Eye Gaze Detection Technique to Interact With Computer.

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Abstract — **In this world of technology everything is being computerized. But there are many people with several disabilities like handicapped people who are unable to take advantage of this technology. The system proposed an efficient approach to handle the computer. The built system software uses the webcam to control the cursor. As the webcam is easily available and most of the new system comes with built in webcams so it will be very beneficial and cost effective. This system is based on eye tracking, at first uses face detection and from that it extracts all image features. From extracted image features it uses pupil to control the cursor of mouse.**

Index Terms — *Face Capturing, Image Extraction, Harris Corner Detector, Contours, Cursor Controlling.*

I. INTRODUCTION

Computer is most common device which is used by individuals all over the world. It is the most intelligent machine available for the computational purpose and lots of input output devices are developed to interact with it (like mouse, keyboard, joystick, scanner, printer and many other).The main motivation behind designing every new system is to make interactions in more humanly fashion. Every new device can be seen as an attempt to make the computer more intelligent and making humans able to perform more complicated communication with the computer.

In the world of humans most of the communications are done by using vision and sound. So this interface will prove better than any other available systems. The most important factor using this system is that the user does not have to be physically in contact with contact with the system. And if we consider noisy environment it will prove better than that.

In this paper we are proposing feature based detection and image localization algorithms [1], [2], [3]. The advantage using this algorithm is that it performs faster but it requires high quality images. Rather we can use combined algorithms such as neural network, genetic algorithm [4], [5], [7] which makes the use of low quality images. Here we are considering steady state fixes system which will continuously detect head movements of the user and capture images of eye. The eye features are extracted in real time using the images captured .From extracted eye features eye gaze is detected to control the cursor. It can be divided into two forms viz. Head mounted [6], [8], [3] and steady state fixed. Both will have their advantages and disadvantage depending on the environment they are used.

Eye is made up of different types of muscles. So we need to consider the actual requirement of eye part which we have to trace to control the pointer, Pupil is the part of the eye from which light enter into the eye and iris muscle controls the contraction and expansion of the pupil. So our main focus will be on pupil i.e. to track the pupil in proper way to control the cursor.

The proposed system can be very effectively used in the gaming sector as a part of advance technology. It will eliminate the use of physical device like keyboards, joysticks and so. Providing the natural interface and making them more interactive. Also it can be used in schools and colleges for interactive learning.

II. BACKGROUND

A. Human Eye Structure

The eye is not shaped like a perfect sphere; rather it is fused two- piece unit. The smaller frontal unit, more curved called the Cornea is linked to the larger unit called SCLERA black centre, the pupil are seen instead of the cornea due to cornea's transparency.

The cornea segment is typically about 8 mm in radius. The sclerotic chamber constitutes the remaining 5/6, its radius is about 12 mm. The cornea and sclera are connected by a ring called limbus. The iris-the colour of the eye and its black centre the pupil are seen instead of cornea due to cornea's transparency.

The eye is made up of three coats, enclosing three transparent structures. The outermost layer, known as fibrous tunic, is composed of cornea and sclera. The middle layer, known as the vascular tunic or uveas, consists of the choroid, cilliary body, and iris. The innermost is the retina, which gets its circulation from the vessels of the choroid as well as the retina vessels which can be seen in an ophthalmoscope.

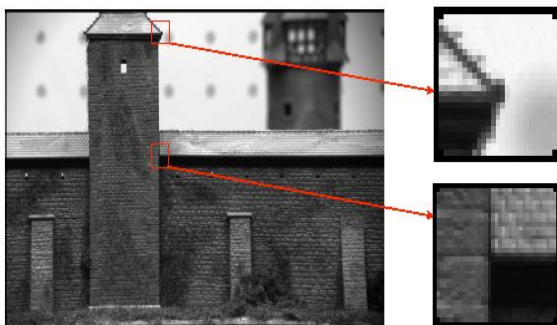### B. Corner Detection
1. What Are Corners?

Fig 1: Corners (Junction of Contours)
- Intuitively, junctions of contours.
- Generally more stable features over changes of viewpoint.
- Intuitively, large variations in the neighbourhood of the point in all direction.
- They are good features to match.

2. Corner Points: Basic Idea
- We should easily recognize the point by looking at intensity values within a small window
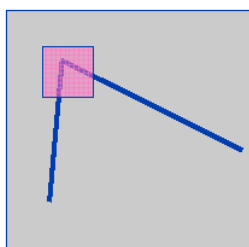- Shifting the window in any direction should yield a large change in appearance.

Fig 2: Detection of Corner Points.

