The Development of Eye Controlled HCI System for Paralytic Person

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***Abstract*— The HCI system is designed for the person with absolutely no speech, no mobility.**
The method which is presented here is the HCI system based on an idea wherethe position of person's gaze is directly related to the relative position of the mouse pointer.System has been developed to provide computer access for people with severe disabilities.
The system tracks the computer user's eye movements with a video camera and translates them into movement of the mouse pointer on the screen. In the proposed system, tracking of the user's eye at particular position for certain period of time and then enable mouse click is introduced.The objective of the present chapter is threefold. First, we capture the real time image from video camera. Second, we execute various methods for image processing in which we convert image into grayscale and then we detect the edges and circle. Third, movement of Mouse Pointer on the GUI with respect to the eye movement as an input mechanism to drive system interaction.

Keywords – HCI, mouse pointer, computer access, mouse click, image, GUI

I.INTRODUCTION

Eye tracking is a technique where an individual's eye movements are tracked and calculated to know where a person is looking at any given time and the series in which their eyes are shifting from one position to another. Trackingthe movements of an eye can help the HCI researchers to be aware of thedisplay-based, visual and optical processing information and also help themidentify the interface of the system and factors that may have an impact on its usability. Activities of an eye can also be used to control signals thatpermitindividuals to communicate withthe graphical user interfaces without using mouse or keyboard. This canbenefit the people with disabilities. In order to present a practical guide about various measures of eye-movement, and the technique by which an individual can interact with GUI is a key component of this discussion.

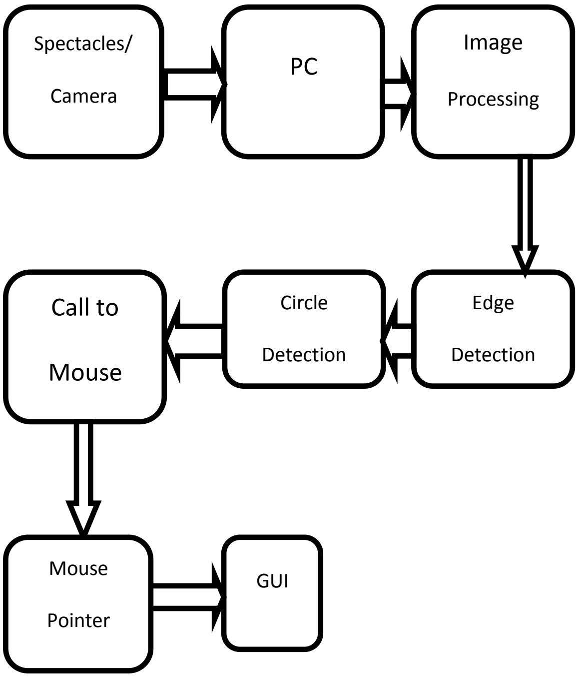

Fig1: *Overview of the main stages in the system*

II. SURVEY

A. EYE TRACKING

- *ELECTRONIC METHOD*

In the 1920's, it was discovered that by placing electrodes on the skin in the region of the eyes, one could record electrical activity which changed in synchrony with movements of the eye in the head. It was initially believed that these potentials reflected the action potentials in the muscles that are responsible for moving the eyes in the orbit.

In eye movements, a potential across the cornea and retina exists, and it is source of electro oculogram (EOG). EOG can be modelled by a dipole and these systems can be used in medical systems. It is now generally agreed that these electrical potentials are generated by the permanent potential difference which exists between the cornea and the ocular fundus (cornea-retinal potential, 10-30mV: the cornea being positive).

This potential difference sets up an electrical field in the tissues surrounding the eye. As the eye rotates, the field vector rotates correspondingly. Therefore, eye movements can be detected by placing electrodes on the skin in the area of the head around the eyes

- *VIDEO BASED METHOD USING BLINK DETECTION*

The algorithm used by the system for detecting and analysing blinks is initialized automatically, dependent only upon the inevitability of the involuntary blinking of the user. Motion analysis techniques are used in this stage, followed by online creation of a template of the open eye to be used for the subsequent tracking and template matching that is carried out at each frame. A flow chart depicting the main stages of the system is shown in Figure

