

# Cursor Movement Using Eyeball Motion

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**ABSTRACT:** Scientists are aiming to develop a non-intrusive man-machine-interface with vision systems which has led to the emergence of the field of automatic face recognition and extraction of required features for various applications which involves human computer interface. Human computer interface would be very helpful for aiding the disabled as well as for rehabilitation. This project helps the disabled, use the computer with ease. It aims to replace the most common hardware needed for operating a computer - The mouse. An image acquisition and processing framework is designed to track the human eye for mouse control. Eye tracking can be followed by obtaining the image of the eye. The glint in the eye acts as the Region of Interest and can be located in the real time acquisition of the eye. The human face and its features are extracted from a video stream. The coordinates of the glint is extracted, which is the input to the cursor to change the position in response to the movement of the eye. This depicts how efficiently the software can replace the actual hardware and help the disabled work with the computer just as normal people. A computationally efficient and cost effective application for controlling the mouse cursor using the eye by real time tracking is developed

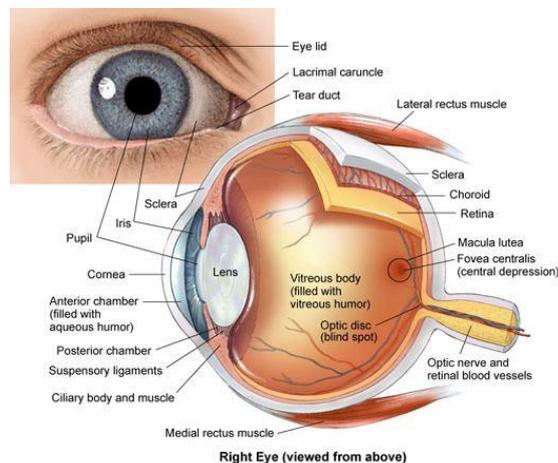
## I. INTRODUCTION

### THE HUMAN EYE

The human eye is an organ that reacts to light and has several purposes. The eye is a slightly asymmetrical globe, about an inch in diameter.

The front part of the eye includes:

- The iris (the pigmented part) the cornea (a clear dome over the iris).
- The pupil (the black circular opening in the iris that lets light in).
- The sclera (the white part).
- The conjunctiva (a thin layer of tissue covering the front of the eye, except the cornea).



The human eye (fig 1.1) can be compared to a camera which gathers, focuses, and transmits light through a lens to create an image of the environment. In a camera, the image is created on film; in the eye, the image is created on the retina, a thin layer of light sensitive cells at the back of the eye. The lens of the eye bends, or refracts, light that enters the eye. The

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cornea, which is a clear, transparent covering in the front portion of the eye also contributes to focusing light on the retina. Nerve fibers extending back from the retina's nerve cells come together behind the retina to form the optic nerve, a "cable" of nerve fibers connecting the eye with the brain. The optic nerve transmits messages about what we see from the eye to the brain. Like a camera, the human eye controls the amount of light that enters the eye through the lens under various lighting conditions. Just behind the iris and pupil lies the lens, which helps to focus light on the back of the eye. Most of the eye is filled with a clear gel called the vitreous. Light projects through the pupil and the lens to the back of the eye. The inside lining of the eye is covered by special light-sensing cells that are collectively called the retina. The retina converts light into electrical impulses. Behind the eye, the optic nerve carries these impulses to the brain. The macula is a small extra-sensitive area within the retina that gives central vision. It is located in the center of the retina and contains the fovea, a small depression or pit at the center of the macula that gives the clearest vision. Eye color is created by the amount and type of pigment in the iris. Multiple genes inherited from each parent determine a person's eye color. The approximate field of view of an individual human eye is  $95^\circ$  away from the nose,  $75^\circ$  downward,  $60^\circ$  toward the nose, and  $60^\circ$  upward, allowing humans to have an almost 180-degree forward-facing horizontal field of view. With eyeball rotation of about  $90^\circ$ , horizontal field of view is as high as  $270^\circ$ . About  $12-15^\circ$  temporal and  $1.5^\circ$  below the horizontal is the optic nerve or blind spot which is roughly  $7.5^\circ$  high and  $5.5^\circ$  wide.