3. Harris Corner Detector: Basic Idea
The most common idea of corner is defined by Harris [9]. The Harris corner detector [10] is based on local auto-correlation function of signal.
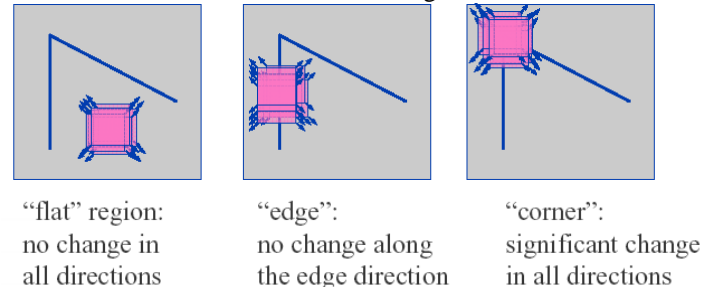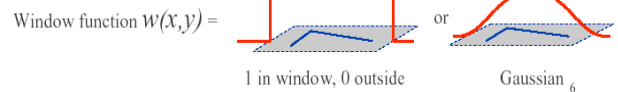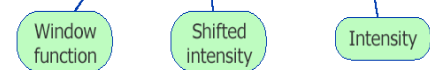

"flat" region: no change in all directions

"edge": no change along the edge direction

"corner": significant change in all directions

Fig 3: Mathematical approach for determining which case holds.

4. Harris Detector: Mathematics
Change of intensity for the shift $[u,v]$:

$$E(u,v) = \sum_{x,y} w(x,y)\left[I(x+u,y+v) - I(x,y)\right]^2$$

Window function

Shifted intensity

Intensity

Window function $w(x,y) = $

1 in window, 0 outside

Gaussian [6]

III. DEVELOP THE ALGORITHM TO DETECT IRIS POSITION AND CALCULATE EYE-GAZE DIRECTION

In this section, we describe the proposed algorithm for position's iris detection and eye-gaze estimation. A single web camera is used for eye movement detection. This web camera can continuously capture images of user's eye and find out the information of eye movement.

In this paper, matching between the iris boundary model and the limbus are performed as an approach to detect the eye movements. The part between dark iris of eye and the white sclera is called as Limbus.
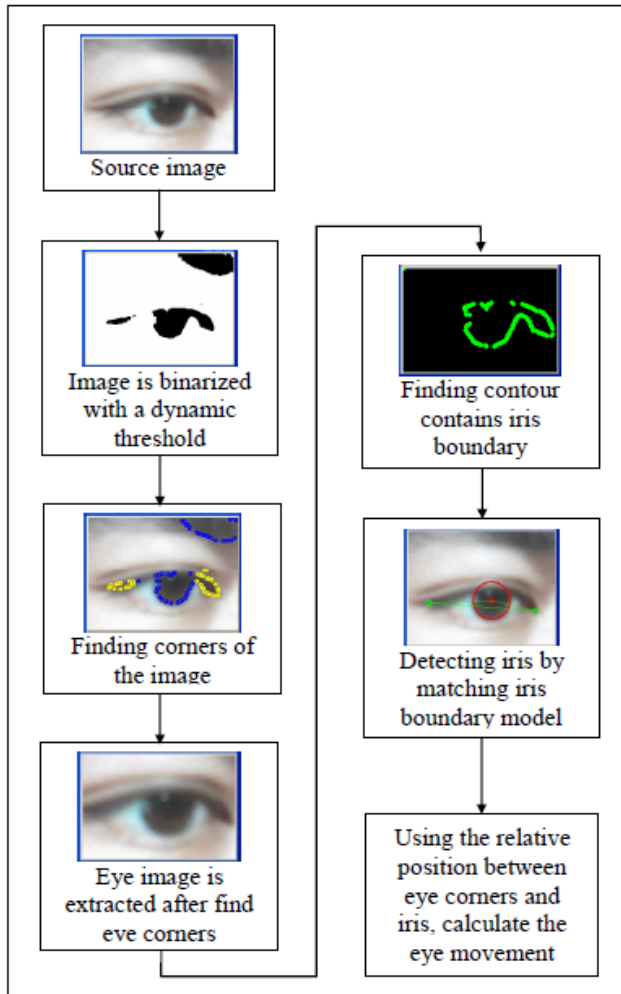
Fig 4: Structure of eye movement tracking algorithm

Above figure shows the flow chart of proposed algorithm:

- A dynamic threshold is used for binarized the source image.
- On the basis of two eye corners selected from corners of binary image, an eye image is extracted.
- The contour that contains iris boundary is selected after finding the contours of the eye image.
- To detect iris position, the contour obtained from previous step and the iris boundary model is matched.
- Calculate the eye movement using the relative position between iris and eye corners.

A. Thresholding the Source Image

The image which is captured from web camera is converted from RGB to Grayscale. After that, by

using Peak and Valley method a dynamic threshold is found. At last, the gray scale is threshed with this threshold.