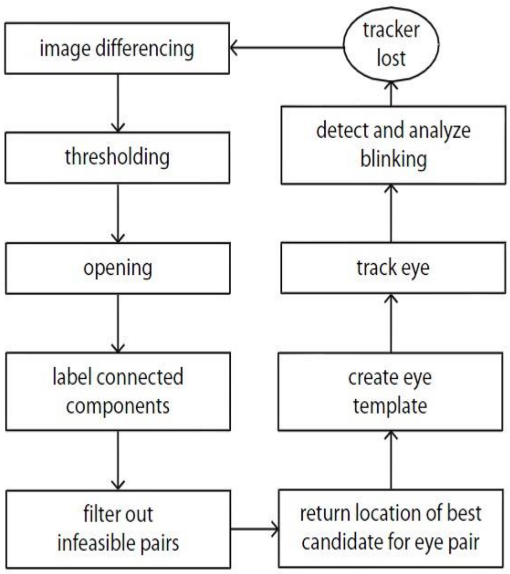

Fig 2: Flow chart of video based method using blink detection

- *VIDEO BASED EYE TRACKING*

Video-based eye tracking systems use a video camera to image the eye. Based on how this 'eye camera' is positioned, video-based eye tracking systems can be divided into two categories: head-mounted and remote. Head-mounted eye trackers typically include an additional camera to image the scene in which the subject is looking while remote trackers commonly operate in accordance with a computer monitor on which the subject is performing a task. Head-mounted video-based eye trackers have an optical module set on a headgear worn by the user. They are, to some extent, more intrusive than remote trackers but provide the observer with more freedom of motion. The recent rapid improvements in compact electrical and optical components have greatly reduced the size of head-mounted modules. On the other hand, remote video-based eye trackers have the eye camera mounted remotely on another base, which can be completely unobtrusive at the sacrifice of overall flexibility.

II. OUR PROPOSED METHOD

- Connect the camera to the laptop's USB port.
- Calibrate the eye positions with the GUI's button positions.
- Look in the direction of a button whose function is to be performed.
- Stare for a couple of seconds to click on that button.
- After the click, the function desired is performed.

In this system, the major and the most important part is the image processing. It is described in the following paragraphs.

III.IMAGE PROCESSING STEPS

A.RGB TO GRAYSCALE

In image identification it is frequently supposed that the technique used to translate RGB images to gray scale has modest impact on recognition performance. The original or the input eye image is first converted to Gray scale image to calculate its edges accurately. All image values are assumed to be between 0 and 1, i.e.functiong that take a $R^{n|m|3}$ RGB image and converts it to a $R^{n|m}$ representation i.e. gray scale. Let R, G, and B represent linear red, green, and blue channels. The output of each gray scale algorithm is between 0 and 1.

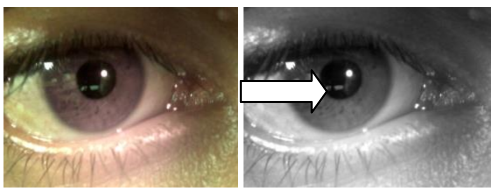

Fig 3(a): An input RGB image. Fig 3(b): Gray scale image

All transformations are applied component-wise, i.e., applied independently to each pixel.
Perhaps the simplest RGB-to-grayscale algorithm is Intensity.
It is the arithmetic mean of the RGB channels:

$$G_{INTENSITY} \leftarrow 1/3(R+G+B).$$

Although Intensity is calculated using linear channels

B. EDGE DETECTION

Detecting edge in any imageexactly means discoveringedge points of an image orverdict discontinuity in an image. The performance of other processing units gets better due to edge detection.A variety of methods have been adopted for boundaries detection e.g. theMarr-Hilderth edge detector, Local Threshold and Boolean Function Based edge detector, Canny Edge Detector etc. and among all, canny edge algorithm is the most popular one.

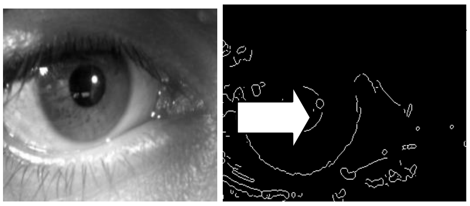

Fig 4(a): An input eye image.Fig 4(b): edge detection in Image using canny algorithm

Gaussian filter is the crux of this algorithm. The filter does blurs the input imageto a quantity specified by σ in order to diminish the outcome of an unnecessaryinformation.

Fig. 3(b) is the output of a 5X5 Gaussian filter with σ=1.4 and whose input is fig. 3 (a).

