Controlling Mouse through Eyes

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Controlling Mouse through Eyes

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Abstract- User-computer dialogues are typically one-sided, with the benefits from computer to user far greater than that from user to computer. The movement of a user's eyes can provide a convenient, natural, and high-bandwidth source of additional user input, to help redress this one-sidedness. We, therefore investigate the introduction of eye movements as a computer input medium. Our emphasis is on the study of interaction techniques that incorporate eye movements into the user-computer dialogue. In this paper, an advanced approach to man machine interaction is proposed, in which computer vision techniques are used for interpreting user actions.

Index Terms –Computer vision, Image Processing, Artificial Intelligence.

I. MOTIVATION

Eye tracking is now entering in a more mature phase. Various projects regarding eye tracking are now available. Amongst all, a project was carried out at the University of Stanford regarding the analysis of an internet user's behavior while reading news or surfing the internet. A headgear was used that tracked the motion of the user's eye. The object was to point out the exact location on screen where the user looks at the first instance, as shown in Figure 1.1 [1].

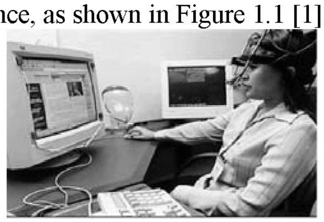

Fig 1.1 - Tracking the motion

The success factor of an eye tracking system depends on Image processing because how well the processing has been performed is its success rate. Another reason that motivates us is that, handicapped persons can use computers and perform their tasks as normal persons can do so.

II. INTRODUCTION

The problem of human-computer interaction can be viewed as two powerful information processors (human and computer) attempting to communicate with each other via a narrow-bandwidth, highly constrained interface. Current technology has been stronger in the computer-to-user direction than user-to-computer. Using eye movements as a user-to-computer communication medium can help redress this imbalance [2-3]. A user interface based on eye movement inputs has the potential for faster and more effortless interaction than current interfaces, because people can move their eyes extremely rapidly and with little mindful effort [4].

A. Background

From the last decade it was thought that there was a mechanism through which disable persons can easily interact with the computer. It was commonly said that: "Some systems are sold to people who just wish to use a computer without their hands" [5].

More disabled people have already gained access to information through computers with these devices. The systems are too expensive and awkward to have a significant impact on society today. If these systems do become less expensive and are integrated within our everyday environment, we need to keep in mind ethical issues such as privacy if the devices can be used to track user patterns and collect data [6].

B. System Context

Eye tracking is a technology in which a camera or imaging system visually tracks some feature of the eye and a computer then determines where the user is looking through the use of cameras. Eye tracking in Human Computer Interaction [7] is now moving into a more mature phase. Different image analysis algorithms are used to analyze the image captured through cameras [8].

Eye Tracking gives an accurate measure of where one's visual attention is directed Enhances or backs-up observations May reveal patterns which may become proof of effective or ineffective usability Can lead to many potentially useful applications [9-10].

C. Goals and objectives

For designing any particular thing, the first and the most important question is that what is its importance and what are the needs to build it. So the basic goals and objectives are as follows:

1. *Goals*
   - Hands - free computing
   - Facilitating the handicapped in using the computer
   - Controlling the mouse pointer through eye movement
   - Eye based human computer interaction provides real time eye tracking and eye-gaze estimation
2. *Objectives*
   - Easy interaction with computer without using mouse
   - Facilitating the subject to use the computer through

the movement of their eyes

- Limitation of stationary head is eliminated.
- Pointer of the mouse will move on screen where the user will be looking & the clicks will be performed by blinking.

III. SUB SYSTEM DESCRIPTION

Eye tracking in Human Computer Interaction is now moving into a more mature phase. Studies have established its potential both as a means of measuring usability and for controlling aspects of the human computer interface.

In this section, the detail description about each subsystem is described. This information is essential because the user / reader can't understand the working of whole system without knowing the structure and description about the processes and things that are in consideration. This process is divided into three subsystems i.e. Image processing, Image capturing and Desktop co-ordinate calculation & output. The description about each subsystem is as follows:

A. Image capturing

Before the capturing of videos starts, the user has to fulfill some requirements for the proper movement of mouse. These requirements are stated as follows:

- User sits straight at the time of start
- Adjust the goggle
- Adjust the cameras properly on the
- Adjust the proper lighting conditions

Left eye camera, right eye camera and desktop camera respectively receive the input from the left eye, right eye and head position. These captured streaming videos are broken into frames. After that we have to break these streams into frames approximately 20-30 frames per second.