Peak and Valley method is described as follows:

- Let the number of pixel which have gray level (g) is denoted as h(g).
- Now, two most prominent peaks of histogram's image are found with constrain: g is a peak if
- $h(g) > h(g \pm \Delta g)$, $\Delta g = 1, ... , k$
- Suppose g_1 and g_2 be two highest peak, with $g_1 < g_2$.
- Find g as the deepest valley between g_1 and g_2: g is the valley if
- $h(g) < h(g')$, $g, g' \in [g_1 , g_2]$
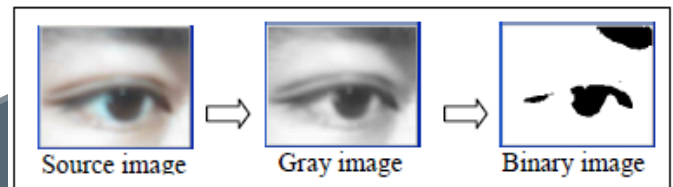- g is used as the threshold.

Fig 5: Process threshold image.

B. Detecting Position of Eye Corners.

First, Harris corner detector is used to extract the corners from binary image. Then, based on Geometric structure of eye, the corners that belong to the eye are selected. Then, detect the position of two corners of eye. At the end, we extract a part of binary image that is limited by two eye corners and the remaining parts are rejected. Finally, the image of eye is found.
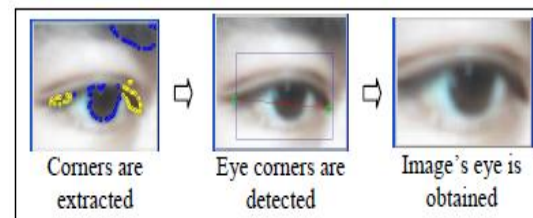

Fig 6: Detection of eye corner and extracting eye image.

C. Finding Contours

In this process, the contours that probably contain the iris boundary are found. For this, from the boundary of the binary eye image contours are detected. Based on the number of elements in this contours we choose one that have this number higher a certain amount. The contours which are found above contains iris's boundary which is extracted from original contours.
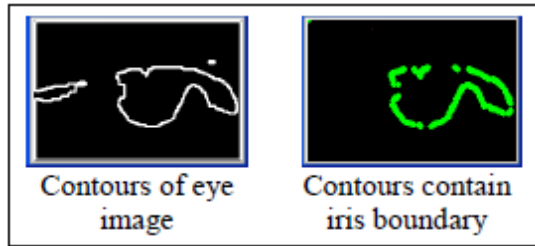
Fig 7: Results of finding contours.

D. Modelling Iris Boundary

We know that, the boundary of the iris is generally circular. While Haslwanter et al. was researching the robust method to find the eye movement and the iris boundary [4], they observed that the error in modelling the iris boundary as a circle is very small.

Therefore, three parameters are found after modelling the iris boundary as a circle which are, centre of iris (x_c, y_c) and radius $r_{min} < r < r_{max}$ which present the circle model.
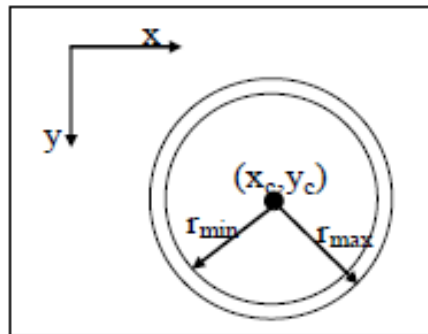

Fig 8: The iris boundary model

E. Matching Model

Position of iris centre is detected by matching between the iris boundary model and contours found in the previous section. Results of detecting iris position using model matching method are shown in Fig.
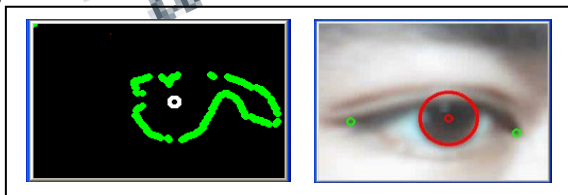

Fig 9: Results of iris position detection

F. Calculating the Eye-Gaze Direction

Three coordinates and their relationships are determined to compute eye-gaze direction.

These are listed as coordinates of:

• Image captured from web camera.

• Eye image based on positions of two eye corners.

• Monitor.

After detecting the position of iris centre, the position that the user is looking at monitor is calculated based on relationship of these coordinates.

