Hands-free Cursor Control

Yashaswita Bhoir, R. Mathangi, Neha Malusare, Bhagyashree S, Ms. Prachi Goel
Dept. of Information Technology
Fr.C.R.I.T, Vashi
Navi Mumbai, India
bhoir.yashaswita@gmail.com, mathangi101@gmail.com

***Abstract*—With recent increase of computer power and decrease of camera cost, embedded camera has become very common. With this it seems logical for the field of human computer interaction with camera usage, to increase. But it is not so. The reason for this lies in the inability to track human faces both precisely and robustly. This paper describes a face tracking technique based on tracking iris of the eye which resolves this problem. The goal is to simplify use of mouse for disabled persons, provide an alternative mouse cursor positioning system for laptops, make games more immersive and improve the existing HCI convenience for common users.**

Keywords—Human computer interface, perceptual user interfaces, computer vision, face tracking, feature detection, image processing.

I. INTRODUCTION

With technologies evolving rapidly, and usage of computers increasing exponentially, there has been a major effort to develop new tools that allow an advanced human-computer interaction. Many have ventured into the field of perceptual interfaces (ability to sense and produce analogues of the human senses), with the hope of providing a better interface for interaction of humans with computers. Use of web camera for this interaction is one such approach.

A. Human Computer Interaction

HCI can be seen as a human and a processor trying to effectively communicate with each other. The advances in this field are to make the process faster, user friendly and interactive. There are many on-going researches in this field, especially with respect to the use of human facial features for computer interaction. An increasing number of researchers are concentrating on the topic of computer vision, a field with a lot of commercial applications. The dependency on hands diminishes.

B. Human Eye

As a conscious sense organ, the eye allows vision. Rod and cone cells in the retina allow conscious light perception and vision including color differentiation and the perception of depth [1]. A person's eye position gives us an indication of where he/she is looking. The fovea, located near the center of the retina, is densely covered with receptors, and provides much higher acuity vision than the surrounding areas. The fovea covers approximately one degree field of view, that is, a one-degree angle with its vertex at the eye, extending outward into space. Though the density of foveal receptors is not uniform, it is sufficiently high over its approximately one degree area that one can obtain a clear view of an object anywhere in that area It follows, inconveniently for eye tracking purposes, that it is not possible to tell where within that approximately one-degree circle the person is looking. Thus, no matter how accurately an eye tracker can measure the eyeball position, we can infer the user's attention only to within the one-degree width of the fovea. The eye does not generally move smoothly over the visual field. Instead, it makes a series of sudden jumps, called saccades, along with other specialized movements[2], yet another hurdle in making an accurate eye tracker[3].

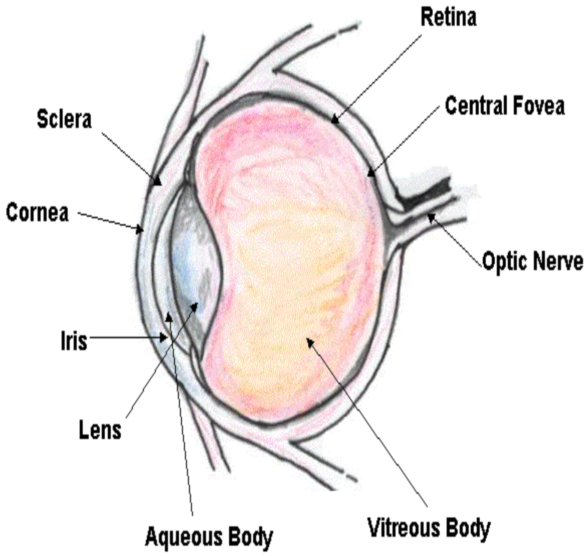

Figure 1 Human Eye

II. PREVIOUS WORK

This application is certainly not the first of its kind. The previous applications can be classified based on what they recognize and utilize for cursor movement. One technique used colored papers stuck on the face for face position recognition and appropriate movement. The Perceptual Window: Head Motion as a new Input Stream[4] presents a method through its research with correlation matching as its tracking technique. Here the head is defined as a frame of reference. The system memorizes the image at initialization and then correlates with the new image and moves the cursor accordingly. This system can act as a complement to the mouse rather than a replacement.

In another system, patterns are learnt from study examples and based on this knowledge appropriate movement of the cursor takes place. In real time tracking, template matching is done to make appropriate movement. In Hands-free navigation in VR environments by tracking the head [5], system is initialized when the detected face image matches the reference face image stored. This method uses the position of the face, determined by warping the reference face image to minimize intensity difference between the warped reference face image and the current face image. The warping matrix transformation is then decomposed to yield the face translation and orientation. Subsequently, the view point of the 3-D virtual environment changes accordingly.

The facial features are utilized as per the developers' convenience, camera capability and user's ease of use. Single blinking cannot be considered as a mode of command as it will make the user conscious of when to blink. Commonly used method is to pause on the specified object for a fixed time to enable the click.

Figure 2 EagleEyes [6]

Research of this type involves retrospective analysis of a subject's eye movements; the eye movements have no effect during the experiment itself. Our interest, in contrast, is in using eye movements to effect the user-computer dialogue in real time. There is a much smaller body of research and practice for this situation, much of it concentrated on helping disabled users, such as quadriplegics, who can move their eyes much more effectively than they could operate any other computer input device [7].

One of the least expensive and simplest eye tracking technologies is recording from skin electrodes, like those used for making ECG or EEG measurements(as seen in the figure above). Because the retina is so electrically active compared to the rest of the eyeball, there is a measurable potential difference between it and the cornea. Electrodes are placed on the skin around the eye socket, and can measure changes in the orientation of this potential difference.