Fig 5(a): A test image

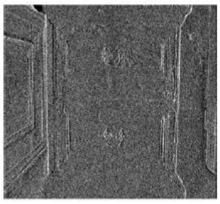

Fig5(b): Filtered Image

The Gaussian function is,

$$h(a,b) = \exp(-\pi(a2 + b2)/\sigma)$$

The parameter σ (sigma) determines the width of the filter and therefore the degree of blurring i.e. the greater the value of sigma the more the blurring is.

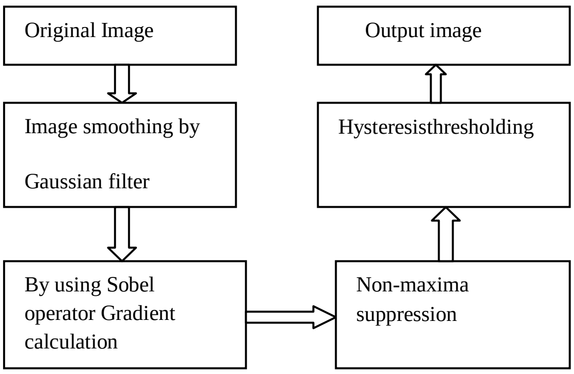

Fig 6: the main stages in the edge detection using canny algorithm

C.CIRCLE DETECTION

There are many algorithms for detecting circles in an input image.The HoughTransform (HT) is a criteriontechniquewhich is used foridentificationof different shapes in digital images. Initially it was used to detect straight lines in the image and soon extended to finding the circles, ellipses and arbitrarily fashioned items or shapes. The benefits consist of robustness to noise, robustness to shape distortion as well as to occlusions/missing parts of an object. The main drawback is - as the power of the dimensionality of the curve increases computationally so does the storage needs of the algorithm. The computational complexity and storage requirements are *O* (*n*3) for circles.

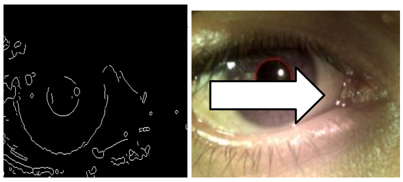

Fig7 (a): An input edge detected image Fig7 (b): circle detection in image using Hough transform

The resulting associated components are categorized after detecting the edge. Each linked component is expressed as a sequence of the coordinates of its points.

By using a sliding window we attach pairs of points, of the similar component. If the coordinates of the points are *P* (*xP*, *yP*) and *Q* (*xQ*, *yQ*), the equation of the line that perpendicularly bisect

$$Q = \frac{xP - xQ}{yP - yQ} + \frac{x^2P + y^2P - x^2Q - y^2Q}{2(yP - yQ)} \quad ....(1)$$

Highly chosen points give hint of the existence of digital circles.These are the centres of these circles.Since we are dealing with circles digitization,itaffects the points of theircircumference or parameter and, hence, donot exactly satisfy the standard circle equation:

$$r^2 = (x - x_0)^2 + (y - y_0)^2 \quad .... (2)$$

Where, (x_0,y_0) are the coordinates of the midpoint of the circle and$r$ is the radius of the circle.

The circle detection algorithm is run on the edge detected image but displayed in a window on the original camera image.

IV. CAMERA

Fig8:eye spectacle prototype

The normal LEDs attached to the camera were replaced by IR LEDs as the LED glowing so closely to the eye would irritate the patient.The camera is connected to the eye glass through copper wire and wire ties.The glasses are chosen as the position of the camera would remain stable and so it would be helpful for error free processing.

V. MOUSE API

An application programming interface (API) is a source code-based specification intended to be used as an interface by software components to communicate with each other. An API may include specifications for routines, data structures, object classes, and variables. An API specification can take many forms, including an International Standard such as POSIX or vendor documentation such as the Microsoft Windows API, or the libraries of a programming language, e.g. Standard Template Library in C++ or Java API.

An API differs from an application binary interface (ABI) in that the former is source code based while the latter is a binary interface. For instance POSIX is an API, while the Linux Standard Base is an ABI.

An API can be:

- Language-dependent, meaning it is only available by using the syntax and elements of a particular language, which makes the API more convenient to use.
- Language-independent, written so that it can be called from several programming languages.

Thus, the scope of meaning is usually determined by the context of usage.

1.) Setcursorpos ( )

This is used to set the position of the mouse cursor as desired

2.) wm_lbuttoncdclk

This is used to pass left click event to the OS

3.) wm_lbuttondown

This signifies that the left mouse button is pressed

4.) wm_lbuttonup

This signifies that the left mouse button has been released

VI. GUI

In computing, a graphical user interface (GUI, commonly pronounced gooey) is a type of user interface that allows users to interact with electronic devices with images rather than text commands. GUIs can be used in computers, hand-held devices such as MP3 players, portable media players or gaming devices, household appliances and office equipment. A GUI represents the information and actions available to a user through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation. The actions are usually performed through direct manipulation of the graphical elements.

