An image processing based novel approach for eye movement detection

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Abstract — Statistics suggests that there are more than 20000 new cases of quadriplegia every year in all over the world. Great people like Stephen Hawking and Max Brito have been suffering from this crippling phenomenon. Our project is an attempt to make lives of the people suffering from this phenomenon simple and by simpler we mean self-reliant, which will thereby reinstate their confidence and their happiness. The idea is to create an Eye Monitored System which allows movement of the patient's wheelchair depending on the movement of eye.

Keywords- *matlab,viola-jones,eye detection,image,eye movement*

I. INTRODUCTION

Various methods have been proposed for allowing disable persons, including a quadriplegic to control a motorized wheel chair

A system for hands and legs paralyzed person can be proposed using eye movement detected through MATLAB image processing.in this methodology, it would be used for a person who lost or paralyzed hands and / or legs.

There are proposed methodologies in recent times which involve various gestures like hand gesture, accelerometer & voice controlled, EEG based system etc.

A) Hand Gesture :

In this method, hand is used to control motion of wheel chair. Actually, it is much difficult for an aged person. They cannot keep their hand steadily. Also, this system requires use of hands and hence it is not useful with a person who is paralyzed with hands.

B) Accelerometer and voice command gesture :

This system might be useful for hand paralyzed person. But, they have to keep voice command sensor very near to their mouth to operate the wheel chair smoothly, which might be quite be difficult.

C) EEG System :

This system might be useful for hand paralyzed person. But, approximately more than 10 electrodes are to be mounted on the head and it becomes difficult for patient to handle.

Hence, a system for hands and legs paralyzed person can be proposed using eye movement detected through MATLAB image processing. In this methodology, it would be used for a person who lost or paralyzed hands and / or legs.

II. VIOLA-JONES ALGORITHM

This algorithm is used to detect the face or object [3]

The Viola–Jones algorithm is the first object detection framework to provide competitive object detection rates in real-time proposed in 2001 by Paul and Viola and Michael Jones[1].it can be trained to detect a variety of object classes.it was motivated primarily by the problem of face detection [3].
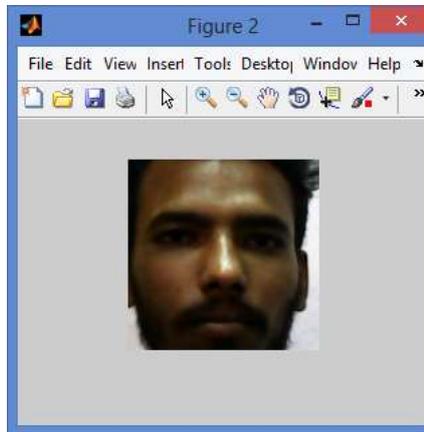
Result is shown in Fig.1 and Fig. 2

Figure 1.Face detection

The algorithm has four stages [3]:
1. Haar Feature Selection
2. Creating an Integral Image
3. Adaboost Training
4. Cascading Classifiers

Figure 2.Cropped image of face

1. Haar Features – All human faces share some similar properties. These regularities may be matched using Haar Features [3].
A few properties common to human faces [3]:

- The eye region is darker than the upper-cheeks.

- The nose bridge region is brighter than the eyes.

Composition of properties forming match able facial features [1]:

- Location and size: eyes, mouth, bridge of nose

- Value: oriented gradients of pixel intensities

The four features matched by this algorithm are then sought in the image of a face (shown at left).

Rectangle features[3]:

- Value = Σ (pixels in black area) - Σ (pixels in white area)

- Three types: two-, three-, four-rectangles, Viola & Jones used two-rectangle features

- For example: the difference in brightness between the white &black rectangles over a specific area

- Each feature is related to a special location in the sub-window

An image representation called the internal image evaluates rectangular features in *constant* time, which gives them a considerable speed advantage over more sophisticated alternative features. Because each feature's rectangular area is always adjacent to at least one other rectangle, it follows that any two-rectangle feature can be computed in six array references, any three-rectangle feature in eight, and any four-rectangle feature in nine[3].

The integral image at location (x, y), is the sum of the pixels above and to the left of (x, y), inclusive [3].

III. ADVANTAGES OF VIOLA-JONES ALGORITHM

- Extremely fast feature computation

- Efficient feature selection

- Scale and location invariant detector

- Instead of scaling the image itself (e.g. pyramid-filters), we scale the features.

- Such a generic detection scheme can be trained for detection of other types of objects (e.g. cars, hands)

IV. DISADVANTAGES OF VIOLA–JONES ALGORITHM

- Detector is most effective only on frontal images of faces

- It can hardly cope with 45° face rotation both around the vertical and horizontal axis.

- Sensitive to lighting conditions

- We might get multiple detections of the same face, due to overlapping sub-windows.

V. MATLAB IMPLEMENTATION

Viola-jones algorithm has been used for eye detection by selecting parameter as "Left EyeCart". Fig 3 shows the result of eye detection using Viola jones Algorithm.

After eye detection from video, the only eye portion has been cropped (containing pupil and sclera area) as shown in Fig 4. Figure 5 shows the only pupil and sclera cropped area.

Now, this image will be divided in to two parts. By calculation white pixel in any portion it can decided whether pupil of eye is at center, right or left position. If white pixels are less than 33% of total pixels then pupil has moved to 'Left' position and if white pixels are between 33% to 66% of total pixels then pupil has moved to'Center' position and if white pixels are more than 66% of total pixels then pupil has moved to 'Right' position .as shown in Fig.6

Figure 3.Eye detection

Figure 4. Cropped Image – Eye detection using Viola–Jones algorithm

Figure 5. Cropped Image – With Pupil and Sclera area only

Figure 6. Result of eye movement detection in console window

Now, this image will be divided in to two parts. By calculating number of white pixels in any portion we can decide whether eye is open or close. If eye is open then close and then open, we will consider as an eye blink.as shown in Fig 9.Fig.10 shows the cropped image of closed eye and Fig.11 shows the result of closed eye.
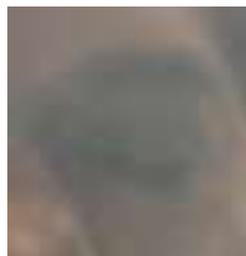

Figure 7. Cropped Image – Eye detection using Viola – Jones algorithm

Figure 8. Cropped Image – With Pupil and Sclera area only

Figure 9. Result of eye is detected as open and eye blinked

Figure 10. Cropped Image – Eye is closed

Figure 11. Result of eye is detected as close

VI. CONCLUSION AND FUTURE WORK

The eye detection algorithm has been developed in matlab using Viola Jones algorithm, which can detect the movement of eye, right and left, as well as blink of the eye.

The eye movement can be seen in a texted format using Hyper Terminal software in windows using serial port. In future device can be developed using this this algorithm where a patient sitting on the Wheel Chair assembly looking directly at the camera, is able to move in a direction just by looking in that direction. The camera signals are monitored by a MATLAB script using Viola-Jones algorithm, which will then guide the motors wired to the Microcontroller over the Serial Interface to move in a particular direction. The system is cost effective and thus can be used by patients spread over a large economy range.

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