## EYE MOVEMENT

Eye movement refers to the voluntary or involuntary movement of the eyes, helping in acquiring, fixating and tracking visual stimuli. Humans use three types of voluntary eye movement to track objects of interest: smooth pursuit, vergence shifts and saccades [4]. These movements appear to be initiated by a small cortical region in the brain's frontal lobe.

## EXTRA OCULAR MUSCLES AND SMOOTH PURSUIT MOVEMENT

Each eye has six muscles that control its movements: the lateral rectus, the medial rectus, the inferior rectus, the superior rectus, the inferior oblique, and the superior oblique [1]. When the muscles exert different tensions, a torque is exerted on the globe that causes it to turn, in almost pure rotation, with only about one millimeter of translation. Thus, the eye can be considered as undergoing rotations about a single point in the center of the eye [5].

The eyes can also follow a moving object around. Following an object moving at constant speed is relatively easy, though the eyes will often make saccadic jerks to keep up. The smooth pursuit movement can move the eye at up to  $100^\circ/\text{s}$  in adult humans [2-3].

## SACCADES AND MICRO SACCADES

Saccades are quick, simultaneous movements of both eyes in the same direction controlled by the frontal lobe of the brain. Some irregular drifts, movements, smaller than a saccade and larger than a micro saccade, subtend up to six minutes of arc.

Even when looking intently at a single spot, the eyes drift around. This ensures that individual photosensitive cells are continually stimulated in different degrees. Without changing input, these cells would otherwise stop generating output. Micro saccades move the eye no more than a total of  $0.2^\circ$  in adult humans [8].

## VESTIBULO-OCULAR AND OPTOKINETIC REFLEX

The vestibulo-ocular reflex is a reflex eye movement that stabilizes images on the retina during head movement by producing an eye movement in the direction opposite to head movement, thus preserving the image on the center of the visual field. For example, when the head moves to the right, the eyes move to the left, and vice versa.

The optokinetic reflex is a combination of a saccade and smooth pursuit movement. When, for example, looking out of the window at a moving train, the eyes can focus on a 'moving' train for a short moment, until the train moves out of the field of vision. At this point, the optokinetic reflex kicks in, and moves the eye back to the point where it first saw the train.

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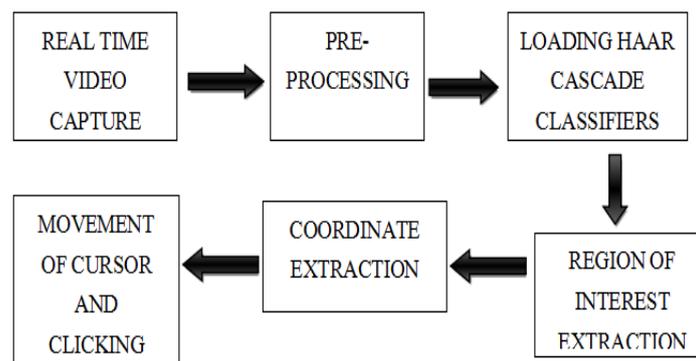
## PUPILLARY LIGHT REFLEX

The pupillary light reflex is a reflex that controls the diameter of the pupil, in response to the intensity of light that falls on the retina of the eye, thereby assisting in adaptation to various levels of lightness/darkness [6]. A greater intensity of light causes the pupil to constrict (miosis/myosis), whereas a lower intensity of light causes the pupil to dilate (mydriasis, expansion). Thus, the pupillary light reflex regulates the intensity of light entering the eye. The image produced by any lens is blurry around the edges (spherical aberration). It can be minimized by screening out peripheral light rays and looking only at the better-focused center. In the eye, the pupil constricts while the eye is focused on nearby objects. In this way the pupil has a dual purpose: to adjust the eye to variations in brightness and to reduce spherical aberration [7].