B. Image processing

After receiving inputs from their respective cameras we have to determine the position of left and right eye (i.e. iris detection). This task can be briefly described as follows:

- Input to this module is the captured video frames.
- These frames are representing eyes of a human.
- Color frames are converted into Black'n'White, shown in Figure 3.1.
- Than edges of eye balls are detected, as illustrated in Figures 3.2(a) and 3.2(b) respectively.
- Iris co-ordinate can be calculated from it.

Fig 3.1 - Converted image in Black'n'white

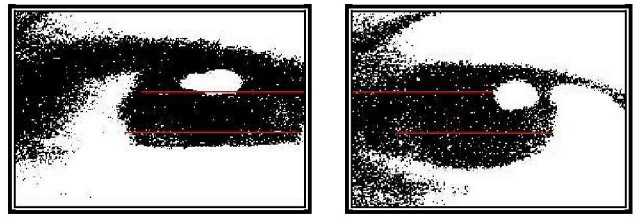

Fig 3.2(a, b) - Edge detected images of eye

C. Desktop co-ordinate calculation & output

Frames from desktop camera, position of the head can be determined. This task can be accomplished by placing two white dots on the goggle, as shown in Figure 3.3. Desktop camera will track these dots and tells us their corresponding position i.e. head's position

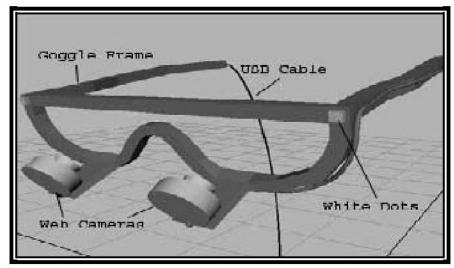

Fig 3.3 - Design of a Goggle

Two consecutive frames from each source are used to determine any movement in left and right eyes and head relative to the previous frame, as shown in Figures 3.4(a) and 3.4(b) respectively. If variation is found, the difference is calculated and subtracted. This task can be easily understood with the help of following steps which are as follows:

- A co-ordinate is obtained by calculating the mid point of iris.
- Another point is obtained from head's position.
- Mean co-ordinate is than obtained.
- Head's position is subtracted from the mean point of iris, if there is any head movement.

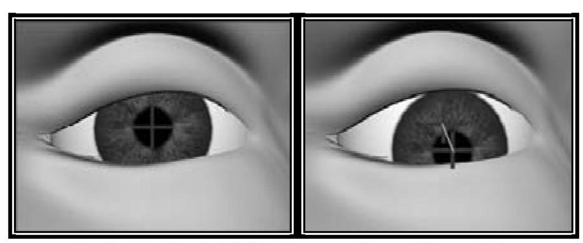

Fig 3.4 (a, b) - Initial & New position of Cross Hair

The difference is then use to determine the screen coordinates. Mean of two screen coordinates one from each eye camera is then taken by the mouse pointer to position it self on the screen. Movement of mouse takes place from one place to another. User can perform clicking on desired item (i.e. icon) by blinking their left eye for some specified time, as exposed in Figure 3.5.

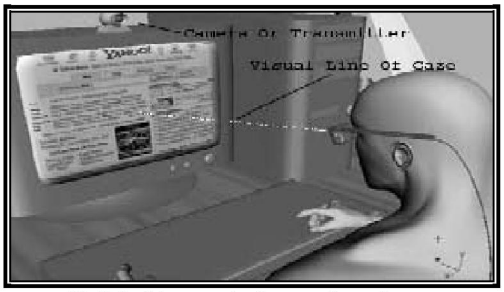

Fig 3.5 - Movement of mouse through eyes

IV. PROPOSED ALGORITHM

In view of the knowledge provided in previous sections, a complete procedure is presented that moves the mouse from one place to another on desktop through user's eyes movement. Before the processing for the movement of mouse begins, user has to fulfill some of the basic requirements for it (i.e. adjusts their position, goggle and cameras properly). The detailed processing is presented below and shown in Figure 4.1

1. Left eye camera, right eye camera and head positioning camera respectively receive the input from the left eye, right eye and head position.
2. After receiving these streaming videos from their respective cameras, it will break into frames.
3. The frame rate may vary from camera to camera. But in this case the typical frame rate for low-resolution web-cameras is 15-20 frames per second.
4. After receiving frames of desired rate it will check for lighting conditions because cameras require sufficient lights from external sources otherwise error message will display on the screen.
5. The captured frames that are already in RGB mode are converted into Black'n'White.
6. Images (frames) from each of the input source focusing the eye are analyzed for Iris detection (center of eye).
7. Frames from desktop camera are read for determining the position of the head.
8. The required detections can be obtained by analyzing the Black'n'White picture of human eye.
9. After this, a mid point is calculated by taking the mean of left and right eye centre point.
10. Another point is obtained against the head movement.
11. Again, the mean of these new points are calculated and recorded.
12. If the head position is moved from their original position, then the head position is subtracted from the mean point of iris of both the eyes.
13. Based on the new co-ordinate obtained, finally the mouse will move from one position to another on the screen and user will perform clicking by blinking their left eye for 5 seconds.