1) Relationship between captured image and eye image coordinates

The central point of the line segment connects two eye corners is the origin of the eye image coordinate. Fig. depicts captured image and eye image coordinates and their relationship.
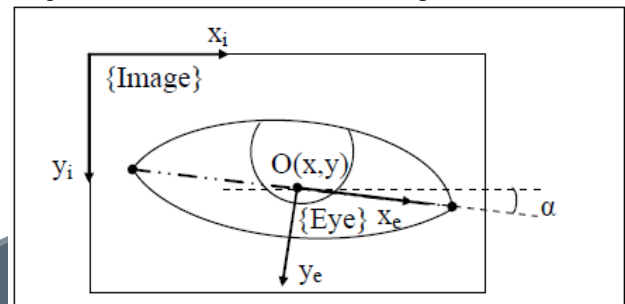

Fig 10: Captured image and eye image coordinates.

Relationship between the two coordinates is as follows,

$$\begin{cases} x_e = (x_i - O(x))\cos\alpha \\ y_e = (y_i - O(y))\cos\alpha \end{cases}$$

where $O(x, y)$ is origin of eye image coordinate.

2) Relationship between eye image and monitor coordinates

Horizontal axes of monitor and eye image coordinates are opposite to each other because captured images incidentally obtains horizontal movements which are opposite to actual movements of the eye.
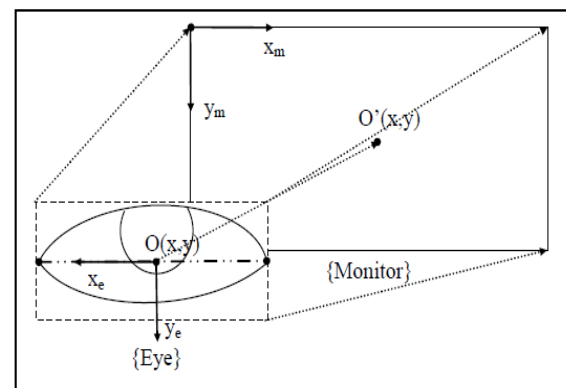

Fig 11: Eye image and monitor coordinates
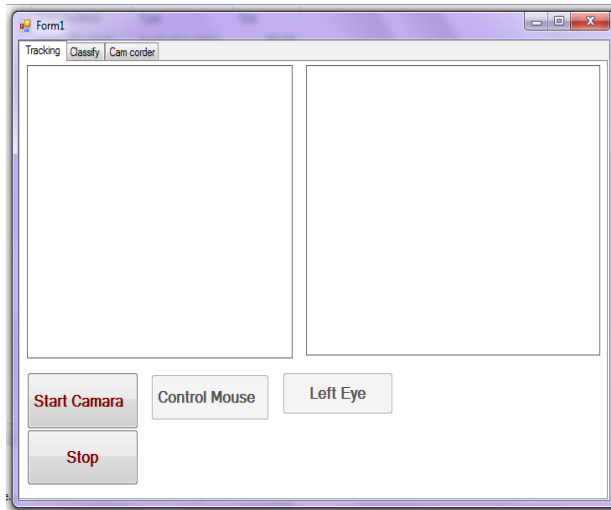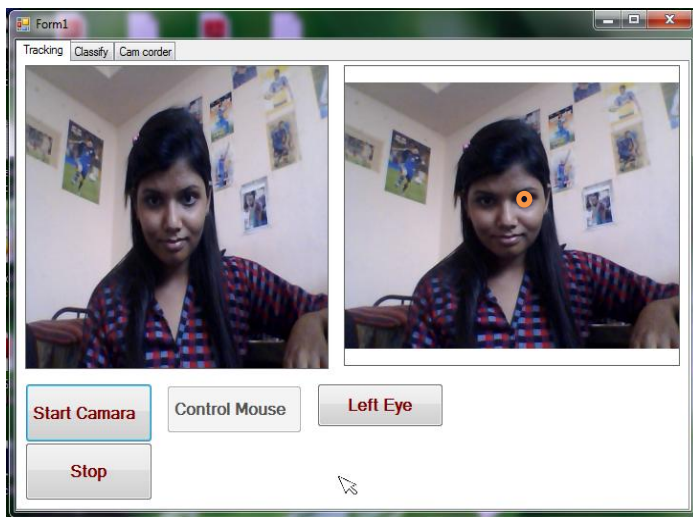
IV. EXPERIMENTAL RESULT

Fig 12: Main Form

Fig 13: Captured Image

V. CONCLUSION

In this paper, a real time eye-gaze detection system is presented. We proposed an eye-gaze detection algorithm using images captured by a single web camera. The user with several disabilities can use this system for handling computer. A real time eye motion detection technique is presented. We verified the system accuracy by performing the experiments. Although the proposed algorithm may look rather simple, but it is able to detect the eye gaze with high successful rate.

VI. FUTURE WORK

Our future work will mainly concentrate on improving the accuracy of the proposed eye-gaze detection algorithm, making the system quicker and robust, and considering other eye movements such as the user blinking. The proposed system will be verified by numerous experiments with different users.

VII. REFERENCES

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