## HUMAN COMPUTER INTERFACE

A human-computer interface (HCI) as shown in fig1.2, is often called a mind-machine interface (MMI), or direct neural interface (DNI), synthetic telepathy interface (STI) or a brain-machine interface (BMI), is a direct communication pathway between the brain and an external device. HCIs are often directed at assisting, augmenting, or repairing human cognitive or sensory-motor functions [9]. HCIs focusing on motor neuroprosthetics aim to either restore movement in individuals with paralysis or provide devices to assist them, such as interfaces with computers or robot arms. There have been experiments in humans using non-invasive neuroimaging technologies as interfaces. Signals recorded in this way have been used to power muscle implants and restore partial movement in an experimental volunteer. Although they are easy to wear, non-invasive implants produce poor signal resolution because the skull dampens signals, dispersing and blurring the electromagnetic waves created by the neurons [10-11]. Although the waves can still be detected it is more difficult to determine the area of the brain that created them or the actions of individual neurons. Electroencephalography (EEG) is the most studied potential non-invasive interface, mainly due to its fine temporal resolution, ease of use, portability and low set-up cost. The technology is highly susceptibility to noise however [12]. Another substantial barrier to using EEG as a brain-computer interface is the extensive training required before users can work the technology. For example, In Germany trained severely paralyzed people to self-regulate the slow cortical potentials in their EEG to such an extent that these signals could be used as a binary signal to control a computer cursor.

## II. BLOCK DIAGRAM



## WORK FLOW

The working flow of the project is as follows:

- The subject is made to sit in front of the PC. Initial adjustments are made. The program is made to run and the image is acquired .
- The image is converted into Grey scale (U8).
- Each frame is converted to array and size of the image is extracted.
- The size and array data of the image is fed to the dll via the library call function node VI.
- The direct link library provides the detected size of the face and the eyes from the acquired real time video.

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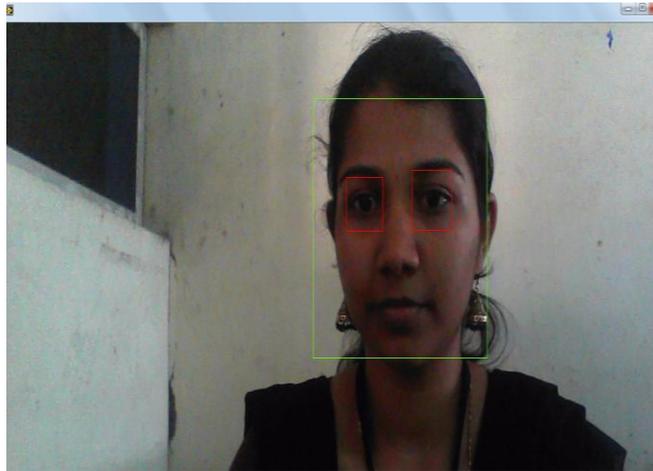
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- The size of the face and eyes are used to create an array, and the array is given to the get\_results function of the dll.
- The get\_results function provides the coordinates of the detected ROI.
- The obtained coordinates are used in mathscript to increment or decrement the coordinate position of the mouse.
- The coordinates is given as input to the user32.dll setcursorpos function using call library function node VI.
- According to the given coordinate value the cursor moves to the exact coordinate position [13].
- The left click is performed when the one of the eye is detected and other eye is closed. Similarly the right click is performed both the eyes are closed
- It is performed by checking the number of eye detected and the corresponding hexadecimal value is pushed to the mouse event function of user32.dll [14].

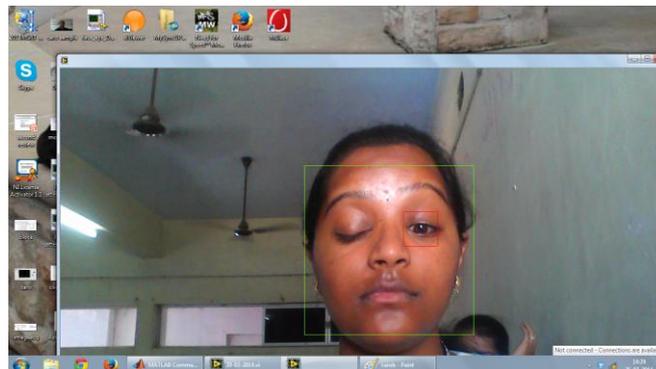
### III. RESULTS AND DISCUSSIONS

The feature extraction is performed over an histogram equalized image. The facial features such as the face and the eyes were extracted as shown in fig 4.9.



**Fig 4.9 Detection of Eyes**

- The number of eyes detected were calculated and the coordinates were found for the region specified . The cursor on the screen was moved according to that position .
- Left click is performed when only one eye is detected as shown in fig 4.10



**Fig 4.10 Left Click**

