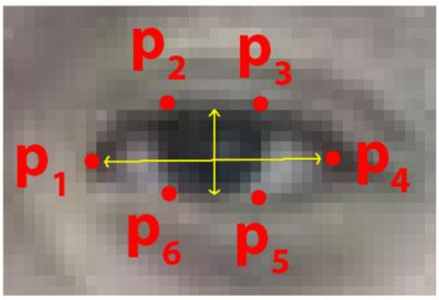
function ADABOOST(*examples*, *L*, *K*) **returns** a weighted-majority hypothesis
inputs: *examples*, set of *N* labelled examples ($x1, y1$),…,(xN,yN)
L, a learning algorithm
K, the number of hypotheses in the ensemble
local variables: **w**, a vector of *N* example weights, initially $1/N$
h, a vector of *K* hypotheses
z, a vector of *K* hypothesis weights
for $k = 1$ **to** *K* **do**
h[k] ← L(*examples*, **w**)
error ← 0
for $j = 1$ **to** *N* **do**
if **h**[k](xj) ≠ yj **then** *error* ← *error* + **w**[j]
for $j = 1$ **to** *N* **do**
if **h**[k](xj) = yj **then** **w**[j] ← **w**[j] · *error* ⁄ (1 − *error*)
w ← NORMALIZE(**w**)
Z[k] ← log(1 − *error*) ⁄ *error*
return WEIGHTED-MAJORITY(**h**, **z**)

IV. RESULTS AND DISCUSSION

The Eye Aspect Ratio is an estimate of the eye opening state. A program can determine if a person's eyes are closed if the Eye Aspect Ratio falls below a certain threshold. This implies that we can extract specific facial structures by knowing the indexes of the particular face parts.

Fig. 4

Facial landmark detection to localize important regions of the face, including eyes, eyebrows, nose, ears, and mouth. This also implies that we can extract specific facial structures by knowing the indexes of the particular face parts. Each eye is represented by 6 (x, y)-coordinates, starting at the left-corner of the eye. The eye aspect ratio will remain approximately constant when the eyes are open and then will rapidly approach zero during a blink, then increase again as the eye opens.



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

Fig. 5

V. CONCLUSION AND FUTURE SCOPE

The numerator of this equation computes the distance between the vertical eye landmarks while the denominator computes the distance between horizontal eye landmarks, weighting the denominator appropriately since there is only *one* set of horizontal points but *two* sets of vertical points. Using this simple equation, we can *avoid image processing techniques* and simply rely on the *ratio of eye landmark distances* to determine if a person is blinking. Accuracy of scoring the eyes of patients with facial paralysis using EAR was 85.7%, which can be used to enhance the objective and rapid assessment.

VI. CONCLUSION

Modern era of science and technology is always trying to increase the comfort and improve the health conditions of humans. The machine learning developments in medical industry have intense impact on better living standards. The emerging technologies are trying to make everyone’s lives easy and comfortable. We need to provide training to the required patients regarding the basic eye blink patterns which correspond to their everyday basic needs and necessities. This system efficiently detects their eye blinking patterns and outputs the corresponding results in the form of an audio.

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