The term GUI is restricted to the scope of two-dimensional display screens with display resolutions able to describe generic information, in the tradition of the computer science research at the PARC (Palo Alto Research Center).

A GUI may be designed for the requirements of a vertical market as application-specific graphical user interfaces. Examples of application-specific GUIs are:

- Automated teller machines (ATM)
- Point-Of-Sale touch screens at restaurants
- Self-service checkouts used in a retail store
- Airline self-ticketing and check-in
- Information kiosks in a public space, like a train station or a museum
- Monitors or control screens in an embedded industrial application which employ a real time operating system (RTOS).

VII. RESULTS

A. Patient with camera device

The camera is mounted on a square glass frame with the help of some wires and small metal support. A small PCB with IR LEDs is placed on the face of the camera in order to capture the eye image in dark or improper ambience light.

Fig 9: Patient wearing the camera device

B. Image processing output

First the RGB image of the eye is captured by the camera. The pink shade in the image is due to the IR LEDs. The IR LEDs make the image more clear and bright which in turn is very helpful for the image processing steps.

Fig10(a): original camera image with infrared LEDs

As we do not need the colour information of the image, we convert the RGB image to grayscale with the RGB to grayscale algorithm.

Fig10(b): gray scale image

In order toedges the circle i.e. the pupil of the eye, we pass the grayscale image through the edge detection algorithm. We have used canny's algorithm for detecting the edges.

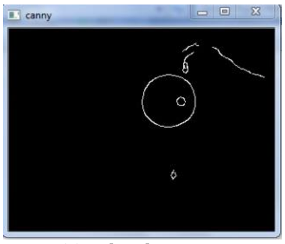

Fig10(c): edge detection image

The edge detected image is finally passed through a circle detection algorithm to detect the eye pupil. We have used hough transform for detecting the circle.

Fig10(d): circle detected image

C. eye positions

After detecting the eye pupil, we captured its various positions like up,down,left,right and centre.These positions were then in turn used to move the mouse accordingly.

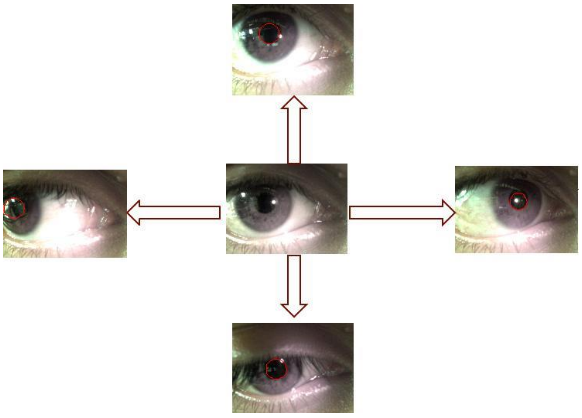

Fig11: eye positions – up, right, down, left and at rest

D. Graphical User Interface

The buttons on the GUI were fan,light,help please and off. These were placed exactly with respect to the different positions of the eye captured.

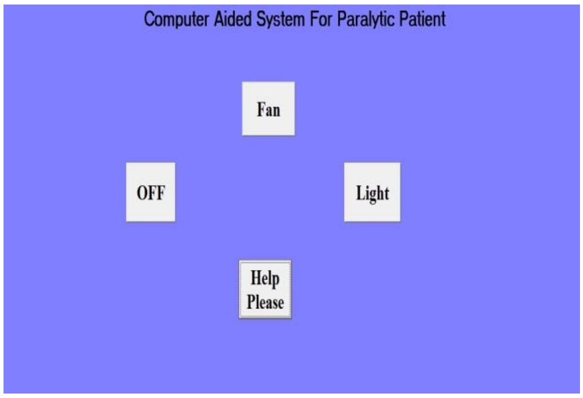

Fig 12: GUI with buttons positioned similar to the different eye positions captured

VIII.CONCLUSION

The System provides a dependable software solution for paralytic people and people with motor disabilities, through easy eye tracker hardware, which

ultimatelyallows the person with severe disabilitiesto manage functionalities of thecomputer.
It is concluded that using a web camera as a human computer interface can be viable input method for the severely disabled person.

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