The most accurate, but least user-friendly technology uses a physical attachment to the front of the eye. A non-slipping contact lens is ground to fit precisely over the corneal bulge, and then slight suction is applied (mechanically or chemically) to hold the lens in place[3].

Still in the research phase and far from complete is the eye tracker as an input device. Using high resolution cameras, and infrared light the pupil or the eye ball in general is tracked to make appropriate movements. The designs in the experiment stage make the user head stationary making them rest it on chin rest and detect the eye ball motion.

III. THE TECHNOLOGY

The idea is capable of making use of computer with eye movement, possible. Because eye movements are so different from conventional computer inputs, our overall approach in designing interaction techniques is, wherever possible, to obtain information from a user's natural eye movements while viewing the screen, rather than requiring the user to make specific trained eye movements to actuate the system.

A. Proposition

Our algorithm is aimed at building an effective mouse control using the relative movement of iris and our head. We use 2 algorithms, one to detect the movement of iris, second to find the movement of the head. This is presented in the three scenarios below.

B. Working

The web camera starts to capture the images in the RGB format and then for the purpose of image processing it is converted into a grayscale image. Later the histogram of the image is equalized. After this processing, the face is detected, then the eyes are detected and then the iris is detected. Based on this, we can see three scenarios that can be dealt with.

Scenario 1: Head motion is alone used. Iris detection is skipped. This reduces lag and improves accuracy. Thereby, appropriate head movement is converted into equivalent cursor displacement. For a suitable feature for use, a horizontal line connecting both the eyes is used. The central point of this line is used as the point to be tracked, as shown in the figure below, which is then converted into approximate mouse movement.

Figure 3: Human eye, Scenario 1

Scenario 2: The head is kept stationary and iris motion is detected. As shown in the picture below, two lines are drawn from either ends of the eye to the centre of the iris, as shown in the figure below. The angle of the line drawn is used to calculate the vertical displacement of the iris. Then the change in length of the line gives the net displacement which can be used to find the horizontal displacement. Then, these values together can be used for appropriate cursor movement.

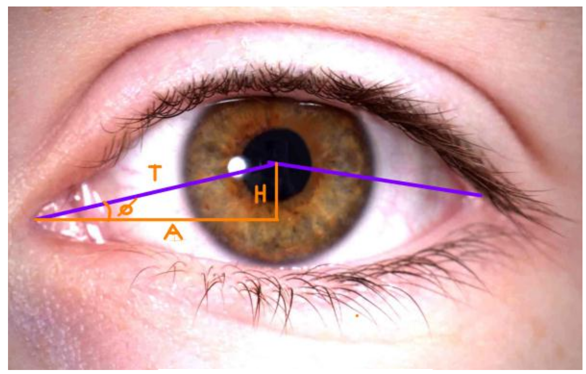

Figure 4 Human Eye, Scenario2

$$A = \cos ø * T$$
$$H = \sin ø * T$$

Scenario 3: Here both, the movement of the head and the eyes is used for cursor movement, i.e. the relative displacement is used. E.g. If the head moves to the right and eye line value shows that it moves to the left then relative subtracted value is used. This relative movement is difficult to realize but is an intuitive approach.

Calculations are done using one of the shown scenarios which is then converted to corresponding mouse position.

C. Associated problem

The system does not have a feedback option. No matter how robust, it can lose the user. This is a very common problem with perceptual user interfaces[8].

Solution: There can be many ways to improve accuracy and go round this problem. One such way can be to plot a bounding box to the tracker generated

mouse, when its coordinates leave the screen, it can again be initialized from the start.
The image stream captured and shown on the GUI can be of great help to detect if there is a mistracking problem or not.

IV. APPLICATIONS

Hands free control of tracker makes it suitable for a wide range of applications. It can be used as a Game controller, as it can prove to be an highly immersive means. The system can be easily used as an additional degree of freedom in 3D world. The virtual keyboard present completely removes the dependency on a physical keyboard, acting as an additional feature.
It acts as a simplified interface through which handicapped people can easily use the computer.
As explained earlier is improves the existing HCI convenience for common users.

V. CONCLUSION

Systems can be built based on this proposition with web camera commonly available. It provides an unique and immersive way of using eyes as a means for human computer interaction. The next step would be in the direction of 3D world and the use of this idea there. Though this is still in the research phase, it can be seen as an intuitive way of mouse control especially for the disabled.

REFERENCES

[1] Human eye, Wikipedia http://en.wikipedia.com/Human_eye
[2] R.N. Haber and M. Hershenson, The Psychology of Visual Perception, Holt, Rinehart and Winston, New York (1973).
[3] Eye Tracking in Advanced Interface Design, Robert J.K. Jacob, Human-Computer Interaction Lab, Naval Research Laboratory, Washington, D.C.
[4] The Perceptual Window: Head Motion as a new Input Stream François Bérard CLIPS-IMAG BP 53 38041 Grenoble Cedex 9 FRANCE, seventh IFIP conference on Human-Computer Interaction (INTERACT), p. 238-244, 1999.
[5] Hands-free navigation in VR environments by tracking the head, Sing Bing Kang, March 1997
[6] Eagle Eyes, http://www.bc.edu/schools/csom/eagleeyes
[7] T.E. Hutchinson, K.P. White, W.N. Martin, K.C. Reichert, and L.A. Frey, ''Human-Computer Interaction Using Eye-Gaze Input,'' IEEE Transactions on Systems, Man, and Cybernetics 19(6) pp. 1527-1534 (1989).
[8] Nouse 'Use Your Nose as a Mouse' – a New Technology for Hands-free Games and Interfaces.
D.O.Gorodnichy, S. Malik, G.Roth, www.cv.iit.nrc.ca/research/Nouse