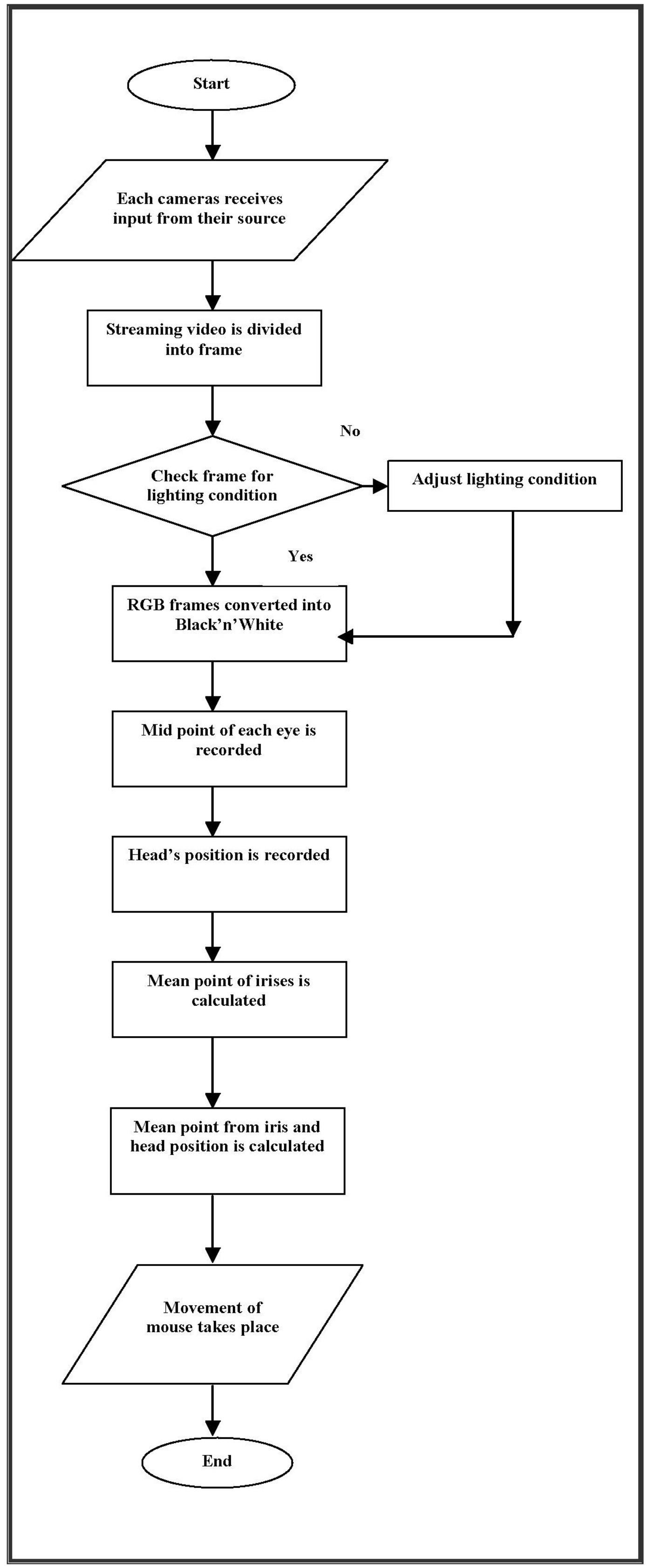

Fig 4.1 - Flow of Processing

V. SIMULATION RESULTS

We have started this experiment by making a small prototype of eye tracking system. This prototype is essential at the beginning time. The concept remains the same afterwards but in addition to it the relative head's position is detected and subtract for accurate movement of eyes.

Some performance issues are also in consideration while making the prototype. These issues are important because it gives us ideas about scaling for mapping the co-ordinate, comparing the speed of mouse pointer movement when used manually as compare to by using eyes. Some main performance issues are as follows:

A. Scaling

Approximately 3 pixels are moved when there is a single co-ordinate movement in eyeball.

B. Speed

Movement of mouse pointer is approximately 1 – 1.25 times slow by using movement of eyeball.

This prototype is tested for checking and verifying the accuracy of moving mouse pointer on desktop (screen) by moving the eyes of human respectively. Approximately on people of all ages whether a normal person or a disabled person, this prototype have been tested. The results are shown in the following Figure 5.1 and 5.2.

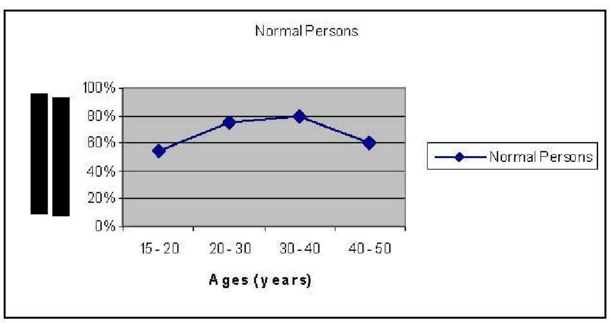

Figure 5.1 - Results obtained from normal persons

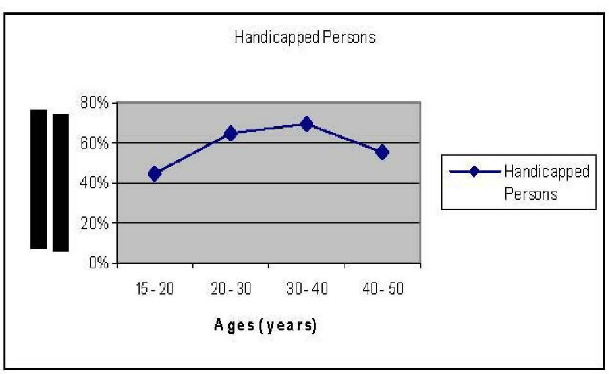

Figure 5.2 - Results obtained from handicapped persons

In the broader perspective, we have divided the human (people) into two categories. One is a normal person and the second category belonged to disabled persons (i.e. persons that didn't have hands). People are taken randomly from all walks of life. If we narrow down the classification more, than we have divided these categories into four major age groups. These are as follows:

- 15 - 20 years
- 20 - 30 years
- 30 - 40 years
- 40 - 50 years

We have started gathering results after giving a brief introduction to all the users of this project. These results are gathered by observing human's interaction with computer and how easily they have moved mouse and perform desired clicks by blinking their eye. From results, it is clear that approximately all the age groups provide satisfactory results because this is a research project. Due to this reason, people have faced some difficulties at the time of starting and moving the mouse pointer but gradually they all are easy with its usage. People from 20-40 years have provided much better results as compare to other age groups because they have more mental sharpness than others.

VI. FUTURE RESEARCH

Though the eye-gaze tracking techniques available today are far more sophisticated than 20 years ago, they are still far from perfect. Users are still fighting severe problems concerning head-movement over-sensitive trackers and equipment that loses its calibration far too soon. It's hard to make predictions especially about the future. And this is no less true for eye-gaze media. In this section I will try, however, to make some of these predictions to give a taste of what the future could look like. I do not believe that eye-gaze media will be the big panacea of the next decade, but we do think that many applications will be multimodal and support eye-gaze control in the future.

A. Future Work

The most important problems for future development are listed below:

- The equipment of eye-tracking must be much less sensitive to user movement. Users might put up within a `field of view' of an angle of, say, ±45°
- The eye-tracking equipment must not continually entail user-attended re-calibration.
- The eye-tracking equipment must be able to path more than a few persons in chorus.
- The eye-tracking equipment should be able to recognize the track persons, most likely by iris model identification.
- In what degree does mindful tracking act together with the way people act while surveillance IES media?
- Could new types of physiological troubles be introduced when operational while being eye-gaze tracked at extended time?

VII. CONCLUSION

Today, the human eye-gaze can be documented by relatively inconspicuous techniques. Care must be taken, though, that eye-gaze tracking data is used in a rational way, since the nature of human eye-movements is a amalgamation of several unpaid, instinctive processes.

The main reason for eye-gaze based user interfaces being good-looking is that the direction of the eye-gaze can state the interests of the user-it is a potential aperture into the current cognitive processes-and message through the direction of the eyes is faster than any other mode of human communiqué. It is argued that eye-gaze tracking data is best used in multimodal boundary where the user interacts with the data in its place of the interface, in so-called non-command user interfaces. Furthermore, five usability criteria for eye-gaze media are given.

Our research concentrated on interaction techniques that can naturally and conveniently incorporate eye movements into a user-computer dialogue, rather than on the underlying eye tracker technology itself. Finally, we can view eye movement-based interaction as an instance of an emerging new style of user-computer interaction.

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